An exploration of cultural needs for in-vehicle navigation systems (IVNS)

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**Thesis submitted to the University of Nottingham
for the degree of Doctor of Philosophy (PhD)**

December 2012

Abstract

This thesis explores potential cultural needs appropriate to the design of in-vehicle navigation systems (IVNS). Such research is important given the increasing popularity of IVNS worldwide and the potential impact of their designs on increasing driver's satisfaction which leads towards safe driving environment. A review of the literature showed paucity in considering drivers' cultural values for navigational interfaces. The overall aim of the thesis was to explore characteristics of potentials driver's cultural needs for IVNS

Four empirical studies are described in the thesis to address cultural issues in drivers' behaviour when engaging with IVNS. The exploration took a bottom-up approach, applying different methods and study designs in an effort to cater for potential cultural needs. A non-structured direction giving study, an online survey, a structured direction giving study and a scenario-based design study were used to explore for potential driver's cultural needs. The non-structured direction giving study and the online survey were baseline research aiming to explore driver's navigation behaviour and perception in basic conditions (between drivers and road environment). The non-structured direction giving study utilised participants from four nations, representing different cultural backgrounds; United Kingdom (UK), Malaysia, China and Japan in UK environment. The online survey collected opinions from UK, Malaysia and Japan local drivers. The different cultural groups showed some suggestions of driver's cultural needs. The structured direction giving study and the scenario-based design study utilised participants from UK and Malaysia to investigate

the reliability and characteristics of driver's cultural needs for use in navigational interface.

The four studies showed reliable navigational elements emerging from culturally different environments. Based on the categorisation scheme developed by UK drivers in UK environment, a cultural framework was proposed. The framework makes a distinction of navigational elements into three attributes; basic, trueness and personal. Ego directions and landmarks were consistently used in constructing navigational instructions, suggesting their importance as a basic requirement in designing IVNS interfaces. In relation to trueness of road environment in structuring navigational instructions, junction types and road geometries were commonly used in foreign environments. Differences were observed in navigational instructions across culturally-different drivers for their nation-state environments, suggesting the need to cater for personal preferences in designing IVNS interfaces. Another finding to emerge from the four studies was the need to address how to display satisfactory information density on the interface according to cultural groups. For future work, the proposed cultural framework could be used in developing culture-specific prototypes of IVNS.

Acknowledgements

Papers emerging from PhD research

- MOHD HASNI, Y & BURNETT, G.E. (2011) Exploring cultural values in drivers' behaviour. IN WAARD, D., GERARD, N., ONNASCH, L., WICZOREK, R., and MANZEY, D. (Eds.) *Human Centred Automation* (pp. 227 - 238). Maastricht, the Netherlands: Shaker Publishing.
- MOHD HASNI, Y & BURNETT, G.E. (2010) Exploring cultural differences in drivers' behaviour *Doctorial Consortium, Ergonomics Society Annual Conference*. Date: 19th May 2010 http://www.ergonomics.org.uk/sites/default/files/pdfs/doctoral2010/YMohd Hasni.pdf

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1.1 Introduction

For the past 26 years, enduring challenges in the study of human factors and driving safety which have emerged as strong focal points are individual differences, perceptual capabilities, and in-vehicle technology (Lee, 2008). Each of these challenges is relevant to the design of in-vehicle navigation systems (IVNS), either nomadic (portable systems) or built-in within the electrical systems of the car. IVNS provide support to drivers in the task of planning a journey, and, most importantly, provide navigational directions (voice and visual) to the desired destination whilst on the move.

Nonetheless, as with many technological inventions, problems have arisen with respect to human factors. In particular, the mass media have reported incidents of incorrect navigational instructions which leading to inefficiency in driving and unpleasant driving experiences (Salkeld, 2007; Precey, 2009). It is believed that a change in driver's behaviour when engaging with the in-vehicle navigation systems has emerged due to issues pertaining to user interface designs. Suggestions of improving the designs, particularly the information within map displays across different cultural groups have been highlighted (Heimgärtner et al., 2007) and cultural influence was also raised as a potential factor in considering product design (Honold, 2000; Daimon et al.; 2000; Roessger and Hofmeister, 2003).

This approach is in consistent with other research area relating to interaction between human and computer devices which are also exemplifying cultural concerns. As an example, studies have demonstrated that users from different

national culture prefer different representation of information and structure for web sites (Marcus et al., 2001; Marcus and Gould, 2001).

Importantly, globalisation of in-vehicle navigation systems (IVNS) has raised the potential of considering cultural aspects in the product's user interface (Heimgärtner et al., 2007). The information content and map abstraction are a few of the relevant issues identified in perceived usability of the interface designs (Lavie et al., 2011). A good interface designed for IVNS needs to reduce interaction time between drivers and the systems (particularly visual interaction), which then contribute towards a reduction in drivers' distractions (Young et al., 2007). In a few study on interaction behaviour, Roessger and Hofmeister (2003) and Heimgärtner (2007) claimed for a consideration towards drivers' nationality in developing navigational user-interfaces (Daimon et al., 2000). Drivers could potentially find satisfying experience with designs of interface (Marcus et al., 2001) that consider drivers' embedded cultural values (Hofstede et al., 2010).

The effort of considering culture in driving should enlighten an understanding of drivers' behavioural adaptation when engaging with IVNS (Daimon et al., 2000). The use of IVNS as an automation tool for navigation is inevitable in the near future, given the increasing ownership of motor vehicles worldwide, in which would usually incline towards high rate of road traffic accidents (Kopits and Cropper, 2005). It has been estimated that global vehicle ownership will grow by 2.5 times, from 800 million in 2002 to over 20 billion in 2030 (Dargay et al., 2007). Therefore, the current doctorate research would be beneficial in

improving usability issues in the designs of in-vehicle navigation systems (IVNS).

1.2 Growth and development of in-vehicle navigation systems (IVNS)

IVNS came onto the market in the 1980's (Hamahata and Liaw, 1995) following advances in technology. In its earlier years, road users perceived IVNS as a luxury product being built as part of high-end cars (Forbes, 2009). However, further advancement in the product's hardware has made it more affordable for drivers. Now, drivers have a variety of options in choosing vehicle navigation systems that best suit their needs and convenience. The systems are either integrated in the dashboard of vehicles or nomadic/portable devices which can operate independently in any make of cars.

More recently, navigation systems in the form of applications on smart phones have experienced a growth in popularity amongst road users (Oh and Ambroggi, 2011). Similarly, IHS iSuppli market research has forecasted a 130 million increase in smart phones with navigation abilities in 2011 (Kim, 2011). Meanwhile TomTom, one of the global providers of IVNS have claimed that 50 million people worldwide usually use their portable device in 2010 with 54% regularly updating their devices (TomTom, 2010).

The significant increases in the number of road networks and increases in road traffics have been reported as a factor affecting why road users prefer automation in navigation (Janssen et al., 1995). Road users have looked for economical alternatives to navigation systems aiding their mobility in vehicles. Following statistics from various sources above, it has been noted that over the

last decade, IVNS have gained popularity despite the economic downturn (Alleyne, 2007).

1.3 Designs of current in-vehicle navigation systems (IVNS)

There are currently three types known for current IVNS, static, nomadic and smart phones applications. The overall designs of these systems vary considerably as shown in images of in-vehicle navigation systems (IVNS) sampled from online sources (Figure 1.1). Images A and B shows examples of a nomadic IVNS for UK markets, image C shows an example of a nomadic IVNS for Japan market, image D shows an example of a mobile application IVNS for UK market and image E shows an example of a nomadic IVNS for Singapore and Malaysia market.

E.

Figure 1.1: Samples of IVNS interfaces[1]

1.4   Drivers' satisfaction

Usability issues in devices such as in-vehicle navigation systems (IVNS) are increasingly difficult to ignore (Harvey et al., 2011). Drivers' experience while engaging with IVNS improves when the system performs the task according to drivers' expectation (Lavie et al., 2011). Importantly, IVNS which are generally not impairing a driver's safety and has a system that is visually appealing would also improve driver's experience (Lavie et al., 2011). The design of the system's interface has been one important component in improving drivers' experience (Marcus, 2000). The increasing popularity of in-vehicle navigation systems (IVNS) globally has increased the needs to consider differences in drivers across nations which are accountable to culture (Daimon et al., 2000; Roessger and Hofmeister, 2003; Knapp, 2007).

