

Chapter 1

Human Interaction and Human Factors

nInteractionandHumanFactors

sec:the41

1.1 Introduction

The core goal of ARTS (Autonomic Road Transport Support Systems) is to provide the framework and support the development and application of autonomic road traffic system elements with management based on high-level objectives. These autonomic applications shall exhibit self-* properties such as self-organization, self-adaptation, self managing and self-maintenance for realising the robustness and functionality needed for fulfilling the high-level objectives. For an ARTS system as described in the previous sections, human factors will play a role in different forms:

- Human users who delegate the problem solution to the ARTS system by communicating the high-level objectives that they want to be fulfilled. For example, the user may be a driver who wants to go to a particular location in an autonomous car, guided by an adaptive routing system, or advised that going later may be more advantageous due to the current traffic conditions. Alternatively, the user may be a traffic system operator who shall determine a particular level of service in terms of minimum flow or sets a localised goal to limit acceptable emissions near a hospital.
- Humans who do not directly use and interact with the autonomic system by setting its goal, but form the context of the system and thus indirectly influence its function. Humans may be or may control entities which are monitored and guided by personalised information; for achieving the intended effects, the ARTS system needs to anticipate the effects of its measures. Thus, the potential behavioural response to measures and information given by ARTS is relevant not only for evaluating such systems, but also for its construction as to achieve particular self-* properties this behavioural response needs to be taken into consideration.

Starting from these two perspectives on human interaction with an ARTS system, the analysis of human factors in ARTS turns out to be a wide and heterogeneous area of research. For the first point of view, ergonomic factors are the focus, whereas the

second one focuses on social factors. This also determines the basic structure of the following part of the roadmap.

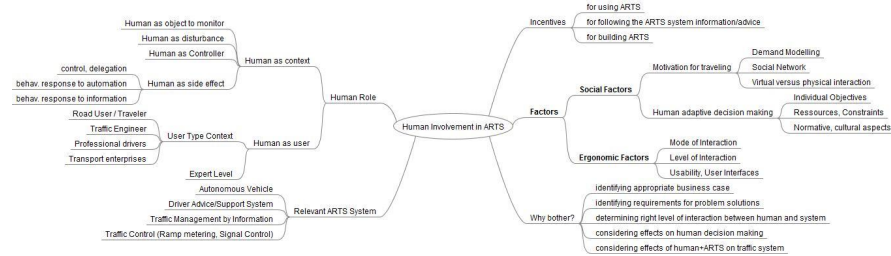


fig:4.1

Fig. 1.1: Overview of human involvement in ARTS.

1.2 Objectives

Individuals objectives key factors

This section details the key factors in understanding travel drawn from the state of the art descriptions of current thinking on why and how people travel. It is possible to conclude that an all-encompassing explanation of travel behaviour needs to move from a singular disciplinary approach and identify the key or significant factors in the range of perspectives. In summarising the findings of the different perspectives it is important to first acknowledge that it would be difficult to simply combine them. Each perspective has its own set of underlying assumptions and internal logic providing good internal validity. In combining perspectives one would need to have agreement of both ontological and epistemological focus. It is clear that this is not the case and that combining and comparing the perspectives would have to be done with a great deal of sensitivity to the reasoning and nuances. The first difference is that each perspective has a different focus, so the phenomenon under investigation is not always the same, although we have purposefully chosen those perspectives that take people as the primary focus. In summary we can see that within each of the perspectives there is some overlap.

It is possible to conclude that there has been a focus on the individual and on finding explanations of individuals' travel behaviour and it is possible to conclude that an ARTS system approach differs from the orthodox in that it has a focus on the individual and a focus on the individual interaction within a social network and on social networks. The focus of both the economics and social psychology approaches is the individual. The focus of the social science is the individual in interaction with other groupings and most fruitfully the interaction with the household. Time geography is complementary to both the social and the econometric ap-

proaches given that “[m]any travel behaviour studies focus on actual travel choices and decision making, time geography concentrates on the possibilities to enact certain behaviours“ [NSW10]. The time-space prisms are used as ways to appreciate the constraints and the patterns of opportunities available for any household and the individual members of the household.

There are a great variety of methods in use in all the perspectives and each has merit, yet the most similar methodological approaches are those of the quantification and enumeration of social and economic attitudes. However, in recent years the innovation has been in contextualising the empirical research and geographic representations have shown to add explanatory power. In the next section we have adopted a pragmatic approach and identified across the perspectives, the factors that are common and have the potential to work with an incentive.

These differences in focus provide an indication of the way forward. Future work on incentives in ARTS can take into consideration the factors most prominent within each of the perspectives to develop more efficacious incentive packages. Incentives can be ‘tailored’ around different groupings of people based on criteria identified in the perspectives, such as modal needs or social categories e.g., age, or life stage.

In this section the perspectives are analysed to produce a set of key factors present in the perspectives and significant for the development of an ARTS system and the incentives. The key factors are identified as those that are common in all perspectives or ones that can be combined across perspectives or ones that are at the foundations of the perspectives. It should be noted that this includes those factors relevant to both individual and to households. This includes the following.

1.2.1 Time

sec:Time

Time emerges as a key factor in any understanding of travel motivations regardless of approach. Along with space it is one of the basic resources of everyday life and there are many beliefs and cultural values, attitudes and narratives surrounding the use of time, for example within European culture beliefs about how time should be spent include concepts and values such as, ‘being efficient’ or ‘not wasting time’ and narratives around the quality of life and how time is spent such as the ‘slow living’ social movement. Time use studies, such as those using the Harmonised European Time Use Study (European Commission, 2007) persistently find patterns in time use showing variation according to socio-demographic characteristics, for example women are repeatedly shown to perform more household maintenance tasks than men and in households with children women have a higher probability of being more ‘time-poor’ compared to men. Within the study of an individual’s travel objectives time has been conceptualised in a number of ways, e.g. Travel time, Waiting time, In-vehicle time; Transfer time; Scheduling delay and time taken to meet a probability of a service being early or late; Reliability; Time in congestion; Delay time; Travel time activities whilst travelling or waiting; Time poor and time-rich. It

is important to note overlap between this category and the other which is household resource.

1.2.2 Scheduling

sec:Scheduling

This factor refers to the time taken and the effort required to plan and coordinate. Scheduling can be a very complex activity requiring planning, information searching and coordinating over a multitude of resources, across households, over time and over many individuals and over institutions and services such as public transport fixed route timetables and appointment times at hospital or meetings. So individuals are engaged in three processes according to Church et al [CFS00]. These are processes of "time-space organization in households, the interaction between household members and other individuals, (e.g. friends and relatives) and the manner in which time-space budgets influence the ability to travel and travel choices". Secondly the nature of the transport provision and space and thirdly the "time-space organization of the activities that people are seeking to access". It is also clear that in the economics perspective there is the idea of optimisation; that is of the individual maximising their travelling activities. In the social science perspective it is argued that households coordinate across their activities but this is recognised as a negotiation that is dynamic and changing. It is also recognised that the negotiation is to satisfy a range of varied factors which are not maximised as such, and can change in the future. It is not necessarily a process of scheduling optimisation or a maximisation of efficiency. One other key difference is the emphasis that the economics perspective places on the individual whereas other perspectives focus on the social grouping.

1.2.3 Household resources and costs

c4Householdresourcesandcosts

A household has a range of resources available. These can be thought of as a range of 'stocks' or capitals (see for example Ellis, 2000, on Livelihoods framework) and can be thought of as more than the orthodox financial capital. So can be thought to include access to natural capital (e.g., good quality air, water); political capital (e.g., voting, participation); social capital (e.g., relations with others, exchange of favours, time, information); financial capital (car availability, bike ownership, wages, savings, public transport discount card); physical capital (parking privileges, other infrastructure provision) and human capital (education). Households are engaged in maintenance and improvement of position and that includes resources through improvement to capital or saving of costs. We know that travel is relatively price inelastic but there is no empirical work that reveals and aids understanding about how travel practices and behaviour respond if other forms of 'capital' are taken into consideration and manipulated. It is worth noting that a household can take many

forms. It can include an orthodox one house and two parents and children, but it can mean any number of adults and children over more than one house and obviously it can also include a single person living in shared accommodation or alone. The implication of this is that individuals may be optimizing and budgeting over a number of households in a range of locations and across a time trajectory. This enables households to 'make sacrifices' in the present for the accrued benefit or a perceived advantageous change in opportunity structures in the future.

1.2.4 Social networks

sec:Socialnetworks

Social network refers to the relationships that a person has with others. A household or individual can have a very large social network, this could result in parts of the network not knowing each other. The relationships that a person or household has can be very significant and important in influencing life-course and lifestyle. Social networks constitute resources, such as skills and friendship, they also constitute a set of normative beliefs and practices and they provide opportunity structures to engage in social processes of participation, community and belonging. Put simply, social networks are a significant aspect of an individual's and household's accessibilities and engagement in everyday life. Social networks and friendships are of significant importance to understanding why and how people travel.

1.2.5 Identities and culture

sec:Identitiesandculture

Travel can impact on identity in a number of ways. First and straightforwardly it provides the accessibilities to participate and join in with others and secondly we can have identities which are associated with our consumption and use of travel. Our cultural roles can have a significant impact on our travel. There is a body of work that details how cultural roles around gender, race and ethnic group can impact on travel [SG04]. These can vary according to country and culture but in the UK and other northern EU countries women's cultural roles as parents generally result in different level of 'time-poverty'.

1.2.6 Normative beliefs and expectations

ormativebeliefsandexpectations

A factor present in a range of perspectives encompasses beliefs about appropriate behaviour as well as our belief about ability to change behaviour. This includes perception of travel performance relative to peers- how others see me or what they believe about my travel practices. The social norms of a culture can impact on beliefs about status, about car use, about health, about environmental impact,

about contribution to a better society. This can be illustrated by understanding the sense of entitlement different social groupings or categories can have about occupying certain space or using transport system. For example many women feel insecure about using the transport system at night when it is dark and studies in the UK [hana] [dft] [Hod11]; and in Finland [kos]; and the USA [dun] [wes] show it to be a widespread phenomenon. The normative beliefs and expectations are a dynamic set of beliefs that have the potential to change and evolve all of the time.

1.2.7 *Pleasure*

sec:chap4Pleasure

An understanding of the pleasure of travelling has been neglected and overlooked in orthodox transport studies that emphasise the disutility of travel. The inclusion of pleasure in more recent understandings of why and how people travel represents an attempt to develop a better understanding of the intransigence around car use and more accurate predictive models. Understanding of the pleasure associated with travel is still in its infancy [Mok01a]. Pleasure can be thought of as simply the physiological sensation experienced when travelling but it can also be related to the normative beliefs about their travel particularly related to the status and it can also be related to physical act of being able to travel as well as the accomplishment of attaining the goal at the end of the journey.