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[1]All images were last assessed on the 23 September 2011. Sources of images:

    A. http://pda-gpsnav.bestproductsreview.net/2010/07/12/garmin-nuvi-265w-gps-navigator-review/
    B. http://www.tomtom.com/en_us/products/car-navigation/go-2435-series/
    C. http://www.houseofjapan.com/electronics/mitsubishi-bdnav-system
    D. http://www.carbuzz.co.uk/blog/Top-Ten-Car-Apps
    E. http://www.eastgear.com/holux-gpsmile-nav-62f-car-navigator.html

1.5 Cultures in drivers' behaviour

Culture is often associated with human behaviour which later results in the formation of distinct characteristics among people. Importantly, there are many ways of defining culture, depending on the classification of research (such as psychology or anthropology) and its context-of-use. A reflection of this is documented in the work of Kroeber et. al. (1952) which estimated a total of 162 definitions was accounted to culture from various perspectives (for example history, psychological and many more).

Despite these different definitions, this thesis research considered cultural definitions that are applicable in the field of human computer interaction. It is hoped to bridge relevant thoughts of culture from various sources (Hofstede et al., 2010; Allwood, 1985; Hall and Hall, 2001), which may be beneficial in enhancing drivers' experience with navigational interfaces. Therefore, attempts of investigating culture require explicitly explaining all relevant contexts of cultures within a driver. Nevertheless, such exploration should hold drivers' accountability in adapting to other national cultures.

1.5.1 National culture

Shared values between the majorities of people with similarities in their country of origins are often grouped into one national culture. The mutual understandings and shared knowledge amongst a group of people from one nation is often learnt through generation and accepted by members of a group. Moreover, these collections of mutual understanding are translated into behaviours (Hofstede and McCrae, 2004). Nonetheless, the transparency of cultural values at national level has been argued as static (Myers and Tan,

2003) given the time differences in existence between cultures. For example the Islamic culture began more than twenty centuries ago (Stone, 2002), while comparative 'nation-states' are a more recent phenomena, such as the formation of commonwealth nations after the collapse of the British empire in the 19th century (Myers and Tan, 2003). Thus, most nations in the world are relatively new and have had the influence of other nationalities during colonization (Myers and Tan, 2003). Notwithstanding this, national culture has been accepted as a working tool to understand the norms of the said community, particularly in multi-national business relationships (Cannon et al., 2010). Therefore, national culture could potentially acknowledge differences in beliefs and norms across politically-drawn geographic locations.

1.5.2 Ethnic culture

It is important to understand the nature of ethnic culture as opposed to nationality, of which made the national culture. Ethnic culture owes its distinct behaviours according to biological and genetic factors (Barth and Bergen, 1969). The word ethnic in the Oxford English Dictionary (March 2011b) has many definitions, however in the context of an adjective, the relevant definition is:

> "pertaining to race; peculiar to a race or nation; ethnological. Also, pertaining to or having common racial, cultural, religious, or linguistic characteristics, especially designating a racial or other group within a larger system".

1.5.3 Organisation Culture

Having known the existence of national and ethnic cultures, research into human behaviours has to compromise the influence of organisation culture onto individuals. Given the length of time people spend working for their organisation (Hofstede et al., 2010) and notwithstanding the monthly earnings, satisfying the organization cultural needs is expected. Most organizations would have shared values within members which are later translated into acceptable behaviours amongst members. New members of the organization would then have to adapt to the organization culture in order to be successful.

A concise definition for organisational culture was given in the work of Schein (2010, p.18) as:

> "A pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way you perceive, think, and feel in relation to those problems".

1.6   Navigation

1.6.1 The influence of culture

Culture is a vast area of research with more than one way of placing it into perspective. The existence of a certain culture is due to a group of people who act in a similar manner (Cannon et al., 2010; Moeckli and Lee, 2007; Shen et al., 2006; Hofstede and McCrae, 2004), and often expressing identical ideas. However, members within a cultural group may still vary in personalities given the nature of cultural values (Myers and Tan, 2003). For example, Malaysia

has three major ethnic groups – Malays, Chinese and Indians due to the flow of labourers from China and India during the British colonization era in the late 18th century (Hirschman, 1987). Hence forth, this multi-cultural country would be more likely to experience situations such as Chinese-Malaysia personnel working at a Honda car assembly production in Malaysia.

The above individual would have a mixture of ethnic, national and organization cultures. It is noteworthy to acknowledge the complexity of cultural values that are often translated into human behaviours. Such knowledge would later help in interpreting the findings of one's research.

Notwithstanding this, nationalism and sovereignty remain strong in the majority of individuals given that every individual is accounted to follow the rules and regulations enforced by the ruler in that particular geographical area where one resides (Edensor, 2004). Ideally, the act of following the legislation by law directs these individuals to then form a large group which could be represented as one nation. Normally, reacting as a nation is doctrine from the early stage of formal education, where every pupil has to learn factual information such as the national flags, customs and anthem (Edensor, 2004; Featherstone, 2004; Moeckli and Lee, 2007).

1.6.2 The development of navigation skills

In this context of this research, it is believed that national culture is a good platform to compare people across national boundaries with regards to their respective navigation skills. In general, people develop their navigation skills from the environment they typically navigate in; and more often that particular environment is their home country. Hence, the acquired navigation skills are

'restricted' to the local environment. Navigation skills develop over time as drivers' gain more driving experiences. However, there are representatives of people who have had opportunities to travel outside their local environment. In other words, there are two common groups of people across the globe - people who have only travelled in their home environment, and people who have travelled in both home and foreign environments. Hence forth, in researching drivers' cultural behaviour across national boundaries, experiences gained in these environments (home and foreign) have potential in explaining drivers' navigational needs whilst on a journey.

1.7   Human factors issues in culture

1.7.1 Concerns over drivers' satisfaction

Drivers' satisfaction is one of the key goals in delivering usable in-vehicle navigation systems (IVNS). There have been growing concerns about designs of IVNS when drivers showed differences in perceiving attractiveness (Knapp, 2007), receiving navigational directions (Ishikawa and Kiyomoto, 2008), colour combination (Noiwana and Norcio, 2006), map abstraction (Lavie et al., 2011) and many other issues related to drivers' region. Despite the ongoing improvements in designs of current in-vehicle navigation systems (IVNS) particularly in the display of digital maps with useful information, very little knowledge is known about cultural effects on drivers in the context of using IVNS.

1.7.2 Concerns over driver's distractions

The growth of IVNS has also been associated with concerns over driver distraction which could potentially lead to increased risk in road safety. Driver's distractions resulting from visual or physical demands of non-driving tasks have the potential to reduce performance, given that drivers have to compensate their focus in driving (Young et al., 2007). Literature reviews conducted on distraction have shown that entering information on IVNS increase physical demands away from the road (Young et al., 2007). Whilst receiving navigational instructions without voice prompts increase drivers' visual attention (Young et al., 2007).

1.7.3 Globalisation effects on drivers

Popular brand name such as TomTom and Garmin claimed in their company's recent annual report that their automotive products have managed to enter the global market (Garmin, 2010; TomTom, 2010). Garmin, for example reports to have sold their range of products in approximately 100 countries (Garmin, 2010) while TomTom had extended its map database to over 103 countries (Privat, 2011). A wide coverage of map area supports and strengthens products' sales. However, these examples of global market penetration have shown that vehicle navigation systems have not been available at the same point in time across the world. Road users in Japan, USA, Netherlands and most European countries have had the opportunity to experience in-vehicle navigation systems (IVNS) since their infancy stage. Meanwhile, restrictions from various sources (such as the availability of vector maps and local governments' policies) have slowed uptake for other parts of the world. Nevertheless, the difference in time

does not affect the industry given that their products have been improving over years with more value added features.

These end-users in other parts of the world could potentially be affected positively as well as negatively due to globalization. The transparent positive affect given by IVNS is a reduction in driver's workload, particularly in planning road journeys (Wickens et al., 2004; Young et al., 2011). Nonetheless, this in-vehicle automation could also increase drivers' distraction should more visual and physical demands be required to comprehend the navigational instructions (Young et al., 2007). The meaningfulness of text instructions and the icons used in the navigational interface may not translate into the actual definitions as intended by the systems' designers (Lee et al., 2005).

Drivers with different nationality share similar knowledge of performing the primary task of driving a vehicle. However, differences have been found that account for culture in the context of use of IVNS across national borders (Marcus et al., 2001; Heimgärtner et al., 2007). Furthermore drivers' perceptions and expectations could also differ regionally (Daimon et al., 2000; Lee et al., 2005; Knapp, 2007). Hence, globalisation of IVNS is likely to have an effect on drivers.

1.7.4 Considerations for cultural navigational interfaces

During its infancy stage, issues pertaining to the design concept for in-vehicle navigation systems (IVNS) emerged. For example, in the work of Hamahata and Liaw (1995), differences in providing directions were noted across national borders which were believed to have taken shape from the map layouts and

road environment of the country. Hence, the design of IVNS in 1980s reflected the local drivers' preferences in direction-giving (Hamahata and Liaw, 1995). Importantly, the road environment has also influenced the characteristics of drivers' behaviour, in particular in selecting a route to a common place (Daimon et al., 2000).

Comparatively, a geographic area that has an abundance of landmarks is different from another area that uses road street names for every path. Therefore, road environments that are significantly different across regional and national boundaries should be taken into account in designing IVNS. Given the knowledge of national culture, it would be worthwhile to explore further the characteristic of drivers' behaviour from the perspective of culture.

Notwithstanding this, the later generation of IVNS continue to add more features such as real time traffic updates and infotainment capabilities, following the rapid development and increasing popularity amongst road users. The investigation of cultural affects on drivers' behaviours have been relatively minor compared to studies that contribute to understanding models of drivers' performance. Therefore, a literature review indicated that the role of culture within the context of using vehicle navigation systems was not studied comprehensively when compared to the length of time the products have been in the global market. Concerns for cultural differences develop when design issues were place alongside the products' usage. The designers' cultural values were taken onboard and arises concern over the brands' concept of design following globalization. Would a person who purchased a product locally find a similar comfort in their driving experience when using it abroad?

Importantly, is the manufacturers' standard design, in particular the physical design of the interfaces, fit for global road users?

Following this, the thesis is motivated to understand the role of cultural values in drivers' navigation behaviours, which could be subsequently taken as guidelines for a culturally-aware navigational interface. Given the complexity of culture, the investigation has applied various methodologies to identify the cultural elements between drivers and road environments.

1.8   The definition of culture in the thesis

This section defines the context of culture used in the thesis. In accordance to the Oxford English Dictionary online database (March 2011a), the definition of culture is:

> "The distinctive ideas, customs, social behaviour, products, or way of life of a particular society, people, or period. Hence: a society or group characterized by such customs, etc"

Furthermore culture, with modifying noun (Oxford English, March 2011a):

> "A way of life or social environment characterized by or associated with the specified quality or thing; a group of people subscribing or belonging to this"

Culture is often used to distinguish one group of people from another group (Allwood, 1985; Hall and Hall, 1990; Hofstede et al., 2010). Members within a particular group would have developed common behaviours (Hofstede et al., 2010), silent language (Hall and Hall, 1990), patterns (Allwood, 1985) that are often understood by each member and are less likely to occur in other groups, hence the evolution of distinction in characteristics.

The main element that contributes towards the formation of any particular culture is human behaviours, in which case when more than one person reacts towards an event in similar manners (Allwood, 1985; Hofstede and McCrae, 2004); or when the events are understood in silence with no efforts of explaining reasons (Hall and Hall, 1990). Thus far, these situations transform culture into a vast dynamic field with possibilities of more than one culture co-existing in a person. Furthermore, the dynamic feature of culture also enable it the ability to remain strong or turn weak over generations.

In this thesis for example, exploring cultural values in drivers (sharing a space between one and the others) could not disregard the existence of nationalism, the inherency of ethnicity and the learned organisational culture within a driver. Apart from that, drivers together with vehicles and in-vehicle navigation systems (IVNS) had their shares in globalisation in the automotive industry. Importantly, both drivers and their respective vehicles are part of road traffic culture (Featherstone, 2004; Moeckli and Lee, 2007).

Notwithstanding the natural complexity of culture being bore in each individual and other associated element (such as vehicles or environments), this thesis will focus on nationalism cultural values. The platform of investigation is the context of use between drivers, road environments and vehicle navigation systems. The thesis is investigating the behavioural expression when drivers are manoeuvring motorized vehicles, particularly in novel journeys.

Similarly, differences due to national culture were suggested by the anthropologist, Geert Hostede who defined culture as 'the collective

programming of the mind which distinguishes the members of one human group from another' (Hofstede and McCrae, 2004, p.58). Hofstede (2010) argued culture as values resembling preferences of one state over another at a national level. These values are cultural dimensions of power distance, uncertainty avoidance, individualism, masculinity, long-term orientation and indulgence. Meanwhile Hall and Hall (1990) conceptualised culture as a communication of the silent language which is rooted from the shared experiences of people. Culture, according to Hall and Hall is derivative of context, speed, time and space.

Conversely, Allwood referred culture as 'all the characteristics common to a particular group that are learned and not given by nature' (Allwood, 1985, p.1). Analytically, culture to Allwood (1985) could be differentiated into four patterns; thoughts, behaviour, artefacts and imprints in nature. According to Allwood, in the event where communication occurred between two cultural groups, intercultural communication should be defined as,

> 'the sharing of information on different levels of awareness and control between people with different cultural backgrounds, where different cultural backgrounds include both national cultural differences and differences which are connected with participation in the different activities that exist within a national unit' (Allwood, 1985, p.3).

However, each of the above-described definitions (from Oxford dictionary, Hall, Hosfstede and Allwood) would be insufficient to address cultural elements in the field of ergonomics. Hence, the definition of culture given by Pia Honold (2000, p.328-329) was considered in this thesis to elaborate on

drivers' cultural position in the threesome relationship between drivers, road environments and vehicle navigation systems.

Honold (2000) had attempted to elucidate culture in the context when a human interacted with a computing machine. Honold (2000) claimed that constructing culture in a specific area of interest would then define potential cultural influences. In the work of Honold (2000), cultural influence was explored using German product, a front load washing machine in Bombay and New Delhi, India. The test product used in this study was for United Kingdom market, therefore the labels and instruction manual was in English. A group of 35 Indian housewives were recruited as participants and two interviewers (a female Indian market researcher and the author herself). A combination of observation and semi-structured interview was applied to collect participants' experiences in using the test product. Both methods were recorded on audiotape and videotape. Think aloud technique was used to understand participant's perceptions for every operation, such as turning dials and pushing buttons.

The outcomes of the study have demonstrated that participants have applied their mental models from previous experience to determine the operational procedures of the test product. This outcome has demonstrated differences across national culture in interaction between user and global product. Eight influential factors were deduced from the study, '*objectives of the users, characteristics of the users, environment, infrastructure, division of labour, oraganisation of work, mental models based on previous experience, and tools*' (Honold, 2000, p.341)

In the effort to achieve the overall aim of this thesis, given the complexity in the interaction process between drivers and vehicle navigation systems along with the influence from the road environments, conceptualising cultural values in drivers would need to follow the process of defining culture as described in the work of Honold (2000).

The excerpts are:

- *Culture defines members of a group as distinct from members of other groupings;*

- *Culture creates an orientation system and a field of action for these members;*

- *Culture manifests itself in cultural models. These may be internal cognitions or external artefacts and institutions;*

- *Culture models may differ in their scope and therefore in their significance to a culture;*

- *Culture models are acquired through interaction with the environment. Action and experience on the one hand and cultural models on the other affect one another through the processes of accommodation and assimilation;*

- *Culture does not determine the behaviour of individuals but it does point to probable modes of perception, thought, and action. Culture is therefore both a structure and process"*

(Honold, 2000, p.328-329)

The thesis intends to explore drivers' behaviour, particularly whilst interacting with in-vehicle navigation systems (IVNS). Reflecting on Honold's approach to culture, researching into the 'orientation system' of drivers when engaging in an

'external artefact' such as a navigation systems, the outcomes point to 'perception, thought and action' (2000, p.329). More importantly, interaction with road environments contributes toward the attributes of drivers' behavioural adaptations when using vehicle navigation systems.

On the basis of definitions provided by Allwood (1985); Hall and Hall (1990); Honold (2000); Hofstede and McCrae (2004) and Oxford English Dictionary online database (March 2011a), research activities within this thesis will be guided by a working definition of culture:

> Culture, in the context of this PhD is a skill of life characterized by a driver's nationality in association with their natural road environment. This skill is embedded in a driver's mind and shared with other members who operate within similar road environments. The practices of this skill are in silent language, and are distinctive to a group of drivers who share the origins of driver's licence and have developed skills of navigation skills in similar road environment.

The primary focus of the overall thesis will underline drivers' direction-giving behaviour in home and foreign environments and compare between drivers of different nationality. Given that the road environment has a role in drivers' direction-giving preferences (Hamahata and Liaw, 1995; Daimon et al., 2000; Knapp, 2007), it is vital to investigate drivers' navigation skills and drivers' perception of the environment. This would later assist in locating potential cultural needs within drivers while engaging with vehicle navigation systems.