1.3 Behavioural response

sec:Behaviouralresponse

This section brings the appreciation of the individual's travel objectives and matches these to the incentives with the potential to change behaviour. Each of the key objectives described in 4.3 and known to be underlying an individual's travel behaviour is matched to those incentives that have the potential to impact significantly on that objective. This section takes each specific objective factor and then details the incentives that are compatible with that underlying motivation to an individual's travel.

1.3.1 *Time*

sec:sec451

Time features both as a cost and as a resource in understanding travel. In an ARTS system it would be most productive to think of incentives based around:

- saving time, for example routing based on real-time information, parking availability, public transport trip or journey optimisation;
- changing the productivity of time spent travelling, travel time as active and not 'dead-time'; this can cover a range of different elements, e.g., change mode to be

physically active (not reduction of time but change the way time is spent); work while travelling; or valuing time for opportunity to be alone;

- offering more control over how time is spent, - for example, reduce time spent in congestion or waiting;
- offering more control over how time is planned, for example more information to coordinate between different services, or transport provision;

1.3.2 Household resources and costs

ec:Householdresourcesandcosts

A household has a range of resources available and travelling generates a range of costs, short, mid, long term, fixed and variable. Car travel is relatively price inelastic. In designing incentives it is useful to think of ways to save money although the distinction between saving and generating income can be blurred. In an ARTS system it would be most productive to think of incentives based around:

- ways to save money, for example information on car parking tailored to reduce transaction and parking search costs; car parking space or other capacity (HOV) privileges; information on public transport fares; information on discount fares, cheapest fuel and travel times; information on discount fares and group travel; information on relative mode costs and time; Community of practice to group fare; information leading to a reduction of time spent in congestion (destination/route/departure time/mode eg HOV) or not travelling; information and/or community of practice car sharing, or ride sharing; free training e.g., cycling; 'loan to buy' cycle schemes;
- ways to generate money through adoption of certain behaviours, for example, loyalty cards, cash-back or vouchers for using a particular service; free recharging of small technologies using cycling action.

1.3.3 Normative beliefs and expectations

ormativebeliefsandexpectations

In both the social psychology and social science perspectives the importance of normative beliefs and expectations is identified and in the economics perspective they are being increasingly included into econometric models. It is clear that the beliefs people hold about appropriate behaviour for themselves and each other have a significant impact in determining behaviour [?]. Creation of peer groups around behavioural change objectives may provide a cultural milieu that promotes behavioural change particularly modal shift and car use reduction. One of the implementations can be the use of individualised charts of success in achieving desired behaviour. This is commonly used in the promotion of healthy behaviour, but research in diet and healthy eating tells us that attrition rates will intensify once an individual feels they are not making progress or not making progress fast enough. Participation will reduce if an individual's performance becomes a source of shame to them or to oth-

ers that are significant to them. Research in the promotion of healthy eating and smoking cessation has found that reinforcement comes from peer group positive affirmation. Other initiatives that could be considered include support networks, which offer advice; information; practical help and whose interaction promotes a set of social norms that encourage behavioural change. In a social network the knowledge that others are doing what you would like to do becomes a source of support and a 'normalizing' process. This would develop existing initiatives on information to change travel practices, such as Personalised Travel Planning and Mobility Coaching, from being a relationship between the local authority and the individual, to a peer group relationship. An ARTS system would have the opportunity to 'guide' and advise a peer group to ensure that it acts as a community of practice rather than a 'talking shop' or involves a lot of 'social loafing'.

For an ARTS system incentives based around offering tailored information and charts of success and peer group affirmation. It would be most productive to think of incentives based around:

- recognition of progress and success based on criteria offered by an ARTS system e.g., health, in interaction with the individuals themselves coupled with;
- self generated communities of practice based on key interests or objectives, e.g., desire to reduce car use in favour of walking or cycling, with ethos of supporting each other or attracting each other to particular routes; for example Mumsnet; coupled with
- information on provision for alternative travel practices to driving, for example, cycle networks, cycle locks, maps for pedestrians, making steps attractive, police presence, presence of other people, public transport user privileges;

Social beliefs around ability to change and control over situation offer potential to understand how change can be made easier or more difficult to achieve. In social psychology perspective the perceived behavioural control sets of beliefs are often found to be very influential in determining car use behavioural change, particularly reduction of car use. This variable is related to the beliefs the individual has about their ability to perform the behaviour they would like to adopt. It is always a significant factor in empirical research on the reduction of individuals car use, and is usually least well understood in transport research. For much research it is assumed that travel behavioural change is solely under the control of the individual. It is quite plausible that the social science perspective can shed some light on the 'perceived behavioural control' variable. This is because the focus in the social science perspective is on the need to plan, coordinate and schedule across household members, across different households, across transport provision, across services, and different types of resource to improve and reproduce lifestyle and household. Taking into account the need for household scheduling and also the need to coordinate over a social network in the 'perceived behavioural control' factor then explanatory power may be increased.

In an ARTS system it would be most productive to think of incentives based around:

- ways to swap information with others, for example, linking communication technologies such as SMS and online calendars;

- information real-time around service provision, facility opening hours, movement of significant others;

Very similar in fact to the previous suggestion "ways to offer individuals the chance to be more in control of how they plan their time, for example more information to coordinate between different services, or transport provision;"

1.3.4 Pleasure

sec:Pleasure

Influential research on pleasure [Mok01b] used a large scale questionnaire survey to ask about reasons for travel and revealed that people do experience pleasure when travelling and that this can be a motive for some types of journeys. This can be an important input into the design of incentives. The provision of information and social networks and communities of practice that promote and endorse a view of pleasure in travel can be a significant influence on travelling behaviour. Analysis of current popular culture shows positive promotion and endorsement of the pleasure to be gained from car travel, for example Top Gear programmes and associated merchandise (UK). The implication for an ARTS system is to provide incentives that promote the pleasure and enjoyment from modes other than cars and changing the perceptions individuals have of different modes and different kinds of travel. Previous sections have made a start on identifying the pleasurable aspects of journeys; however, it can be very specific to the journey and to the individual. In an ARTS system a productive start could be to begin by asking users to identify what they find pleasurable or make a note when they are enjoying their travel and then use that information to build individualised advice for future travel change, thus building on those journeys or those elements of journeys that we know have been pleasurable in the recent past.

In an ARTS system it would be most productive to think of incentives based around:

- information and promotion of non-car modes emphasising pleasurable aspects derived from individual or generic, e.g., physiological feeling of walking, jogging, cycling, Tranquility of bike ride; experiencing nature

1.3.5 Identity and culture

sec:Identityandculture

Issues of identity are very culturally and historically specific. In an ARTS system it would be most productive to think of incentives based around:

- enjoying 'slow living' and not being a member of the 'rat-race' member but able to downsize. Probably most relevant to particular social categories e.g., deprived without children and least deprived with young families.
- Population segmentation according to attitude to car use including dissatisfied car owners and users, in UK expect to have a category of frustrated cyclists

- Other aspects of identity and cultural roles- being a good mother or father, being a good friend, being a good neighbour, being a good employee, gendered roles.
- Status. Culturally specific and patterns and perception of ownership and consumption of goods but also behaviour- shopping local, growing own food, cycling, walking. This would lead one becoming healthier and fitter with adoption of the mentioned technique.
- Being green

1.3.6 Summary

sec:Summary

In an ARTS system it would be most productive to think of incentives based around:

- saving time,
- changing the productivity of time
- offering more control over how time is spent
- offering more control over how time is planned
- saving money
- generating money
- recognition of progress and success
- self generated communities of practice
- information
- ways to swap information with others
- information real-time
- information and promotion of non-car modes emphasising pleasurable aspects derived from individual or generic, e.g., physiological feeling of walking, jogging, cycling, Tranquillity of bike ride; experiencing nature
- Messages around: enjoying 'slow living' and not being a member of the 'rat-race' member but able to downsize. Probably most relevant to particular social categories e.g., deprived without children and least deprived with young families.
- Population segmentation according to attitude to car use including dissatisfied car owners and users, in UK expect to have a category of frustrated cyclists
- Other aspects of identity and cultural roles- being a good mother or father, being a good friend, being a good neighbour, being a good employee, gendered roles.
- Status. Culturally specific and patterns and perception of ownership and consumption of goods but also behaviour- shopping local, growing own food, cycling, walking.
- Messages around: Being green
- Information on being healthy and fit

One of the innovations of such an ARTS system over most other systems is that it is able to offer combinations of incentives. It is this combination coupled with the ability to offer accumulation of incentives which makes the ARTS system advantageous over previous implementations and other contemporaneous systems. However, very

little is known about the operationalization aspects of incentives and the impacts of the manner of offers incentives on individual's acceptance and adoption.

1.3.7 State of the Art and Current Research Directions: Interaction Perspective

sec:InteractionPerspective

The implication of issues such as increasing traffic complexity, the broad availability of Intelligent Transport Solutions and current advance in vehicle and communication technology on transport complexity from a driver perspective is that future travellers will find themselves in an environment with significantly more traffic than is currently the case. Additionally, on the basis of current and emerging ITS solutions, from day to day a driver may not know which roads would be available for use, nor which speeds to travel at, nor which lanes to use. On the basis of current and emerging vehicle technology, drivers will encounter reduced lateral and longitudinal separation between vehicles while maintaining current (or potentially higher) speed limits. In this kind of environment, it is possible to envisage that full manual driving is likely to be difficult, impossible, or possibly legislated against.

Given this future context, we must next consider the (expected) role of the driver. First, consider Michon's theory [mic] on level of vehicle control (more recently developed further by, amongst others, [lee]). According to Michon's model, there are three levels of vehicle control; operational, tactical, and strategic. The operational level of control includes actions such as braking and acceleration, behaviors occurring between 0.5 and 5 seconds. On the tactical level, we have things such as changing lanes, negotiating traffic solutions, taking turns, etc. The tactical level includes behaviours occurring between 5 and 60 seconds. Finally, on the strategic level, we have all the planning activities- these actions occur over minutes or days. This final stage links directly to the mention of 'Scheduling and also Household Resources and cost' from the previous section. The behaviour pattern accounts for determining the route, the associated cost and modal choice. Additions here come in the form of considering any of the associated risks.

Second, a review of current technological trends suggests that technology development is currently very much towards autonomous control at the operational and tactical level suggesting that the role of the driver in a future traffic context would be primarily strategic. However, given the future environment described above the driver will remain actively involved in supervising the systems and the environment, and taking supervisory actions. Thus the second role of the driver will be to monitor and supervise their systems and the environment and to take corrective actions as required.