1.9　Aim, objectives and activities of the thesis

The overall aim of the thesis is to explore potential cultural needs relevant to the design of in-vehicle navigation systems. Thus to satisfy this aim, a set of specific objectives were formulated as listed below:

(O1)　To generate an understanding of cultural needs using elements deriving from drivers navigating in a road environment across national culture;

(O2)　To understand cultural needs via perception of local drivers from different national cultures about differences in driving behaviour;

(O3)　To generate a cultural understanding from drivers' navigation strategies in culturally different road environment;

(O4)　To understand cultural needs in drivers' expectations of navigational interface.

To achieve this, a series of activities was structured as listed below:

(A1)　A direction-giving study across UK, Malaysia, Japan and China;

(A2)　Online questionnaire across UK, Malaysia and Japan;

(A3)　A structured direction giving study across UK and Malaysia in culturally different environments, UK, Malaysia and Japan roads; and

(A4) A scenario-based design study across UK and Malaysia in three culturally different environments, UK, Malaysia and Japan roads.

(An illustration of these activities are given in Figure 1.3, page 23)

1.10 Scope of the thesis

There are two potential areas where cultural needs could occur – the context of design and the context of use (as illustrated in Figure 1.2). This thesis aimed to focus on the shaded area where drivers interact with surrounding environments, whilst in the context of using in-vehicle navigation systems.

1.10.1 Driver's National Culture

Exploration of cultural needs begins from drivers' behaviour in navigation. Drivers were examined according to their national cultures. Some published cultural dimensions (Hall and Hall, 2001; Allwood, 1985; Hofstede et al., 2010) from other research areas were carefully considered to investigate a driver's cultural profile.
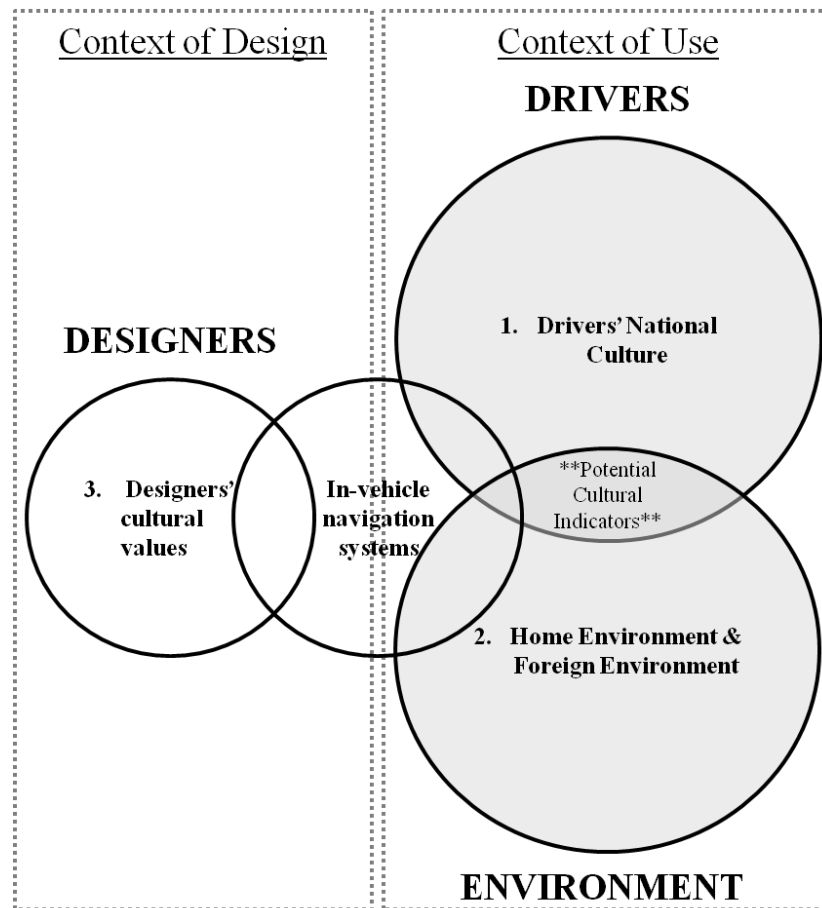
Figure 1.2: Venn diagram illustrating scope of thesis

1.10.2 Home Environment vs. Foreign Environment

Importantly, the research has taken the approach to compare and contrast behaviour and preferences between home and foreign environments. A home environment refers to the nation-state environment of the driver (for example, the home environment for a British driver is the UK road environment). On the other hand, a foreign environment denotes any other nation-state road environment.

Following this, the research investigates drivers' perceptions in navigating for culturally different environments. In particular, the research explores the

potential for cultural needs based on drivers' choice of navigation information in home and foreign environments.

1.11 Thesis framework

In order to achieve the aim and objectives of the thesis, a series of research studies were planned to be conducted in stages (as shown in Figure 1.3). It is believed that an exploration for cultural needs for in-vehicle navigation systems should be rooted back to driving scenarios when drivers interact more with the surrounding environment. Given that culture is such a wide ranging concept (Kroeber et al., 1952), a bottom-up research approach was justified. Furthermore, it seems likely that drivers develop useful navigational strategies whilst interacting with the road environment, which could be influenced by culture.
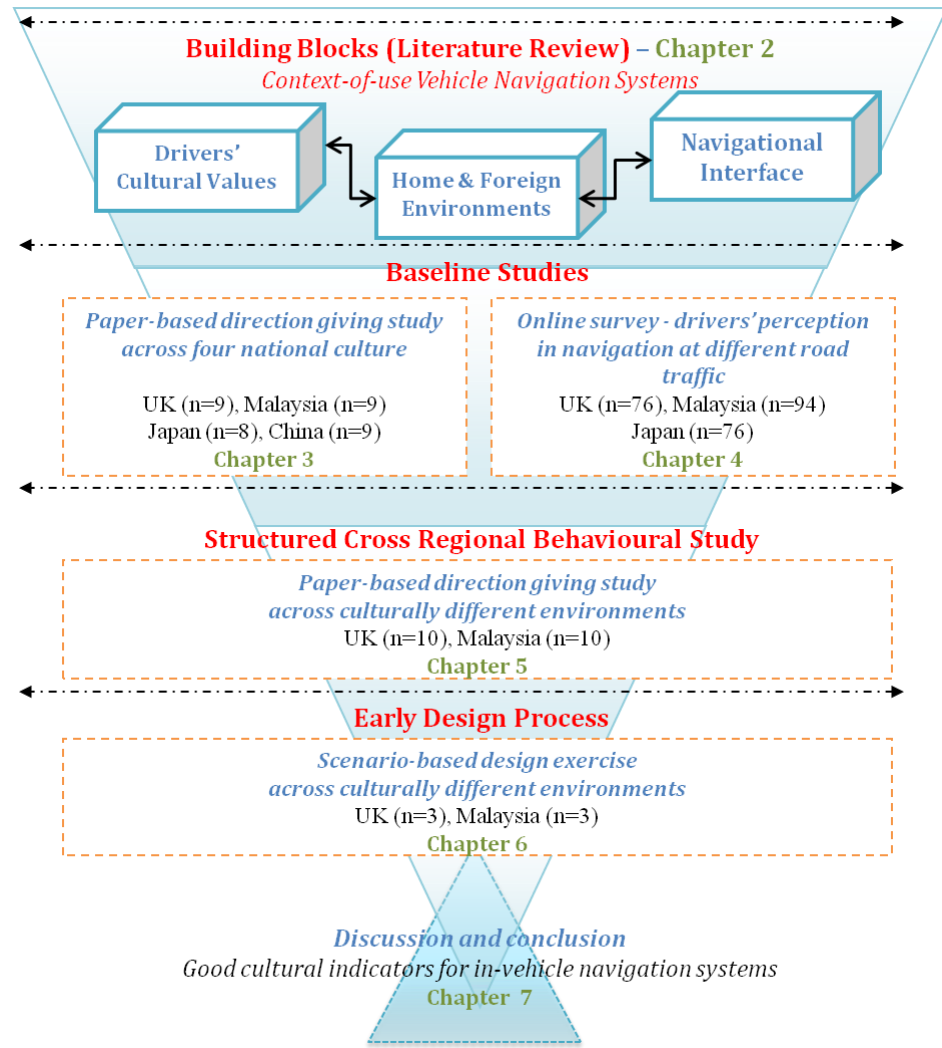
Figure 1.3: Thesis framework

The first step in the research was structuring a review in the context-of-use of in-vehicle navigation system. Three building blocks (research themes) identified and used to build the review were (1) driver's cultural values, (2) home vs. foreign environment and, (3) navigational interface.

Next, due to limitation in information on the right contextual use of culture for studying driver's behaviour, two baseline studies were planned to extrapolate culture. A paper-based direction-giving study was justified for investigating behavioural changes in navigation strategies when measuring drivers' national

cultures according to published cultural dimensions. Meanwhile, an online survey was employed to investigate drivers' perception about behaviour in different road cultures and, drivers' preferences in navigation.

The findings from the baseline studies were considered to justify another paper-based direction-giving study with an additional independent variable (home and foreign environments). This study aimed to explore navigation strategies in different road environments across two cultural groups.

Finally, potential cultural needs identified in the two paper-based direction-giving studies were examined further in a scenario-based design study. Different groups of participants from the same cultural groups were recruited for this study. The aim was to investigate drivers' perception of the environment and drivers' expectations of navigational interface. At the end of the research, it was anticipated that attributes for good cultural needs for navigational interfaces would be discovered which could be used in the future to design and evaluate several prototypes of culturally aware interfaces.

1.11.1 Synopsis of chapters

Chapter 2 – Literature reviews – cultural needs for in-vehicle navigation systems

The research started with a review about issues relating to culture in human factors knowledge for in-vehicle navigation systems. The review revealed that considering culture in drivers' behaviour was loosely defined in human factors field. It was clear from the review that cultural issues exist in drivers' interaction with in-vehicle navigation systems. Given that culture has a wide

ranging definition and contextual use, the review was then structured with three research themes: drivers' cultural values; home vs. foreign environment; and user interface. The review aimed to critically consider published cultural dimensions from other research fields within the context-of-use of in-vehicle navigation systems. The building blocks (as illustrated in Figure 1.2) guided the direction of literature review. Following this, it was clear that good cultural needs were needed for use on displays of in-vehicle navigation systems, as very little exploration had been conducted in this field.

Chapter 3 – Paper-based direction-giving study across four national cultures

This chapter describes the first part of the two baseline studies. It was decided that drivers and road environments were essentially important in road journeys. Therefore, a paper-based direction-giving method was employed in UK road environment across four cultural groups, UK, Malaysia, China and Japan (8 – 9 participants per group). The selected nations were chosen according to Hofstede et al. (2010) cultural dimensions. Unfortunately, the findings of this study suggest a limitation in explaining drivers' navigation strategies using just the published cultural dimensions from other research fields (Allwood, 1985; Hall and Hall, 2001; Hofstede et al., 2010). Nevertheless, a categorisation scheme developed elsewhere in human factors field, managed to explain drivers' choice of navigation information (Burnett, 1998). Several other findings related to navigation skill were also reported in this chapter. The study concluded the potential of the direction-giving method in identifying differences in navigation strategies across cultures. Importantly, the influence of road environment in drivers' national culture was noted, which helped in

structuring the direction of other studies in this thesis. Results of this study were presented at the Doctorial Consortium, Ergonomics Society 2010 (Mohd Hasni and Burnett, 2010).

Chapter 4 – Online survey, driver's perception in navigation at different road traffic

This chapter reports an online survey of 246 drivers across different cultural background (UK, Malaysia and Japan) which formed the second part of two baseline studies. The two studies as a whole aimed to understand drivers' perceptions of behaviours whilst undertaking a journey. Differences in driving styles across nationalities were highlighted in this online survey. Furthermore, differences in naming useful items for navigation between home and foreign environments were also reported in this chapter. Importantly, local drivers from three national cultures gave different opinions in usefulness of eight named-tools for navigation in unfamiliar places. Results of this study were presented at the Human Factors and Ergonomics Society Europe Chapter Annual Meeting 2010 (Mohd Hasni and Burnett, 2011).

Chapter 5 – Paper-based direction-giving study across culturally different road environment

This chapter describes another direction-giving study which aimed to address drivers' perception about different road environments, when seeking to generate useful paper-based navigational instructions. When the findings from chapter 4 were reflected on the different styles, density of information, abilities, preferences and types of elements as found in chapter 3, a similar methodology approach was applied, however with the application of a different

design structure. This step was taken in an effort to explore the embedded cultural values within drivers that could affect their preferences for navigation information. The two cultural groups, UK and Malaysia (n=10/group) evidently expressed differences in their choice of navigational information which was reflected as employing different navigation strategies in culturally different environment (UK roads, Malaysia roads and Japan roads). Certain results for this study were presented at the Human Factors and Ergonomics Society Europe Chapter Annual Meeting 2010 (Mohd Hasni and Burnett, 2011).

Chapter 6 – Scenario-based design exercise across culturally different road environment

This chapter describes a scenario-based design exercise which aimed to understand the attributes of good navigational information across culturally different environments, and between cultural groups. Findings in Chapter 5 directed the needs to explore differences in choice of information within the context of designing navigational interface. Therefore, this study was structured with similar variables as in Chapter 5. The findings suggest cultural needs could potentially be outlined from the attributes of navigation information following drivers' personal valuation whilst negotiating different environments. Importantly, drivers were discovered to perceive the environment differently in their sketch-interface which showed variation across cultures. Thus, it seems possible to consider these variations as cultural needs.

Chapter 7 – Thesis conclusion and future work

This chapter reports a collective discussion about findings from the four studies in this thesis. These findings were synthesised and a cultural framework was proposed to cater for the cultural needs of drivers. Several prototypes were also proposed in this chapter as examples on how to utilise the proposed framework. Another finding to emerge from the studies was the need to address how to display sufficient information density on the navigational interface. For future work, the proposed cultural framework could be used in developing culture-specific prototypes of in-vehicle navigation systems (IVNS).

Chapter 2:   Literature review

2.1   Introduction

The first step in the research was structuring a review in the context-of-use of in-vehicle navigation system (IVNS). This literature review focuses on three building blocks (research themes), driver's cultural values, home environment vs. foreign environment and navigational interface of IVNS (as illustrated in Figure 2.1) to understand cultural issues in using IVNS.
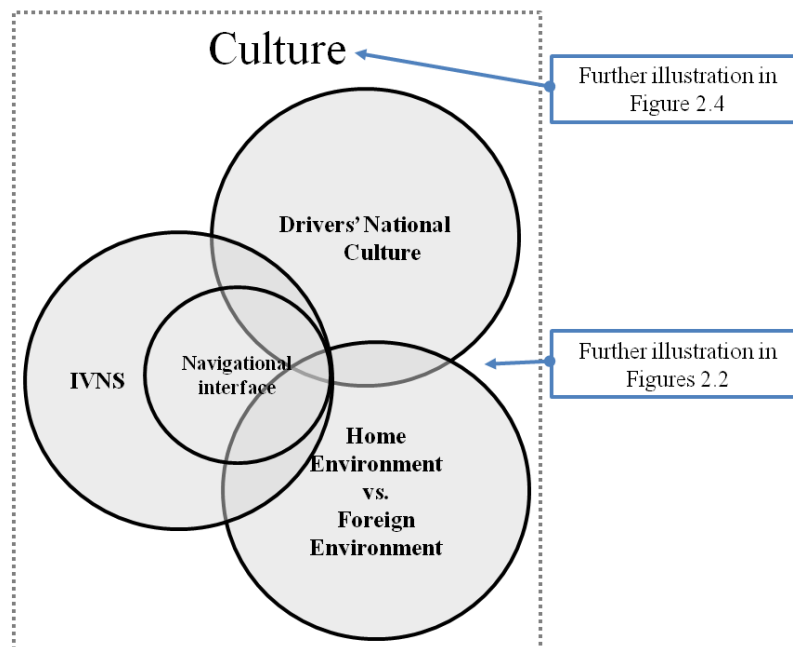
Figure 2.1: Venn diagram illustrating literature review buildings blocks

 The Venn diagram illustrated each building block as relatively related with IVNS's interfaces (navigational interfaces). Culture, in this illustration existed 'loosely' both inside and around the building blocks. Figure 2.2 (in page 31 of this chapter) is an extension to the Venn diagram which illustrates in part, how research related to drivers' cultural values have been reported in published literature.

Exploring potential cultural needs for in-vehicle navigation systems

Driving activity

What do drivers have to face whilst driving in normal condition as described in the literature?

Driving Task (Michon, 1985)

Strategic → Tactical → Control

Novice drivers → Experienced drivers → **Driving skills & Navigation strategies** → Drivers' limitation

Driver's Attention (Wierwille, 1993)

Visual | Manual | Cognitive | Communication

So, how has the literature been considering culture in drivers' behaviour within the context of using in-vehicle navigation systems (IVNS)?