Third, in addition to planning, monitoring, and supervising, a third role of the driver will likely be resilience [hola]. The current state of the driver role can be considered as fairly straight forward. However, in introducing smarter systems into vehicles, [Dek] talks about each simple entity, ie human, when given a task that requires collaboration, cumulative change and a much more advanced feedback model, and

how resilience is key in this changing climate. Resilience, it seems, is more suited to this evolving environment, more so than general risk management that only looks at calculating risk probability, resilience requires the development of capacities that enable one to absorb pressures, disruptions and change. Another word to describe resilience would be cautious.

Following (an inevitable) but wholly unexpected event, it becomes the driver's responsibility to bring the system back to some kind of normal state. This is particularly important when considering the future world as described (increased traffic density travelling faster) where the potential for loss of life following an accident is arguably greater than is currently the case.

Fourth, in all likelihood, despite advances in vehicle and ITS technologies and solutions, the driver will retain overall litigious control. This in reference to the advancements of aviation surpassing all expectation, yet the control still is at the hands of a fully trained pilot, a human. automation Thus this is likely a motivator for the previous mentioned driver tasks.

In summary, we envisage four key roles of the driver in a future scenario: strategic planning, monitoring and supervision, supporting system resilience, and litigious control. The implication of this is significant. If we consider the first three of components as the key features of future 'driving', then a system that affords this kind of control can be significantly different to current vehicles.

1.3.8 Human Automation Interaction

HumanAutomationInteraction

- Funk et al., 1995 [fun]
- Billings, 1979 [bil]
- Ghazizadeh, 2011 [gha]

Designing for system Resilience

- Hollnagel, Woods, & Leveson, 2006 [holb]
- Dekker et al, 2008 [dek]
- Others

Trust and Compliance (Compliance engineering)

1.3.9 State of the Art and Current Research Directions: Behavioural Responses

sec:BehaviouralResponses

What kind of behavioural responses and issues will autonomic systems provoke? This is tied up with the issue of identifying the scope of potential application of autonomies: for example, do self-managing properties apply to all the controlling embedded software systems, or do they encompass the integrated hardware and

software as well? How will ARTS contribute to the implementation of desired behavioural changes?

This theme deals with two different aspects of behaviour in relation to ARTS systems, i.e. social interaction, where travellers are informed about their own travel performance, where travellers provide each other with information and/or incentives, and where the traditional road authorities only play a marginal role, and the autonomous vehicle, where drivers distraction and overloading (in case of on-board equipment), trust and traffic culture/differences in drivers behaviour should be taken into consideration. The description of the state of the art on social interaction is mainly based on deliverable 3.1 of the EU FP7 project SUNSET on Objectives [SUN11].

1.3.9.1 Social interaction

sec:Social interaction

This sub-theme is related to why and how people are travelling. This is related to research on travel demand and travel planning done by the individual, a role as a choice architect [TS08]. The individual is embedded into social networks and is interacting with others. This leads to the question: what role can an ARTS system play there and how an ARTS system can be designed that it has an impact?

The study of how people choose when and how to travel has been traditionally rooted in micro economic analysis of idealized rational actors concerned primarily with utilitarian aspects of the mode and route choices available to them [ZB14]. This approach has led to the development of useful predictive tools, but is a poor framework for understanding how framing, routines, norms, and heuristics influence travel decisions. As principles from behavioural economics and social psychology have begun receiving substantial attention in policy domains, more diverse techniques have appeared in the literature on a variety of transportation topics, including applications of the theory of planned behaviour to mode choice [BAS03]; evaluations of affective experiences during travel [GU07]; and applications of prospect theory to the evaluation of mode characteristics [XZX11].

Behavioural Economic Principles Relevant to Travel Decision-Making

relevanttoTravelDecisionMaking

Behavioural economics is an interdisciplinary field that combines the methodology of both psychology and economics to produce more powerful theories, more accurate predictions, and better recommendations for policy. Foundational research in the field has followed a strategy of identifying clear violations of rationality assumptions through clever experimentation, and creating new models and theories that reflect observed patterns of decision-making.

The heuristics and biases research program describes the effects of a set of cognitive shortcuts used to simplify complex decision criteria by generalizing from more easily accessible information [TK74].

Many types of quantitative estimates and valuations are based on the degree to

which processes and outcomes resemble each other, the ease with which examples of a phenomenon can be called to mind, irrelevant reference values, and affective responses to information. These effects indicate that peoples' valuations and decisions are frequently inconsistent and context-dependent, especially when outcomes- such as future health or climate change impacts- are distant or abstract [ALP03]. In the transportation domain, the heuristics and biases framework can help illuminate divergences between the actual and perceived qualities of different transportation options, and predict when frames can exert a greater influence on choice than utilitarian considerations alone.

Experiments with public goods games have reliably shown higher levels of cooperation than game theory predicts. These results suggest a context-dependent "norm of cooperation" that applies until a player has been taken advantage of. It is strengthened in situations where players can negotiate, make commitments, and punish defectors [TD92]. Demand management measures can leverage this approach by re-framing travel decisions from purely utilitarian decisions to ones governed by social norms, including descriptive norms implied by neutral depictions of others' behaviour and injunctive norms that specify socially approved and disapproved courses of action [SNC⁺07]. The behavioural phenomenon of mental accounting describes the process of assigning different activities and purchases to different 'accounts' governed by different loss and gain calculations.

Prepayment schemes allow consumers to create new accounts that are less aversive to spend from, leading to greater consumption. For example, driving a private vehicle often involves no obvious cost, since gas, insurance, and the vehicle have all been prepaid. In contrast, a taxi ride, vehicle rental, or transit trip all often involve an immediate expenditure [ST06] and are therefore more aversive.

Individual's objectives: perspectives

Individuals Objectives perspectives

This section intends to provide the reader with an understanding of how different objectives have been conceptualized in understanding travel behaviour. It is clear that the model of behaviour has an impact on the conceptualisation of the 'stimulus-response' model and this activity requires that understanding to underpin the development of the incentives as a stimulus to behaviour and travel practices.

This activity aims to provide a critical appreciation of the traditional and emergent thinking currently prominent in the explanation of individuals travel, including:

- economic theories of behaviour- derived demand, utility and the value of time
- transport and society including the 'new mobility paradigm'- corporeal travel, flows and communicative practices; and finally,
- social psychological models of attitude and behaviour.

These three approaches represent the latest thinking in travel behaviour and mobility studies and a 'state-of-the-art' account of each of these strands will be used to understand the objectives people have in travelling and to inform the development of more effective incentives in an ARTS system. On completion of this we should

have knowledge and comprehension of the dominant theoretical perspectives on travel behaviour and demonstrate a critical and nuanced appreciation of the differences, similarities, links and complementarity between the various key theoretical standpoints with respect to the objectives of individuals.

Economics perspective on behaviour

conomicsperspectiveonbehaviour

This section sheds light on individual travel objectives from an economic point of view. It provides an overview of the state of the art on this topic, presenting recent advances of individual travel behaviour in economic modelling and highlighting future needs. It concludes by pointing out relevant and interesting areas to be addressed by an ARTS system through the development of appropriate incentives.

Context / Background

sec:ContextBackground

The existing gap between economists and psychologists lies in the diverse focus of researchers within those two disciplines. Economists assume rational decision making by transport users¹, focusing their attention on the outcomes (travel choices) of rational thinking over all available alternatives. The underlying assumption is that all transport users are capable of conducting this procedure successfully based on their preferences and market or transport infrastructure restrictions. The commonly used term to describe this process is rationality among users (i.e. consumers), regarding preference, perception and process. On the other hand, psychologists focus on a different aspect of the same process, which is considered as a black box by economists. This is due to the disapproval of the theory of rational users and the adoption of an approach assuming that decision making is influenced by individual values and the overarching context, including transport infrastructure limitations [Che09]. A broadly accepted approach in (transport) behavioural economics has been to model travel behaviour including an error term in models, which refers to the: "unobserved aspects of experience and of information on the attributes of alternatives, interpreted as random factors" [McF00]. This error element forms a key factor in most established economic models of travel behaviour and is considered to be random. It should be stressed here that this error estimate corresponds to the modeller's lack of complete information and not to the transport user's level of information. The term error suggests that 'something is wrong' but in this context it means that the structural aspect to the behaviour has not been fully accommodated in the model as it is currently specified. This modelling stream is commonly referred to as Discrete Choice Models (DCM) and encompasses the bulk of attempts to model individual choices about travel behaviour [Che09].

Within DCM, two distinct strands of modelling have developed during the past 30 years, namely Random Utility Models (RUM) and Mixed Multi Nomial Logit

¹ Research commonly focuses on consumers, but those correspond to transport users in a transport context.

(MMNL) models. RUM are founded on microeconomics and utility theory, therefore have strong links with major economists of the 19th century such as Bentham, Mill and Jevons who first introduced systematic quantitative analysis in economics. Despite the innovation of utility theory and the progress achieved during the last century, RUM face the limitation that irrational behaviour is linked with randomness. This however can be explained and predicted, which reduces the credibility of RUM. In contrast, MMNL models have considerably developed during the last decade and attempted to address the limitation observed in RUM, by decomposing the error term. Nevertheless, various other limitations in MMNL model formulation have reduced confidence in those models too [Che09]. Furthermore, it should be noted that although the virtues of both micro-economic theory [McF00] [JD07] and DCM [BAMT⁺02] [Ort06] [Bha07] have been widely praised, their limitations have not been well documented.

This lack of satisfactory standard models and lack of agreement between the two modelling approaches in economic modelling of travel behaviour stands as a general criticism against economic theory and its application in modelling and forecasting of individual travel behaviour. It should be considered when reviewing decision chains or mode elasticities [del] which are relevant to an ARTS system users. The inability of the economic models to explain all the behaviour under observation and to be reliant on an error term implies that the underlying theory of behaviour requires further development. Therefore, the following points should be considered under this perspective, allowing room for integration with approaches by psychologists or geographers [Che09]:

- Asymmetry between willingness to pay (WTP) and willingness to accept (WTA)
- Attitude and personality
- Habit inertia
- Non compensatory choice and other heuristics
- Learning and dynamic processes
- Choice under risk (prospect theory)
- Compromising effects (regret theory)

Deriving the utility function

Since economists have an inherent interest about demand for the transport system and aim at assessing benefits of schemes or policies, the backbone of DCM and rational behaviour is utility maximisation. Utility may be defined as intrinsic, derived or even as disutility [jon]. A wide range of sources offers intrinsic utility to travel, as for example [mat], based on [Mok01b]:

- To escape from routine, workplace, personal problems
- Physical / mental exercise
- Sensation of speed or just movement
- Enjoyment of the machine, bike, car, roller blades etc
- Exposure to the environment

sec:Derivingtheutilityfunction

- Enjoyment of a route (not just a destination)
- Symbolic value (status, independence)
- Buffer between activities

The standard approach to model utility described in the vast majority of economic textbooks is that each (rational) user [DW01]: is aware of their personal attributes (decision criteria or factors), is also aware of all the available alternatives (i.e. perfect information), evaluates each alternative against their own criteria, then assigns a level of satisfaction (i.e. utility) on each alternative based on their own criteria, to finally choose the one which maximises the deriving utility for themselves.

When transforming this decision making process into mathematical formulae, there are two approaches: the theoretical and the empirical ones. According to the theoretical one [TM78], the utility function should abide to micro-economic theory, whereas according to the empirical one [LL78], the utility function should be based on the best fit to the data available (taking into account some minimum theoretical conditions).

The latter has obvious implications for any ARTS system involving social interaction, since an explicit decision has to be made early to derive a fit for purpose utility function. McFadden [McF10] argues that "The standard RUM model, based on a mildly altered version of the economists' standard theory of consumer behaviour that allows more sensitivity of perceptions and preferences to experience, augmented with stated preference, perception, and attitude measures that uncover more of the process by which context moulds choice, will increasingly become the dominant methodology for behavioural travel demand analysis". If existing data (e.g. from i-Zone) are to be used, then an empirical approach may be considered, although this will require analysis of the existing data which would need to be of adequate volume and quality. Otherwise, a standard theoretical utility function may be used based on micro-economic theory. The use of latent variables, that is variables determined a priori and unobserved should be carefully considered in either case [Che09].

Cost, efficiency and equity

sec:Costefficiencyandqquity

It is clear that utility maximisation of rational transport users is aiming at (individual) efficiency. However, there is a frequently neglected side effect of this individual efficiency, which is mainly observed at a system level and relates to equity considerations. To demonstrate this better though, a clarification about the cost of travel should be offered.

Travel cost usually includes the observed cost of travel. This is the value included in most DCMs. However, a distinction between the marginal cost to the provider of the transport service or infrastructure and the marginal cost to society should be drawn. The former includes only the cost(s) that the provider has to pay, whilst the latter includes also costs such as emissions or noise, which are not always monetised to be included in the utility function. Jansson [jan] explains the four components of marginal social cost:

- Costs borne directly by the user (e.g., provision of vehicle and fuel, users' time)
- Costs imposed on the infrastructure provider (provision and maintenance of infrastructure)
- Costs imposed on other infrastructure users (delays, increased risk of accidents)
- Costs imposed on society in general (air pollution, noise, global warming)

This is a crucial point based on the Pareto improvement with implications for both efficiency and equity as has been highlighted by scholars (e.g. [Nas01]), it is anticipated that an ARTS system will need to consider observed costs and to utilise social marginal cost in the future to refine the respective model(s).

Value of travel time

sec:Valueoftraveltime

Another important factor of behavioural models has been the Value of Travel Time (VoTT). This has been a controversial issue, intertwined with travel time savings. At a project level, VoTT savings form one of the most decisive factors in Cost-Benefit Analyses (CBA). At an individual level, VoTT savings form another key element regarding the decision of when/how and if to travel. VoTT could vary depending on the mode, time of the day, activity to name a few examples. A usual distinction is made between business, commuting and leisure VoTT. Such benefits are usually estimated through the consumer surplus, however, it is not always easy to identify a discrete reason for the travel. Nevertheless, there have been fierce debates about the impact of VoTT use in CBA, due to the implications for constructing transport infrastructure projects [Pri08].

The reality for individuals is that a single transport user may have diverse VoTT during different times of the day. This may have deriving effects, since it should be clearly defined by each user what (time of day or activity) travel time savings one is willing to achieve.

An implicit assumption made so far in this section is that travel time needs to be reduced (i.e. saving). Hence, the literature offers examples of fruitful use of travel time, where there is no incentive to reduce (save) travel time. This could be due to a wide range of reasons, such as to use/work on a laptop or a smart phone, to read a book, to listen to music, to socialise with friends, family or fellow travellers [Mok01a]. The latter point has to be taken into account when constructing the utility function by introducing an appropriate condition. Otherwise, the model will not be reflecting the real behaviour of travellers, thus reducing its predictive capacity [Met08]. If travel time is conserved rather than saved, standard CBA is not reliable as to the value of infrastructure investment and models are not based on authentic behaviour of travellers and cannot be relied on to predict consequences of interventions. Additionally, there is the issue of induced traffic [Goo96] which is interrelated with an increased ability to access desirable destinations. A consequent issue to consider is how VoTT is derived, since WTP and WTA methods in transport [TWB11] and environmental [tho] studies have been reported to produce diverse results. The implication is that it is difficult to reach a reliable VoTT if there

is not a stable method to derive them. Consideration of these issues at an early stage is important to develop innovative, attractive and practical suggestions.

Reliability

sec:Reliability

A recurring issue in transport literature is reliability. The rationale is that transport users are expected to have reliability as one of their transport objectives. Additionally, employing reliability overcomes several of the aforementioned difficulties intrinsic in travel time savings. It has been estimated that "a minute of late time is typically valued as equivalent to 3 min of timetabled journey time" [Pre09].

Reliability is intertwined with elasticity for transport though. The same study, which used evidence from the UK, has found that due to the inherent inelastic nature of transport demand, most segments of the rail market are relatively insensitive to delays. The short distance elasticity of rail services outside London was found to be -0.28 in the long run, which indicates that rail passengers in the UK have lower sensitivity towards reliability [Pre09]. It would be interesting to contrast such findings within Living Labs and confirm or contrast those findings. In addition it is important to consider the issue of thresholds to lateness and reliability. Studies show travellers decision making can be very complicated and part of that is based on the impact of being late, e.g. being late for a meeting or being late for childcare pick-up and incurring a fine and another part is on the estimates of probability of being late or early and the degree of variability.

Conclusion

sec:chap4Conclusion

By offering a brief overview about microeconomics and the models used by behavioural economists, this section provides link with the psychologists' approach. Moreover, some of the key factors usually included in DCMs have been introduced. In such, this section has highlighted important elements to be considered throughout the development of an ARTS application. The next perspective is that based on Sociology and other social science disciplines. This area of work is relatively new and has not had the same technical quantitative focus as that from economics.

1.3.9.2 Transport and society perspective

transportandsocietyperspective

The emerging social understanding of why people travel is a contested and rapidly evolving area with as a consequence many different viewpoints and this section has concentrated on that work which has most relevance to an ARTS system. The focus of a social understanding of why people travel is on the social practices and social significance and meanings of travel. There is an interest in the relationships between people and social practices refers both to the behaviour of the individual and in interaction with others and groups. In addition a social understanding focuses on social

processes and the creation and workings of social institutions. There is recognition that travel is not an atomised and individualised set of behaviours but only understandable within a context of everyday social life [JH83]. In social understandings there can be a number of foci from the micro to the macro and including the relationship between the two levels. A social understanding focuses on practice and also the attitudes, beliefs and values, that is the significance and the meanings that are attached to the practices. But in addition a social understanding allows a focus on social institutions, social processes and social structures.

Difference from orthodoxy

sec:Differencefromorthodoxy

Orthodox approaches to transport and travel research under-problematic social relationships in understanding travel with the result that within transport studies and policy-making, there is an over-reliance on the monetisation of travel benefits and dis-benefits and a concomitant lack of knowledge about the social resources involved in travel and the positive aspects of travel [Mok01b] [JL08] [LU05] [Hod11] and, it can be argued, a subsequent dearth of effective transport policies for achieving economic, social and environmental sustainability. Travel can generate resource, particularly social resource and cannot then be conceptualised as simply a dis-utility to be minimized [Gri95] [urra]. Transport provision and use impact on significant areas of life including an individual's strategies for access and inclusion, their ability to cope and thrive as well as both the individual's and a community's sense of belonging, identity and governance. Social science understanding emphasises dynamic processes of household scheduling; access to household assets and resource; interaction across networks; cultural identity and social roles; and the role of travel and transport in communication and communication technologies.

Importance of activities

sec:Importanceofactivities

One of the key strands of this approach is to look at activities. As González, Hidalgo and Barabási [MCGB08] show in their extensive study of human movements documented using mobile phone records, our activities are largely routinized in time and space. Meeting up with others, for any purpose including work, playing etc., are the outcome of the routinized nature of everyday life and the need for social synchronicity to perform activities [H70]. This does not mean that they can be taken for granted, or assumed to be habitual or unproblematic as Giddens argues 'the routinized character of most social activity is something that has to be 'worked at' continually by those who sustain it in their day-to-day conduct' (1984). In this context then there is a distinction to be drawn between routinized and habitual.

Synchronicity

sec:Synchronicity

Social synchronicity involves being with others to perform activities and to communicate. Being with others generates resource both in terms of the more orthodox financial wealth but also social capital, human capital and political capital etc. Boden and Molotc [BH94] argue is there is a 'compulsion to proximity', that being with others carries the reward of being able to communicate and understand each other much more easily and with a higher degree of performance. But it also allows people to complete activities together. In their work on business meetings and communication they argue that there is a hierarchy of communication and that co-present communication is more highly desirable for the efficiencies. It is also the preferred method for setting more routinised communication in the future, so as long as there is a history of having met face to face then future meetings can be mediated by technology. So we can see an imperative or a prioritisation of communication methods that means it is difficult to swap and substitute with communication technologies.

Constraints

sec:Constraints

Our patterns in time and space, where we are going to be and when, and the sequences and interdependencies of those patterns and paths, are characterised by our competencies, social commitments, the properties of time and space, and the iterative nature of our activities. People argue, Gärling and Axhausen, 2003, [GA03] act under constraints of time, budget or social commitment. For example, consider the uniformity and iterative character of the elementary school start time across European countries and the paths, the temporal rhythms and spatial practices involved in making that journey to school to meet that obligation. What is important to take away from this discussion is the necessity of context for understanding routinised activity patterns in time and space.

Access to resources

sec:Accesstoresources

Resources can be financial but also social and time can be a resource. Access to resources is not necessarily equal across all household members. Resource and access to resource are key elements of the social understanding of travel both as a way of conceptualising the travel capitals that are necessary to have access but also as a way of understanding why and how people travel. Resource is conceptualised as including a range of less orthodox resources such as social capital and skills.

Social meaning and significance of travel

meaningandsignificanceoftravel

The significance and meaning of travel is not simply about the instrumental fulfilment of household activities. It is also about fulfilment of the status, identity, im-

agery and social norms that travel is associated with and confers on those engaged in activities. Travelling is understood to be a set of practices in time and space with changing and complex meanings and significances.