Drivers' cultural values

Studies reporting cultures in behaviours at macro level (nation) for example, (Daimon et al., 2000; Michon and Denis, 2001; Lindgren et al., 2008; Davies and Pederson, 2001; Özkan et al., 2006)	**Studies reporting cultures in behaviours at micro level (individual) for example,** **Age** (Itoh et al., 2005; Horberry et al., 2006) **Gender** (Lawton and Kallai, 2002; Carpenter et al., 2004)	**Studies reporting cultures in behaviours at navigation for example,** (Davies and Pederson, 2001; Curzon et al., 2002; Knapp, 2007; Ishikawa and Kiyomoto, 2008)	**Studies reporting cultures in interaction behaviours for example,** (Roessger and Hofmeister, 2003; Heimgärtner et al., 2008; Heimgärtner et al., 2007)
These studies have made comparison across national culture. Cultural differences, reported at macro level were due to behavioural characteristics, road traffic, environment layout and other related issues.	Similarly, cultural effects were also found at micro level, particularly age and gender. Growing aging drivers' population has raised the needs to consider different designs of IVNS, and males/females reportedly prefer different styles in navigation.	Some of the studies which discussed cultural issues in navigation also appeared to have been exploring at macro level. Culture has reportedly affected drivers' mental modals in navigation, environmental layouts, verbal navigation directions, perceptual motor-skills and safety skills along with other related issues.	Culturally different groups were reportedly having different preferences in interacting with interfaces. Studies in this category have used interfaces for IVNS to exemplify the above differences. Drivers' information systems and Intercultural Interaction Analysis (IIA) Tool was developed.

Figure 2.2: Research related to drivers' cultural values in the literature

The review will start first by describing drivers' cultural values. This is followed by review of relevant literatures which addressed road environments in the context of home and foreign. Next review in order is about IVNS interfaces, which set focus on relevant navigational issues. Finally, this review provides the right contextual use of definition for culture, given that culture has wide ranging concept and definition (Kroeber et al., 1952). Figure 2.5 in page 63 of this Chapter is the final extension from the Venn diagram which illustrates in part, how culture was addressed in drivers' behaviours research.

2.2 Overview on drivers' cultural values

This part of the review is focused on driver's cultural needs. In the effort to explore such needs, it is important to understand the hierarchy of driving tasks, limitation of driver's attentions, the development of driving skills, navigation strategies across different cultural backgrounds and its influence on direction-giving. This first part of the review also explored justification of cultural needs at both entry, macro (at national level) and micro (across individuals). In summary, it is hoped such exploration would provide a structured steps in drawing an information gaps on driver's cultural values.

2.2.1 The hierarchy of driving tasks

In the effort to conceptualise the complexity of driving, Michon (1985) describes driving as a combination of strategic, tactical and control tasks (Table 2.1). Each level of task has its definitive role and together these three levels incorporate drivers' navigational skills, which differ from one individual to the other. It appears that through experiences on the road, a driver can accumulate

a considerable amount of navigational skill, which later develops into personal confidence as a road user.

Table 2.1: Showing description of driving task (Michon, 1985)

Levels in driving task	Description	Examples
Strategic	Driver's overall purpose for instance selection of routes and selection of time departure	Planning journeys
Tactical	Driver's immediate purpose for instance selecting speed, decision on taking a break or overtaking another vehicle	Making turn decision
Control	Driver's momentarily purpose for instance lane position control and speed control	Turning steering wheel

2.2.2 Limitation of drivers' attentions

Wierwille (1993) explains the complex nature of primary driving tasks while concurrently performing additional secondary tasks within a vehicle. The report identifies and justifies a ranking order of importance for a 'driver resources pool' (Table 2.2). This is based on the nature of the resources relative to a driver's primary task of manoeuvring the vehicle. According to Wierwille (1993), the given rank on the resources pool could serve as a guideline to car companies in adding features such as built-in in-vehicle navigation systems (IVNS) and adaptive cruise control.

Wierwille (1993) also suggests that a driver's engagement with an interface would increase safety when consideration for these resources is made prior to including additional features on the in-vehicle systems. The move towards good in-vehicle navigation systems (IVNS) would be identifying possible safety threat and being critical at issues relating to visual, manual, cognitive,

auditory and other resources which a driver might use in completing the primary task of driving (Wierwille, 1993).

Table 2.2: Showing rank of importance relative to driver's primary task (Wierwille, 1993)

Rank of Importance	'Driver Resources Pool'
1	Visual Load of In-Vehicle Devices
2	Manual Load of In-Vehicle Devices
3	Cognitive Load of In-Vehicle Devices
4	Communication Load of In-Vehicle Devices

One question that needs to be asked, however, is whether culture could affect the ranking of importance of these resources as claimed by Wierwille (1993). As an example, would people from a national culture preferring high density of information on an interface finds satisfaction driving with navigational systems that place greater auditory demand (such as more verbal instructions). Or, a system that provides limited visual display? This question would instate researching into driver's cultural needs. In particular, when reflected onto Hofstede's claim for *uncertainty avoidance* which was described as 'the degree to which a society feels uncomfortable with uncertainty and ambiguity' (Hofstede, 2010). This could then be a measure of user's satisfaction, particularly when their uncertainties in navigation are catered when using a high density navigational interface. Additionally, relevant cultural issues literature has been indicating differences across national culture in density of information for IVNS (Heimgärtner, 2007b; Heimgärtner et al., 2008).

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2.2.3 Developing driving skills

A driver's licence is an official document which justifies abilities to memorise procedures of manoeuvring and safely control a particular vehicle class. When a person has acquired a driving licence, consequently the person is able to perform driving tasks successfully. Driving task is often referred to in the literature as the primary task (Wittmann et al., 2006; Griffiths and Gillespie, 2005; Lansdown et al., 2002; Wierwille, 1993; Wierwille and Gutmann, 1978). Upon learning the primary task, drivers continue on to the process of acquiring driving skills which involves a series of interactions with road environments and other road users (Deery, 1999; Zhang et al., 2006). This process includes assimilating and processing important navigational information as the vehicle moves (Wickens et al., 2004). This view is parallel to those of Edensor (2004) about drivers increasing environment familiarity due to interaction during navigation. Edensor (2004) argued drivers' skills were limited to spatial knowledge gained from the home environment (denotes nation-state of the driver's environment).

The latter view argued by Edensor (2004) was also demonstrated in other study conducted by Davies and Pederson (2001) about culture affect of a driver's skills in providing directions. The findings showed a difference between residents of two cities in two countries in providing directions, despite similarities of living in a grid pattern city. These residents were from Milton Keynes, England and Eugene, USA. Car drivers who reside in a grid-pattern city of Milton Keynes, England were claimed as being more influenced by the country's generic road layout (i.e. centric grid) in their sketch of directions and

a task of point to non-visual landmarks (more description about the test conducted in this paper can be found at section 2.3.5 of this Chapter). Moreover, difference in the availability of landmarks and road street names were stated in the literature as leading towards disparity in direction-giving across regional boundaries (Daimon et al., 2000).

Therefore, it seems plausible to relate drivers' knowledge about road environments (where novices transform into experienced drivers), with driving skills. Having known the processes involved in developing driving skills, justifying cultural related issues in part, are believed to have been indispensable. Given that such skills develops following interaction with road environments, issues could have been caused by differences in road rules (Simpson, 2001), generic road layouts (Davies and Pederson, 2001), infrastructure (Daimon et al., 2000; Edensor, 2004) and other elements of the environments.

As an example, Zaidel (1992) argued that drivers' perceptual knowledge of a local environment are influenced by varying environmental elements, its general rule of traffic conduct and social norms of the local community. According to Zaidel (1992), such influence originated from a collective of drivers' attitudes towards acceptable behaviours.

Furthermore, drivers do not always necessarily have similar understanding or, sharing similar concept about road safety. Such view was explored in Zhang et al. (2006) where drivers in China perceived skilful driving being more important than maintaining road safety (use of turning lights) when compared with drivers in the USA. This study has employed several focus groups in

Beijing, China and Boston, USA which recruited 18 and 26 participants respectively where similar sets of questionnaire and interview questions were used across cultural groups. Chinese drivers were discovered perceiving aggressive driving as preferable and knowledge on safety driving conditions such as using turning lights were limited (Zhang et al., 2006). Thus in developing driving skills, a 'driving style' could potentially emerge at national level.

Notwithstanding the views of Zaidel (1992); Daimon et al. (2000); Davies and Pederson (2001); Edensor (2004) and Zhang et al. (2006), very little was found in the literature on the claim for 'driving style' as part of national culture. Instead, differences across nation in driving style were reported in travel blogs such as *the culture of driving* (Giovine, 2010) which showed differences in driving culture between Italy and USA. Similar view was shared in a travel blog of a rental car company, Nova Car Hire (www.novacarhire.com) which provided guidance to car rental customers about driving expectations in Italy. Furthermore, another blog article entitled *caught on tape: the art of driving in Lebanon* (Fadi, 2011) demonstrated the Lebanese customary behaviours on video. Similarly, a list of driving scenarios demonstrating Lebanese driving culture was shared in a blog entitled *driving in Lebanon* (Tarek, 2010).

On the contrary, driving styles were described as *'the way drivers choose to drive or their customary driving mode'* (Taubman-Ben-Ari, 2006, p.185). The said author claimed that a *'customary driving mode´* was defined by eight factors: dissociative, anxious, risky, angry, high-velocity, distress reduction, patient, and careful (Taubman-Ben-Ari et al., 2004).

Thus, on the basis of developing driver's skills to navigate in an environment, it may be possible to identify a driving style based on two elements, social deviation behaviour and collective behaviours (as illustrated in Figure 2.3).
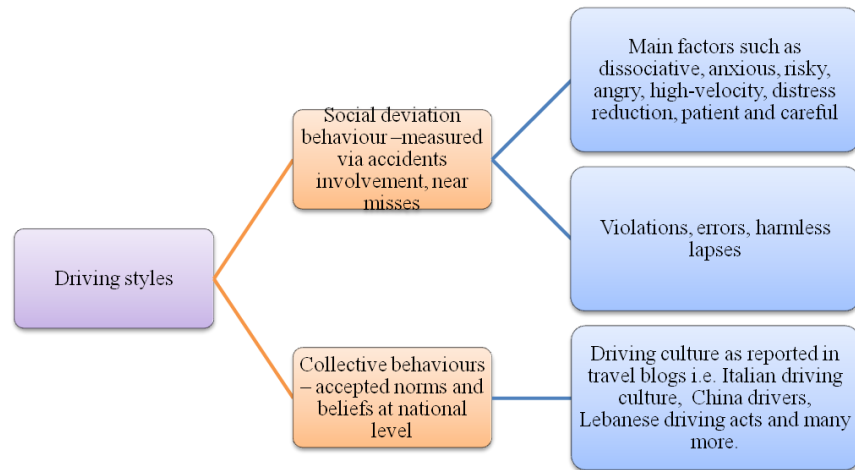
Figure 2.3: Differences in relationship of driving styles between published research and *'national'* driving behaviour

In other research, several questions given in the original Driver Behaviour Questionnaire (the English version) were found sensitive across different cultures, particularly when the questionnaire was translated into other languages, such as Finnish and Dutch languages (Lajunen et al., 2004). It was concluded that comprehensive knowledge of the country such as general culture was essentially important in the effort to understand local drivers' behaviour (Lajunen et al., 2004). This study gave a further suggestion of considering cultural factors in self-reported cross-cultural behavioural studies (Lajunen et al., 2004).

2.2.4 Navigation strategies across culture

The needs to understand more about cultural behaviours were apparent when global products such as in-vehicle navigation systems (IVNS) are appearing to

indicate cultural issues. IVNS have been invented as a secondary task for drivers. Unlike the primary task of safely controlling the vehicle, secondary tasks do not require 100% of driver's attention throughout the road journey. These tasks normally take a portion of drivers' attention such as receiving a call via mobile phone.

Nevertheless, some secondary tasks, for example engaging with IVNS have been reported to encourage drivers to engage in unsafe behaviours such as lane departure (Lansdown et al., 2002) and prolonged glances away from the road (Green, 2000). It has been reported that the phenomenon of engaging with IVNS has certainly changed drivers' behaviours, particularly in their navigation styles (Precey, 2009; Salkeld, 2007). Morever, the experience that drivers have while on a road journey has seen rapid changes, with increasing number of roads being built (Iaych et al., 2009) and multiple technology features adapted onto systems of newly built vehicles.

The introduction of in-vehicle navigation systems (IVNS) into global market may have underestimated potential cultural needs at national level as demonstrated in Lajunen et al. (2004) and Daimon et al. (2001). Moreover, differences in road rules such as those described in Simspon (2001) about navigating through a roundabout. Certain road feature such as modern roundabout was a common road intersections in the UK (Baranowski, 1999; Marshall, 2011) since 1963 with an estimated of 25,000 roundabouts built in the UK (Baranowski, 1999) while many other countries have limited roundabouts. Guidance to navigate a roundabout was also included in the Official Highway Code 2007 from Code 184 to 190 (Driving Standards

Agency, 2007). IVNS have been able to guide drivers through an intersection such as roundabouts yet given its nature as a global product, little attention was given to cultural needs of its navigational instruction.

At the moment, there is a paucity of understanding the cultural needs of drivers for navigational instructions at unique road features such as roundabouts or bend roads. This is exemplified with IVNS used in a cognitive walkthrough exercise in the work of Curzon et al. (2002). The said IVNS provided instruction to manoeuvre a bend road, "*in a quarter of a mile, left turn*", p.3. Then, nearing to the intended bend the said IVNS provide another guide, "*left turn*", p.3. The author argued that the given instruction was unsatisfying and may lead to failure in conforming scenario whereby drivers could possibly think a left turning was required, instead of following the road around to the left. One important issue which was not argued in Curzon et al. (2002) was the possibility of cultural issues given that the cognitive walkthrough was conducted qualitatively using Toyota Navigation System (pre-installed system in Toyota Avensis 2001/2002) in UK environment. It is believed that the system was manufactured using Japanese mental model while the authors of the study were familiar with navigating UK roads.

Numerous studies have attempted to investigate and tackle such negative change of behaviours by improving global products usability, particularly issues relating to designs of in-vehicle navigation systems (IVNS) (Knapp, 2007; Ishikawa and Kiyomoto, 2008). Knapp (2007) demonstrated differences in perceived attractiveness for navigation systems (in the context of navigation systems functionality and structure) between China and German users. Each of

the cultural groups (n=49/group) had to complete navigation tasks using either prototyped Chinese system or German system. These systems were built based on either German mental models or Chinese mental model. These systems have similar functions (such as 'contacts' for storing a contact details) yet offered a difference in its grouping of functions. These similar functions were grouped differently according to respective nation. The Chinese were found affected in their performance when navigating with the German system while the Germans showing impaired system acceptance when using the Chinese system.

In another study relating to participants' behaviour in providing verbal directions, frame of reference was showing effects to participants' performance in following directions (Ishikawa and Kiyomoto, 2008). The authors were exploring the ease of processing information across a specific language speaker. According to Ishikawa and Kiyomoto (2008) following the views of Levinson (2003), the Japanese were at ease in processing information given in relative reference (i.e. *"go straight to the left"*) as oppose to absolute reference (i.e. *"go straight to the west for 110m"*). This study aimed at investigating participant's ease of use swapping from preferred to non-preferred frame of reference. In the first half of the study, 32 Japanese were recruited in an outdoor navigation task where participants were required to navigate through designated route using two sets of written directions, relative reference and absolute reference. In the other half, 22 Japanese were recruited to read similar type of written directions, point to the goal of direction and rate the difficulty of the task. In the work of Ishikawa and Kiyomoto (2008) the Japanese were able to perform the task with ease when the written directions use relative reference prior to absolute reference. Conversely, when the order of written

directions was swapped across the two frames of reference, the Japanese completed the task with high numbers of stops, deviations and off-route distance (Ishikawa and Kiyomoto, 2008).

Although the differences noted in this study were not comparing cultures, it has demonstrated the support specific language user needs to perform navigational task at ease. Furthermore, the authors have indicated implication of these findings on the designs of speech structure for in-vehicle navigation systems (IVNS). However, the authors offer no explanation for gender effects when other navigation exploration study has empirically found males and females preferring different styles providing directions (Lawton, 2001; Lawton and Kallai, 2002; Carpenter et al., 2004). Moreover, this study did not have a balance number of males/females (7 males, 25 females in the first experiment, and 15 males, 7 females) and the authors failed to account such differences were limited in explaining gender effects.