Cultural identity and social roles

sec:Culturalidentityandsocialroles

Travel and the transport provision are both influenced by and influence cultural roles and identities. Gender roles mean that women take on a larger share of childcare and household maintenance and often work part-time resulting in greater time poverty [hama] and a more complex scheduling task. The scheduling can be over numerous childcare services including nurseries and schools, shops, workplaces, and transport provision.

Social processes

sec:Socialprocesses

Social structures, that is the mores, ethical codes, institutions and traditions, are developed in the main through the repetitious nature of our everyday actions. This repetitious action results in normative expectations, which influence directly our sense of entitlement. Social structures change as those repetitive practices are challenged or replaced or altered.

Competencies

sec:Competencies

Any study of relational processes of social networks, community and identity must address travel, as Sheller and Urry [she] argue, the developing and fulfilling of social activities mean that 'travel is necessary for social life, enabling complex connections to be made, often as a matter of social (or political) obligation'. The focus is now drawn specifically to the skills, competencies and strategies individuals and collectivities use to travel, manage social interaction and develop relations. For example the employing of repeated practices and exchanges involved in making the strange familiar in neighbourhoods and streets and households, or the subtle and highly skilled practices of combining absences and presences that make relationships work to our satisfaction and fulfil the 'compulsion to proximity') [BH94]. This section, with its focus on the practice and competencies and strategies of travel adds to a small, newly emerging body of research on the interdependencies of travel and social networks [JH83] [Gri95] [LAU06] [axha] [ohn] [urrb].

Social networks

sec:c4Socialnetworks

The competencies, skills and strategies involved in travelling are part of everyday practice and for many they are routinized daily practices. Repeated exchanges and

interactions are central to everyday life [axhb]. Travelling is social interaction. It is situated social interaction in time and space and the mobile nature of travelling means that emphasis and consideration has to be paid to the dynamic of the time and space. As someone travels, moving through time and space, the patterns of opportunities to encounter others change. The geographies of opportunity to meet up with others and to access services, activities and other resources changes and Axhausen [axhc], Rivas Perez and Hodgson [riv] show how the geographies can change according to mode use. [its]

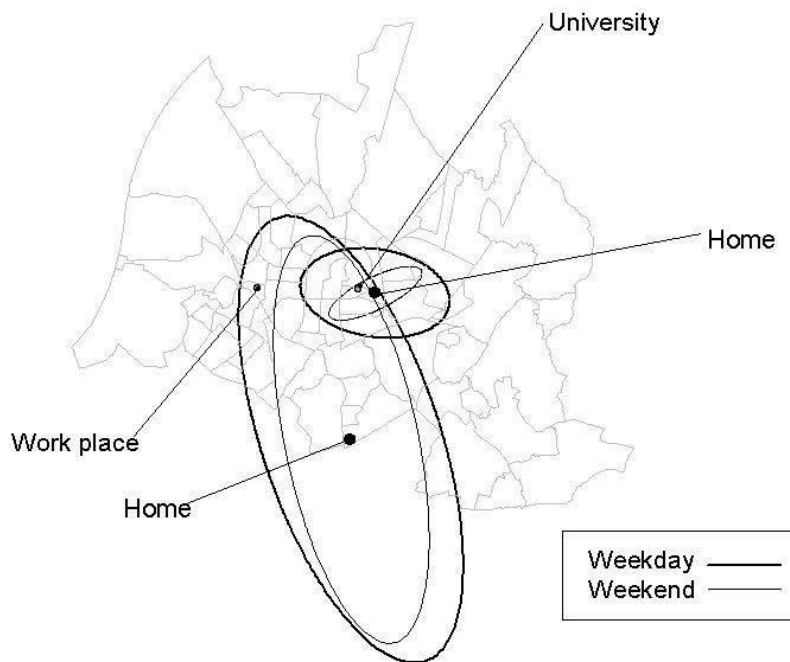


Fig. 1.2: Social networks and travel behaviour by mode, taken from Axhausen K.W. [axhd] (The smaller concentric rings are the travel areas of someone without a car and the larger are the travel areas of a person with a car.)

fig:4.2

We meet up with and encounter others [gof], strangers, acquaintances or those who are related or more well known to each other. It seems clear that the management of one's social interaction involves managing one's absences as well as one's presences and managing the avoidance of 'bumping into', that is encountering others one wishes to avoid. It is the management of one's social network. Consider, for example, the repeated exchange involved in encountering one's neighbour as one steps over the house threshold. Each of these exchanges repeated over time

constitutes and contributes to a process of turning the stranger, yourself and those you interact with, into a familiar face. There is then an inherent connection between encounters and travelling as an everyday practice. Walking around for whatever purpose, be it instrumental or pleasure or both, involves the possibility of encountering others and the ability to manage social interaction. The structures of opportunity to encounter others changes as people go outside and these temporal and spatial patterns of presence and absence are part of the building blocks of social networks.

Social capital

sec:Socialcapital

Social networks provide households with a resource that can act to help them to 'get ahead', (Granovetter). The social capital of social networks has been conceptualised into different forms including weak, strong and linking bonds. Meeting up with others is not straightforwardly for instrumental means but also involves creating the relationships that sustain social life and contribute to psychological and social needs. Social networks are inherent in travelling because we meet up with others by accident and design and also we build social capital as we travel around neighbourhoods particularly when we use the slower modes, cycling and walking. Being visible and seeing others changes patterns of familiarity and has the potential to turn strangers into community members.

Household scheduling

sec:Householdscheduling

A key skill then is that of household scheduling, the complex coordination between different household members to meet social obligations and other imperatives of social mores and ethics. It is also clear that the competencies involved in scheduling include planning ahead and planning over time and across space. Deciding on who might have the family resource such as the car, what the family budget for travelling is to be, deciding on employment practices to suit childcare needs and social mores on parenting, status, identity, deciding on household location to optimise for social obligations, desires for income maximisation and present and future status. "a household's daily routine tends to be built around the obligatory activities of its members, with the more discretionary activities being fitted into this basic pattern. In order to participate in most kinds of activity (and so satisfy specific needs or wants), a person has to make use of specialised facilities", [JH83] travel becomes necessary when those facilities are not available in the house. Hägerstrand [H70] developed the idea of the 'time-space' path which was an analysis of the navigation of an individual through space and time and the time-space prism which represents the activity opportunity available to an individual with a set of constraints. Fig.1.3 below shows a time-space path for a single individual where the vertical axis is time and the horizontal axis is space. The more acute the curve the faster the travel, thus a straight line represents a stationary individual.



fig:4.3

Fig. 1.3: Space-time path

The nature of time and space then act as facilitators or constraints such as the interdependencies between activities, or the opening times of services, or the schedule times for bus services. The necessity to perform with others means that there are constraints on the scheduling as well as prioritisation of activities some may be essential for household reproduction and others might be more optional. Hagerstrand used the time-space path to develop the concept of the space-time "prism". This is the potential or opportunity space around an individual. It takes the starting point and defines all the points that can be reached by an individual given the maximum possible speed from that fixed point in space and time and the ending point in space and time. A simple example is to assume an individual is at working from home and has to leave at 1pm and has to return by 3pm and she can travel at a maximum of 45 kilometres per hour then any point greater than 45 kilometres away would be outside the time-space prism. Individuals in everyday life make, assess and discard complex schedules like this over a range of households, dependents and opening times, and over a range of different speeds and modes including taking into account uncertainties in arrival times and travel times as well as trying to live up to their own ambitions and normative expectations.

The space-time prism describes the potential path spaces [Mil04]. The geographies of opportunity change as modal speeds change, and as control over reliability and

planning changes and we can see how the potential path spaces narrow as congestion builds up and widen if an individual is able to choose to travel outside of peak and congested times.

Accessibilities and travel activities are not simply a matter of the time and space they also depend on the institutional, social and cultural contexts [NSW10] pertinent for any individual. Releasing the potential opportunities around an individual requires an understanding of institutional, social and cultural processes and the interdependencies of the processes and the extent to which they enable or restrict travel.

Social obligations

sec:Socialobligations

Attempts have been made to create a category of social obligations. Larsen et al [LJK05a] suggest a typology of obligations as motivation for travel:

1. Legal, economic and familial obligations
2. Normative expectations;
3. Object obligations (e.g., contract);
4. Obligations to a place;
5. Event obligations (to have been there: soak up the atmosphere).

This typology is focussed on interactions and relations but it should not be used as a comprehensive list of all the reasons why people travel as it does not include pleasure, that is the physiological enjoyment of walking, cycling, flying or of being in control of a machine, such as a bicycle or a car. However it does draw attention to the importance of normative expectations. Normative expectations refer to the beliefs that people hold about the behaviour of others and themselves, what is the appropriate practice and activity. These are culturally and historically specific and can vary according to social category. For example in the past there were very different normative beliefs about how old children should be before being allowed to travel unaccompanied [?].

Life cycle/stage

sec:Lifecyclestage

Life stage and life cycle are key elements of understanding the household scheduling task. We know that households with children have a first task which is to make sure that dependents are being looked after, either within the house by a household member or by nanny or friend or by a service, eg nursery or school, friend etc outside the house. But the first priority of a household with children is to make sure the household's children are looked after. Similarly we know that this scheduling can become complex when both adults work and we know that often concessions are made in areas other than travel to account for poor transport provision or transport provision that does not meet needs of parents who wish to work. For example, in low-income households we know that parents develop skills of asking for time favours of other people and paying back favours particularly around

childcare [Gri95]. In a study of Time poverty, transport policy and gender research Grieco [Gri95] found that women' scheduling of activities was complex and complexity not met by transport system. Transport policy delivery failure reinforced time poverty and necessary to use social networks to swap time favours'. Social networks used to borrow time particularly in poor households and single parent households. Inter-household time favours were swapped (asynchronously) particularly around childcare and household maintenance in both routine and crisis situations. Impacts on the character of social capital: trust, flows of favours, and reciprocity. We also know that socio-demographic trends are making a difference to the scheduling task with lots of middle-aged children having to find time to look after or accompany older relatives. It is clear that daily scheduling for many households is a complex interplay of decisions for the immediate day coupled with decisions over a number of years particularly for those household with children. Competencies and skills involve being about to ask for time favours from friends, relatives and neighbours; (b) navigational skills; (c) collecting information such as parking places.

Dynamic scheduling competencies

ynamicschedulingcompetencies

In this approach much focus has been on the scheduling task and there is evidence that scheduling competencies and practices may be changing. Competencies are dynamic and situated and it can be argued that competencies for negotiating mobilities are developing and changing as mobility patterns, communication technologies and social organisation are changing. Hannam, Sheller and Urry [hanb] illustrate this in their argument that scheduling is increasingly important, 'as daily and weekly time-space patterns in the richer parts of the world are desynchronized from historical communities and place, so systems provide the means by which to schedule work and social life. Scheduling becomes ever more necessary to manage "personalized networking" [hay] [hamb]'. They go on to argue 'Overall there is an increasingly "do-it-yourself" scheduling society commonplace in at least large cities across the world [sou]'. Much research work indicates that there are a repertoire of competencies and practices involved in mobilities, which change and are specific to different modes. Travelling- moving through time and space either riding or walking- obviously involves different competencies depending on how one is travelling. Consider, for example, the modality, the complexity of the machine and the dexterity of control, the physical and intellectual competencies assumed present in the traveller by the design and operation of the transport systems. Research [Hod11] shows that this repertoire of competencies in travelling and making social the space we inhabit through our encounters are part of the social capital that is inherent and generated by travelling. It can thus be concluded that travel is not solely a disutility but also generates benefits.

Communication

sec:Communication

In some research travel is conceptualised as an aspect of communication between people. The work of Urry [LJK05b] is most prominent in this tradition. Urry has posited five different types of mobilities: Travel of people, travel of objects, communicative travel, imaginative travel and virtual travel, arguing that there are different types of mobilities and that these five types are comprehensive, (although not mutually exclusive). This conceptualisation emphasises communication and flows and allows us to start to appreciate the importance of communication technologies in understanding travel. Car and other forms of technologies can be seen to be appliances that allow communication, the meeting up of people so necessary to social life. They enable scheduling to be performed more efficiently without forcing particular kinds of social relationships or communication. Control is key.

1.3.9.3 Social psychology perspective

ec:Socialpsychologyperspective

The social psychology perspective has been applied to the study of a wide variety of travel and transport issues, e.g., safety, demand for travel, travel behaviour and attitudes. There are a number of social psychological theories including Theory of Planned Behaviour, Technology Acceptance Model (TAM) and the more recent Unified Theory of Acceptance and Use of Technology (UTAUT). The most common practice has been to use social psychology approaches to understand the relationship between person's own beliefs and attitudes and intentions and actual behaviour and to use that model to be able to 'predict' behaviour from study of attitudes and intentions. Various 'models' of travel behaviour have and are being developed to achieve a highly nuanced understanding of the different components required to predict behaviour on the basis of beliefs and values and to quantify the relationship between them. The focus of many studies is on managing the travel demand profile and to encourage modal shift.

Theory of Planned Behaviour

sec:sec4331

The theoretical basis to this work is 'attitude theory' and the most influential work has been that of Azjen. The components of the Theory of Planned Behaviour (Azjen) are shown in Fig.1.4 .

Elements of the model of Planned Behaviour

sec:sec4333

The model is based on the empirical measurement of different 'types' of belief using questionnaires, question types and measurement scales (e.g., semantic differential for attitude, or bipolar semantic differential scales) following received guidelines.

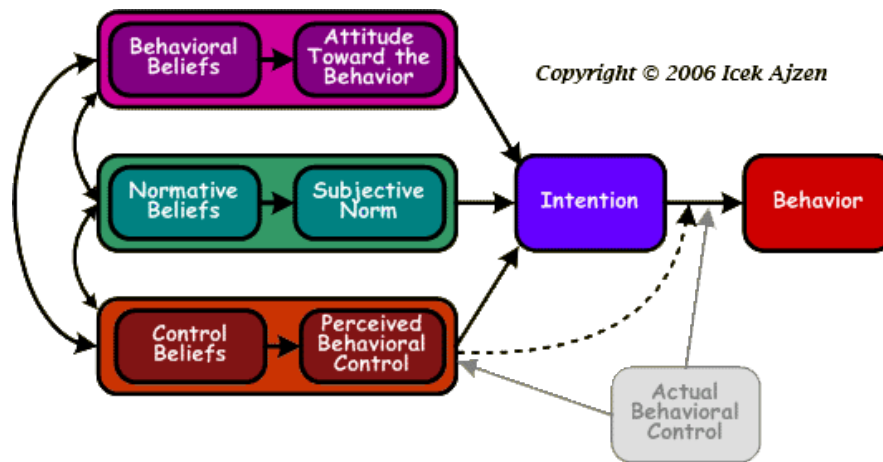


fig:4.4

Fig. 1.4: Theory of Planned Behaviour taken from Ajzen.

Attitudes

sec:Attitudes

Attitudes about behaviour are measured from beliefs about the outcome of behaviour and the belief about the importance of that behaviour. Attitudes can also be measured using a straightforward semantic differential scale to demonstrate positive or negative feelings towards the behaviour. The items for inclusion into the measurement of belief are based either on empirical work or on previous understandings, reviews of experimental work or other work. The number of items in the measurement of beliefs depends on the research and in many cases the greater the number of items and the greater the areas of possible relevance covered the higher the predictive power towards attitude.

Perceived behavioural control

ec:Perceivedbehaviouralcontrol

Measuring perceived behavioural control requires a number of items about the types of competencies required to achieve the target behaviour and the degree to which the individual believes they possess those competencies. So measuring whether the individual believes they have the skills to be able to change and the skills to adopt the desired behaviour. This involves asking about self-efficacy beliefs and beliefs about control over the performance of the behaviour. For example, a questionnaire may ask individuals to rate how easy or difficult they would find it to leave the car at home for the journey to work. Recent developments in transport research have highlighted the importance of past behaviour and there have been attempts to include habit as part of the models of behaviour to explain the seeming intransigence towards car reduction.

Social norms

sec:Socialnorms

Social norms include the individual's perception of the opinions others hold about the behaviour. This includes whether they believe others will approve or not or if others would adopt the same behaviour or the image and reputation and status you will gain by adopting the behaviour.

Intentions

sec:Intentions

This element of the model is measured quite straightforwardly by asking about the likelihood of adopting a particular behaviour. The skill is in the question design and particularly in ensuring that the question is well bounded in time and space. In addition the question should include behaviour that the individual believes to be achievable as well as the behaviour that is under investigation.

Existing studies

sec:Existingstudies

There are a number of existing studies [jop] on changing car use which have found perceived behavioural control and subjective norms to be significant in understanding intentions to change. They have also found that attitudes were not significant in predicting intention and behaviour change and that even when the models were considered to be stable they still could not explain all the behaviour under observation.

Technology Acceptance Model

sec:TechnologyAcceptanceModel

The Technology Acceptance Model (TAM) and the more recent Unified Theory of Acceptance and Use of Technology (UTAUT) have sought to synthesize several older theoretical models of acceptance. It is based on the theory of planned behaviour [?], which states that behaviour, such as using technology, is preceded by a behavioural intention. The intention to behave is considered to be determined by three sets of beliefs. These are attitudes, norms and the perception of control over the behaviour. In the UTAUT model, it has been found that the inclusion of performance expectancy that is a set of beliefs related to the technology and to perceived behavioural control is very influential. Performance expectancy is a measure of beliefs about how well the technology will work for the individual so the extent to which it will perform reliably and also the extent to which it enable the individual to improve their performance. Also in this model is a measure of the effort expectancy, this is a measure of how hard it is to learn to use the technology, which again relates to the perceived behavioural control and specifically to the control over the performance of the behaviour. Beliefs about how hard it is to learn a technology have to address mental effort, time, emotional effort and physical effort. The third element is social

influence that relates closely to the social norms element of the TPB model and is also addressed in the transport and society perspective. This is the belief that an individual holds about what others will think of them using a particular technology. These elements are considered to be the main determinators of a behavioural intention.

Developments of the model include the Senior Technology Acceptance and Adoption Model, [RB08] who developed the model based on TAM, in which they emphasise the experimentation and exploration phase before older people decide to accept or reject a technology.

A central principle in time geography is that time and space cannot meaningfully be separated). This approach tends to adopt a binary division to activities and categorise them according to whether they are 'fixed' or 'flexible' which refers to the extent to which a n activity can change its location of time. So the home location and duration at work are generally considered to be fairly fixed, whereas activities such as shopping and socializing are generally thought to be more flexible.

Summary

sec:chap4Summary

It is possible to draw conclusions about the significant factors in explaining the travel objectives of individuals. It is clear from the previous subsections that travelling can use resources and also generate resource within the same journey. It is also clear that travelling objectives can relate to the specific characteristics of a particular journey or they can relate to necessities of daily life such as caring for dependents, or meeting obligations. Furthermore travel objectives can relate to fundamental social processes such as the way they see themselves or who they wish to be identified with and the ethos and political agenda they have for living their life. The significance and meaning of travel can be fundamentally altered by access to new communications technologies and new ways of networking and the generation of user content. The key factors acknowledged as significant for understanding individual's travel objectives include: time; scheduling; resources and costs of the household (whether an individual lives alone or not); social networks; identities and culture; normative beliefs and expectations; and finally pleasure. These seven factors will be considered in more detail in section 4.3.

1.3.10 Three Pillars for Behavioural Interventions

arsforBehaviouralInterventions

In an ARTS type of system involving social interaction, three pillars are important:

- Design: behavioural interventions based on behavioural economics and social psychology
- Measurement and Incentives: mobile applications as a platform for two-way communication between all users, including travellers and researchers/program

managers, allowing for both data collection and distribution of interventions/incentives

- Assessment: randomized controlled trials as a method of determining the effect of various types of behavioral interventions

1.3.10.1 Mobile Applications

sec:MobileApplications

Existing methods available to transportation practitioners and researchers to examine travel patterns have been constrained by a variety of practical challenges. Conventional survey instruments and travel and activity diaries rely on participants to accurately describe their own mobility, introducing potential omissions and inaccuracies [SFX07] [SA03]. Traffic counts and related measurements can provide an accurate picture of how travel patterns change over time but provide little insight into individual travel behavior and its correlates [Led08]. Active travel studies in public health have productively used accelerometers and GPS trackers to avoid self-reporting biases through objective measurement [fra], but the cost of purchasing and distributing dedicated tracking devices can be prohibitive with large samples. Finally, the emergence of smartcards and large associated datasets from public transportation systems may allow researchers to examine individual and collective activity in great detail, but this approach is necessarily limited to a single mode [BW05]. In contrast to these methods, mobile applications for platforms like Android and iOS have key capabilities uniquely suited to detailed measurement of individual travel activity over time, and of active travel in particular [JW11]. Using GPS and accelerometer readings, these apps can accurately recognize trips by different modes. They have the capacity to recognize even short trips, such as from one part of a workplace to another, and to log when, where, and how a person has traveled. Users can view their activity record and share this information with other individuals (friends, family, coworkers) or organizations (researchers, transportation agencies). Examples of this type of app include Moves (www.moves-app.com), Quantified Traveler [JW11], TripZoom [koo], and the Future Mobility System [cot].

A key advantage of an app-based approach is that while it provides similar strengths to a dedicated GPS instrument, including automatic recording of origin/destination locations, routes, and travel times [wol], it does not require researchers or organizations to invest in monitoring hardware. A commercial or custom-developed app can be distributed at zero marginal cost to a large number of participants, whose travel behavior can be recorded without active participant effort while rewarding the participant with a potentially valuable source of information [JW11]. This enables advocates or researchers to gather data over a longer span of time (months or years) than would be feasible using other methods.

1.3.11 Travel information

sec:Travelinformation

This section is largely based on deliverable 3.3 of the EU FP7 project SUNSET on Incentives [sun].

1.3.11.1 Travel information

sec:sec471

The importance of travel-related information in reducing car use will be described in this section. To start with, providing people with information about the alternative transport modes is a common practice in a TDM marketing program. In general, TDM marketing aims to introduce various transport options and let people decide on which option(s) to take. Such programs are designed depending on their target groups. For instance, in several marketing programs that address the mobility needs of commuters, employers are usually invited to participate.

Their involvement and support have been identified as an important factor that determines the success rate of such programs [mod] [hen]. Besides personalized information, TDM marketing may also include campaigns to market travel alternatives or to de-market car use. For instance, a campaign strategy to promote cycling and walking could highlight issues of stress reduction from not having to search for parking and being in congestion, enjoyment of being in the open air, improvement of personal health, and elimination of travel costs.

However, the success rate of TDM marketing in reducing car use usually depends on participants' initial attitudes towards public transport. For example, people who do not like nor want to use public transport should not be expected to frequently use it [vic]. Changes are typically made one step at a time, such as from not wanting to considering taking public transport, from only thinking about it to occasionally taking it, as indicated by the theoretical model of behavioral change [pro]. With the right information (and sometimes combined with encouragement), some people may eventually reduce their car driving. It is worth mentioning here that TDM marketing is commonly a part of a comprehensive car use reduction program and is supported by government agencies or non-profit organizations. This happens because marketing programs can only work properly when the infrastructure and services of the transport mode alternatives are already adequate [vic]. For instance, even with personalized bus timetables and encouragement, people will not be interested to take a bus if the frequency is low.

To date, several apps have been developed offering real-time and personalized travel information. Specifically, they can be categorised into:

- information about transport mode alternatives;
- information about conditions on the road networks;
- travel planner;
- notifications (e.g. alerts and hazards about travel conditions); and
- weather information.

Some of these apps have been previously reviewed by Vautin and Walker [vau] and they are listed below:

Personalized and real-time information about transport mode alternatives

bouttransportmodealternatives

This includes time to depart from the nearest transit stop. The main purpose of this type of information is to minimize people's waiting time and to reduce the impacts of schedule deviations on their travel. Some examples can be seen in Transporter, OneBusAway, NextBus, and BayTripper.

(Real-time) travel planner

sec:Realtimetravelplanner

This includes single-mode and multiple-mode planners. Multiple-mode planner offers additional benefit because it allows users to obtain route and schedule information and make them seamlessly able to switch between car, transit, bike, and pedestrian. There are several websites that offer this type of information and some of them also develop smartphone apps with similar features. Examples of this are Google Transit and 9292ov Mobile from the Netherlands.

Personalized and real-time information about road networks and parking

aboutroadnetworksandparking

Examples of this are Google Now and Google Transit. They give users information about how much traffic to expect before making a trip. This may significantly help car users to switch to other modes or adjust their departure times, especially when there are disturbances on the road networks (e.g. congestion).

Notifications and alerts

sec:Notificationsandalerts

The main purpose is to notify users about disruptions on the road (e.g. traffic accidents and road works) or related to particular services (e.g. train cancelation) using emails or SMS. several apps are able to send non-personalized information about the road networks (e.g. NJ Transit, FileWekker, and InMaps). However, this feature can be annoying for people who are not affected by the disruptions because the same information is typically sent to all users. Apps that can provide personalized notifications are fewer than the former type. An example of this is a Dutch app called Onderweg.

Weather information

sec:Weatherinformation

The main purpose is to give detailed weather forecast information. Some examples are Buienradar.nl and WeerAlarm.mobi, both are applicable for the Netherlands. In most of the examples above, specific services and authorities provide users with real-time travel information. However, travel-related information can also be collected from other app users (such as in Google Transit and Google Now). This information is processed afterwards and used for different research purposes. Other examples are Mobile Millennium developed by the University of Berkley and Waze. Mobile Millennium collects and processes mobility data monitored using the smartphone's GPS and use the data to redistribute real-time traffic information among users. Waze is a social app that provides navigation based on the actual road conditions collected from the users.

1.3.11.2 Feedback and Self-Monitoring

sec:FeedbackandSelfMonitoring

Another type of incentives that could be useful in reducing car use is self-monitoring and personalized feedback. Rose & Ampt [ros] argued that people are often not able to reflect on their past travel behaviour because in many cases the consequences of travels cannot directly or indirectly be seen. For instance, CO₂ emissions that people contribute to the environment because of their travels and the amount of exercises that they can do when cycling or walking. Therefore, people do not have any tangible evidence that reducing their car use may result in some "beneficial" outcomes. To solve this, a travel diary is often used in travel behaviour research that aims to change people's attitudes and increase people's awareness of travel costs, CO₂ emissions, and the alternative modes of transport. People travel patterns are monitored for a period of time and accordingly individualized feedback is given periodically. This section highlights the potential of self-monitoring and personalized feedback to reduce car use based on several existing studies and current applications.

Several studies have been carried out to investigate the impact of having insight into own travel behaviour on car use reduction, such as those from Tertoolen et al. [ter] and Rose & Ampt [ros]. Interestingly, conflicting results were found from both studies and therefore they are discussed further below.

Tertoolen et al. [ter] carried out a study in Gouda, a Dutch city, to investigate the influence of self-monitoring and feedback on the environmental and financial consequences of car use. 350 car users have participated in an 8-consecutive-week experiment. Every participant was assigned to one of the five groups. The participants in the first to the fourth groups were able to self-monitor their travel behaviour. A specific additional treatment was also assigned for each of these groups. In the first group, the participants were given regular feedback on the environmental impact of their car use.

In the second group, the participants received regular feedback on their travel costs. In the third group, the participants were given both environmental and financial

feedback.

In the fourth group, participants were only able to monitor their travel behaviour and no feedback was given. This group was intended to measure the influence of feedback.

The last group was the control group and therefore the participants in this group were not able to monitor their behaviour nor to receive any feedback. The self-monitoring was set as a straightforward and direct process for the participants, because they had to fill in their trip diary, registering mode and distance travelled during the course of experimental weeks. The feedback was given once every two weeks. The researchers and every participant in the first to the third groups had a person-to-person talk in which direct consequences of an individual's car use in the last 2-week period were explained. Some conclusions of that research are relevant to be presented here:

- Self-monitoring alone is not sufficient to establish environmental awareness among people and therefore it should be combined with other types of information;
- Self-monitoring combined with both environmental and financial feedback resulted in the reduced frequency of considering the financial consequences of car use, suggesting the appearance of psychological reactance (or reverse psychology);
- Without any feedback on the negative consequences of car use to the environment, providing people only with financial feedback only resulted in better estimates of car costs;
- None of the incentives (i.e. self-monitoring and feedback) caused the decrease in car use;
- Results also confirmed the social dilemma: people do not want to sacrifice themselves (such as by reducing the CO_2 emission) for the collective interest and would only behave in a "good" way if others do the same.

1.3.11.3 Points and Rewards

sec:PointsandRewards

It has been briefly explained in Section 2.1 that rewards could be a useful incentive type to persuade people to reduce their car use. However, the potential of rewards to altering people's behaviour should also be discussed from the viewpoint of the psychological research. Many studies have been done within the psychological research field to investigate people's motivations, an important aspect of behavioural activation.

Methods to influence people's behaviour are rooted deep into the concept of extrinsic [ski] [ski] and intrinsic motivations [mas] [whi] [hara]. Rewards and punishments are examples of extrinsic motivation, defined as external factors outside individuals that aim to encouraging people to accomplish a goal. Both rewards and punishments are also regarded as methods to discipline people, making them retain the promoted behaviour. Rewards are varied from simply giving a verbal complement to monetary reward. Likewise, punishments also have a wide range, from verbal

warning to financial punishment (e.g. speeding ticket) and social exclusion. Many behavioural [car] [gab] and transportation research [blia] [BEE09] [blib] have found that reward strategies are generally more preferable than punishments. Kohn [koh] argued that punishments make people suffer to teach something and are effective to give compliance only when the punisher is around. Kohn [koh] also stated that even if punishments eventually can change people's behaviour, they may give negative effects on people's motives and values as they teach some worrying lessons about the use of coercion and power instead of reasoning.

While the ineffectiveness of punishment to support a lasting behavioural change has been verified by many behavioural studies to date, the effectiveness of rewards is still a subject of debate. For instance, Kohn [koh] found that rewards can lead to effective results but only for a short period of time. Cameron and Pierce [cama] [camb] argued that rewards can be used to motivate and maintain people's self-interest in doing certain activities. On the contrary, Deci [deca] [decb]; Harackiewicz [harb] found that rewards, in fact, reduce people's intrinsic motivation. Intrinsic motivation is defined as motivation linked to people's innate psychological needs, such as senses of curiosity and exploratory. It can also be motivation derived from an activity itself. Deci [decc] argued that intrinsically motivated behaviour requires no reward because it is performed out of interest and enjoyment. These differences of research outcomes have caused a series of scientific debate, published in various journals.

Cameron & Pierce [cama] [camb] conducted a series of meta-analyses from around 100 studies. The results found that rewards can be used effectively to increase and maintain people's intrinsic motivation and interest in certain activities. Specifically, they indicated that verbal rewards (or prizes) can be used to increase people's intrinsic motivation and unexpected tangible rewards (such as financial rewards) can maintain such motivation.

They further argued that the negative effects of rewards on people's intrinsic motivation only appear in specific conditions and circumstances that can easily be avoided. However, Deci et al. [decd] published a paper which indicated some flaws of meta-analyses conducted by Cameron & Pierce [cama] [camb].

Deci [deca] conducted two lab-based and one field-based experiments to find out about the influence of extrinsic motivation on individuals' intrinsic motivation. In the first experiment, two groups of undergraduate students were formed each served a function in either a control ($n = 12$) or an experimental group ($n = 12$). All participants in these groups participated in three sessions scheduled in three different days. In these sessions, the respondents were asked to solve Soma cube puzzle tasks, assuming that this activity would intrinsically make the students motivated. The Soma cube is a puzzle made out of seven pieces of cube units, allowing for different types of configuration such as a $3 \times 3 \times 3$ cube. In the experiment, the participants were given a piece of paper showing four configurations, and they were asked to reproduce those configurations while being timed. Both control and experimental groups received the same treatments in the first and third sessions. However, in the second session, the participants in the experimental group were offered 1 USD for every puzzle they solved in time. In the middle of every session, the researcher left the

room for an eight-minute break but informed the participants beforehand that they could do anything they liked in that timeslot, while actually being observed. The time that the participants spent during the break to continue working on the puzzle was measured and used to determine motivation. The results showed that the respondents in the experimental group spent more time working on the puzzle during the break in the second session when the rewards were involved than in the first and third sessions. Moreover, in the third session, the participants in the experimental group performed worse than in the first session in terms of less time spent working on the puzzle. In the end of each session, all participants indicated that the tasks were interesting and enjoyable, confirming the initial assumption that the students were intrinsically motivated to play the Soma puzzle game. This study concluded that in fact there is a decrease in intrinsic motivation after the monetary reward is introduced as extrinsic motivation.

In the second experiment, Deci [deca] carried out a field-based experiment involving eight students who worked at a college biweekly newspaper. Four participants who worked on Tuesdays were assigned in an experimental group while others who worked on Fridays in a control group. All subjects were not aware of being observed. The first observation time was for ten weeks, separated in three time slots. The participants were given a task to write headlines for the newspaper. In the second time period, the participants in the experimental group received 50 cents for every headline they wrote. In the end of the second period, the participants were told that they would not be paid in the next periods because the newspaper were facing some financial problems. The participants' intrinsic motivation was measured by the amount of time spent to write the headlines. Their attitude was determined by the number of times being present and absent. Five weeks from the third observation period, the fourth observation period was conducted for two weeks, allowing to assess the stability of the observed effect. The outcomes of this experiment were similar to the first experiment: monetary rewards cause the reduction of intrinsic motivation.

The last experiment by [deca] was set as another lab-based study and was identical to the first experiment. However, instead of using some financial rewards, this experiment gave verbal prizes, in the second session of the experimental group, to indicate the social approval. The results showed that the participants significantly performed better during the third session in comparison to the first one. This showed that a verbal prize strengthens performance and intrinsic motivation. Furthermore, Deci explained why the two types of external rewards (i.e. monetary and verbal rewards) affect people differently. He argued that the introduction of monetary rewards make people reevaluate the importance of the task at hand and shift their intrinsic motivation from having enjoyment to gaining the financial rewards. However, verbal prizes do not affect the importance of the task and therefore, people's views on the task remain the same.

The increase in intrinsic motivation was also explained by the increase in the perceived locus control to perform the task. The outcomes of this experiment support, to some extent, Maslow's theory [mas]. The theory grouped people's needs into five categories (hierarchically, from the lowest to the highest); namely physiologi-

cal needs, needs of security, needs of affiliation, esteem needs, and self-actualization needs. Verbal prizes serve the latter type of needs as they show acceptance of self and others.

Subsequently, [pri] conducted research to re-evaluate Deci's studies on the role of extrinsic motivation on intrinsic motivation. For this purpose, they conducted two data collection sessions using chess problem tasks for the control and experimental groups. In the beginning of the session, the participants were asked to indicate the amount of time they usually spent to play chess in a week, the number of years they played chess for, and the amount of enjoyment they gained from the game. Afterwards, the researcher excused him-/herself out from the room for ten minutes arguing that he/she would use the time to enter information from the participants into the computer. During this time, the participants were welcome to do whatever they liked while secretly being observed through one way glass. The room used for the experiment was equipped with several chess problem tasks and magazines. The participants' intrinsic motivation was measured by the amount of time spent on chess tasks during this break. Once the researcher returned back to the room, the participants were told that they would be given monetary rewards and the amount would be based on the number of chess problems they could solve (in the first session for the experimental group). In the second session, there were no monetary rewards offered. The participants in the control group did not receive any reward in both sessions. Similar to the results of [deca], [pri] indicated that there was a significant decrease in the amount of time spent in the second session in comparison to the first one for the experimental group. Other studies have also been conducted around this issue, such as [lep] [ama] [harc].

1.3.11.4 Social Networks

sec:4SocialNetworks

Nowadays, social networks are becoming a new phenomenon in the world of internet and has lead us to the Web 2.0 era. Social networks allow users to communicate, create, share, and get information, tips, and other content. Boyd & Ellison [boy] defined social networks as: "... web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system. The nature and nomenclature of these connections may vary from site to site." Therefore, using various social network services, people can connect not only with their acquaintances but also with strangers who share the same interests, activities, or certain world and political views. A qualitative study conducted in the UK by Binsted & Hutchins [bin] mapped individuals' usage patterns of social networks (Fig.1.5), namely: keeping in touch with contacts, sharing photos, playing games, following celebrities, organizing social events, getting recommendations, as well as gaining and sharing information. Social networks have also been used in the political arena, to facilitate election and to find information during political unrest.

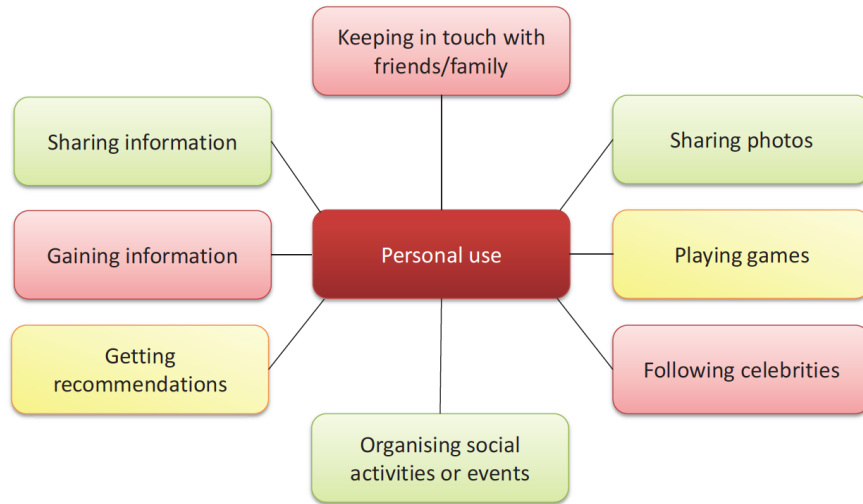


fig:4.5

Fig. 1.5: Personal use patterns of social networks [hin]

Some social network services work globally, covering a variety of users and an extensive geographical area, while others focus on specific regions/nations, languages, religions, and so on. Many of these sites also provide users with additional features, such as mobile connectivity, blogging, and photo/video sharing [boy]. There is a large number of social network services to date and certainly the figure is getting higher periodically. Many of them have been mentioned in existing publications [nex] [hin]. Therefore, we will put our effort in reviewing only literature that focuses on the use of social networks to support behavioural change. Afterwards, we will investigate the potential of social networks in travel behaviour, especially to persuade sustainable ways of travelling.

1.3.11.5 Conclusion

sec:Conclusion

To conclude, in-depth literature reviews allow us to see the potential incentives to encouraging travel-related behavioural changes and supporting people's daily travels. These incentives are identified within the four categories of travel information, feedback, points and rewards, and social networks. They are further detailed below.

Travel information

sec:sec4751

Many studies have shown that providing people with personalized travel information could eventually alter people's travel decisions, for instance with regard to mode,

route, and departure time choices. This could be strengthened by providing this information type in real-time. Travel information could take various forms, namely:

- Real-time personalized travel information about road networks, such as delay information, road works, and parking availability. This may also include alerts about road conditions.
- Real-time personalized travel information about transport mode alternatives, such as (the closest) bus stop and departure time information.
- Other relevant information in making travel choices, such as accurate weather forecasts.

Feedback

sec:Feedback

Feedback may have the ability to alter people's travel behaviour and retain the changes for a long-term. Allowing people to self-monitor their behaviour will let them have a full control over their own travel choices. This could happen because people would be able to see direct impact of their travel behaviour on the environment (CO_2 emissions) and on themselves (e.g. calories, costs, and time). However, alone, it may perhaps be a tricky incentive. It could be useful for those who, to some extent, have already positive attitudes towards the environment, health, or costs, but may not work as intended when their attitudes are somehow negative. However, any conclusion about this incentive type cannot yet be made. Empirical works should test this incentive further to find out about potential SUNSET users' preferences towards self-monitoring combined with the possibility to set personal travel targets (e.g. related to time, cost, distance, CO_2 and calories).

Rewards

sec:Rewards

This incentive type is particularly interesting because of the mixed results of various studies. Some argued that tangible rewards (such as monetary rewards) can reduce people's intrinsic motivation. However, non-tangible rewards (such as verbal prizes) do not necessarily influence people's intrinsic motivation. In games, points, another form of non-tangible rewards, are often used. The empirical works should investigate this further by studying potential ARTS users' attitudes towards this incentive type, in particular related to: points when performing "good" behaviour, and tangible rewards (or possibilities to redeem the collected points).

Social networks

sec:ch4Socialnetworks

It has been confirmed by many studies that social networks can be used to alter people's behaviour due to the peers' influences. Thus, social networks should be used as a medium to enhance other incentive categories. For instance, combined with self-monitoring and setting personal targets, social networks will allow ARTS users to

share their performances and to trigger competition with others. Combined with individuals' recorded mobility patterns, ARTS users with similar mobility patterns can be identified. Therefore, the system would be able to suggest users to cycle, walk, or to take public transport together with others who have similar travel patterns. Or in other words, it can be used to search for a (travel) companion(s). Combined with the location tracking, social networks could perhaps be used to make trusted friends or family 'watch over' a traveller when making a trip, making him/her feel safer when walking on a dark road or being in an unfamiliar city. This feature can also be used to setting a meeting place with a friend. At last, social networks are a very useful medium for people to exchange tips and experiences, such as tips related to certain modes or routes.

Actions for the ARTS Community

ActionsfortheARTSCommunity

- The area of human factors is still in its infancy when considered alongside the more technical, system producing groups within this Action. One future step that could yield results without much effort would be a proper collaboration between the 4 groups. Unknown to each ARTS group member is the inner workings and findings of each other. This problem means the human factor research cannot be applied to the system created for the human end user. Considering this most important cog in the system will ensure that first hand, a user friendly, research based system will come to fruition.
- Keeping with the topic of collaboration, sometimes literature and research can only take an academic so far. With the help of potential users, an academic has the possibility to refine their learning's, gain real life perspective that will most certainly further their understanding and also view how what they create would potentially fit into the real world which is the most important element of all.
- One interesting point raised within the report was the geographical perspective with which the report was written. Currently, the bias of the report enjoys a sole European perspective of the world an especially travel objectives, with any solutions or uncovering based on the European traveller. One would most definitely find that considering a different market (e.g. American, Middle Eastern) would yield a different result which would be fruitful in itself but also serve as a strong research opportunity in a comparison of sorts.

Appendix A
Appendix 01

sec:appendix1

Appendix B

Appendix 02

sec:appendix2

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