Knapp (2007) and Ishikawa and Kiyomoto (2008) have demonstrated differences in drivers' behaviour in two different ways, behaviours when navigating through navigation systems, and behaviours when navigating in the real world. Both types of navigation strategies have shown potentials of being affected by culture. These findings have demonstrated critical points of cultural needs in the effort to improve drivers' overall satisfaction whilst engaging with in-vehicle navigation systems (IVNS). It may be possible that drivers' cultural needs are required at the design stage of IVNS system. This move could potentially reduce drivers' difficulty in processing information offered by the said system which eventually leads to unsafe driving behaviours.

2.2.5 Direction-giving

Current literature review on driver's cultural values has lead towards a need to cater for differences in navigation strategies and development of driving skills. In particular, most of studies found were demonstrating differences across drivers' of different nationality. These differences in drivers were concluded from various tasks involving the use of road environment. Examples of methods used were think aloud, sketch maps, pointing to a place, following written directions and providing written directions.

In views of exploring driver's needs for navigational instructions provided by in-vehicle navigation systems (IVNS), it may be crucial to regard the tasks given in the above examples as in part activities undertaken by drivers to move from a starting point to a destination. It may then be worthwhile to explore for driver's cultural needs via a construction of their personal navigational instructions in a direction-giving exercise. This exercise has been used in by many researchers to demonstrate differences in drivers' behaviours (Collett and O'Shea, 1976; Burnett, 1998; Lovelace et al., 1999; Davies and Pederson, 2001; Lawton, 2001).

A direction-giving exercise requires a participant to produce navigational directions based on a journey undertaken outdoor (Collett and O'Shea, 1976; Lovelace et al., 1999; Davies and Pederson, 2001) or indoor with a video footage (Burnett, 1998). The exercise of creating preferred navigational instructions by participant has managed to extract useful information out of the road environment.

In the work of Burnett (1998), participants' paper-based directions were taken into a coding process after completing the direction-giving exercise. The thirty (30) paper-based directions were coded based on information types from the literature, e.g. *nodes, landmarks* as stated by Lynch (1960) and a card sorting exercise between eight (8) human factors specialists (Burnett, 1998). The main aim of the card sorting exercise was to establish a consensus opinion of suitable information categories for navigation (Burnett, 1998).

Following this, a categorisation scheme was deduced using UK participants in UK roads (further elaboration of the categorisation scheme is given in Appendix 3-2). Based on Lynch's (1960) segmentation of environment (discussed later in section 2.3.5 of this chapter), this scheme showed an expanded categories which were more suitable for describing driver's choice of information from the environment.

2.2.6 Cultural concerns at macro entry level

In the recent years, Moeckli and Lee (2007) argued considering culture in drivers' behaviours could possibly improve road safety and mitigate the negative effects of IVNS. Such view was also debated in Redshaw (2001) where drivers' behavioural adaptations should consider the importance of social approach in developing safe driving experience. These views are supported in much research where drivers' perceptions have been argued to impartially be governed by their social communities, attitudes and beliefs (Lynch, 1960; Edensor, 2004; Featherstone, 2004; Hofstede et al., 2010; Moeckli and Lee, 2007; Özkan et al., 2006). As pointed out by Edensor (2004), memories held

onto from the past (such as historical events, war time) enrich a driver's knowledge, thus increasing the sense of being in a place.

The first known research referring to behavioural differences across national culture was by Collett and O'Shea (1976) where Iranians were empirically found to point to fictional place in direction-giving task when compared to participants from England [the author was not able to retrieve the full version of this research paper to explain in detail the method applied for this paper]. However, the focus of this research was not on navigational behaviour, instead it was researching about values of the Easterners. Nevertheless, it is important for consideration in this review given that differences were discovered between the Easterners and the Westerners (across two national cultures) which showed the possibilities of cultural needs in providing directions.

Apart from the above, drivers' behaviour has been concluded as one of major contributors for discrepancy in the designs of advanced drivers assisted system (ADAS), apart from infrastructural issues and problematic situations (Lindgren et al., 2008). The studies (a series of three iterative studies) were comparing drivers' perceptual knowledge on different road situations in China using participants from China and Sweden (Lindgren et al., 2008). The methods used in the study were questionnaire, video footage of potentially dangerous traffic situations and interviews with system designers (Lindgren et al., 2008). In the questionnaire task, the original Driver's Behaviour Questionnaire (Reason et al., 1990) was adapted to include questions pertaining to traffic problems in China. 60 respondents took part in the questionnaire task and the outcomes of the questionnaire showed a list of nine serious traffic problems including

pedestrians and bicyclists did not cross at the crosswalks and driving on hard shoulders (Lingren et al., 2008, p.44).

Next, in the effort to understand driver's perceptions of the listed traffic problems, video footages of China road environments were used in the subsequent study. 13 video footages categorised into four, *city driving, lane changing, obstacles along the roads* and *vehicle drifting* (Lingren et al., 2008, p.46) were used in a structured interview with 20 participants from China and 20 participants from Sweden. During the interview, participants were asked about potential traffic safety situations, familiarity and stressfulness of the identified traffic situations. The Swedish participants viewed city driving, road obstacles and vehicle drifting as stressful traffic situations while the majority of Chinese participants viewed such situations as common and non stressful. The final study in the work of Lindgren et al (2008) was interviews sessions with experts. 5 systems designers for advanced drivers assisted system (ADAS). These interview sessions were conducted to evaluate how ADAS is related to dangerous traffic situations discovered from the questionnaire and the video footages methods. The expert evaluation from these interviews concluded infrastructural issues (i.e lane marking), problematic situations from ADAS (i.e. inappropriate warning to a change in traffic situation) and driver's behaviour.

Differences in perceptions across two national cultures were also explored in the work of Daimon et al. (2000) where a different combination of methods, sketch map and question-asking protocol were applied onto Japanese and Swedish participants. There were 7 native Swedish (living in Sweden), 8 native

Japanese (living in Japan), four Japanese immigrants (living in Sweden) and six Swedish immigrants (living in Japan) in the sketch map method. Meanwhile, the question-asking protocol method has a lesser number of Swedish immigrants (three participants) Participants were asked to sketch a map of their preferred route from their house to their office/university, while in the other method, participants were asked to drive from a starting point to a destination for approximately 20km with limited information from a navigator (based on questions asked by the participants). The findings of this study showed significant differences between the natives in their respective countries. The natives Swedish use more paths (i.e. roads) and nodes (i.e. intersections/junctions) while the natives Japanese prefer landmarks in their sketched map. The immigrants have showed a tendency to follow the natives' choice of road information (for example the Japanese immigrants have used more paths and nodes compared to the natives Japanese, however the immigrants were noted to have used more landmarks than paths and nodes in their sketched maps).

The findings in the work of Daimon et al. (2000) have demonstrated a possible cultural effect on choice of route information across national boundaries. Such findings were in parallel to those of Lindgren et al. (2008) about driver's perception and Davies and Pederson (2001) on generic environmental layout (described in greater detail in section 2.3.5 of this Chapter).

Nevertheless, the breath of definition for culture, consideration of driver's cultural needs at macro level (nationalities) should also address limitations in

justifying individual differences, described next as cultural studies at micro level entry.

2.2.7 Cultural studies about behaviours at micro level

It is noteworthy to include reviews of driver's behaviour at micro level in the effort of justifying the cultural needs of drivers for in-vehicle navigation systems (IVNS). A review of current literature showed that consideration for individual differences of driver's behaviour were researched mainly for understanding human needs such as age limitations and gender (Shinar et al., 2001; Carpenter et al., 2004; Itoh et al., 2005; Horberry, 2006; Lee, 2008; Baldwin, 2009).

For example, in self-reported questionnaire from the work of Carpenter et al. (2004) had shown different gender preferences in navigation strategies (the males were incline towards survey directions whilst the females prefer route directions). The study had applied two survey instruments developed in Takeuchi (1992) and Lawton (1994) onto drivers from USA and Japan to consider the importance of way finding behaviour (Carpenter et al., 2004). In accordance to the surveys' findings, interface with survey/cardinal directions would increase mental workload to drivers whom prefer route directions (Carpenter et al., 2004). Moreover, drivers preferring survey/cardinal directions would have been in advantage with additional route/landmark directions (Carpenter et al., 2004).

Apart from the above, disparities in level of motorization and infrastructure across nation has to be taken into account in designing in-vehicle navigation systems (IVNS). As an example, China is the largest developing country that

had experienced rapid motorization over the last decade (Zhang et al., 2006), hence addressing cultural research of drivers' behaviours at individual levels (within Chinese drivers) would be inevitable. Moreover, the China group has interesting cultural factors in direction-giving given that the cardinal directions (such as East, North West) are used as part of the country's road signs and route directions (as shown in Figure 2.4).
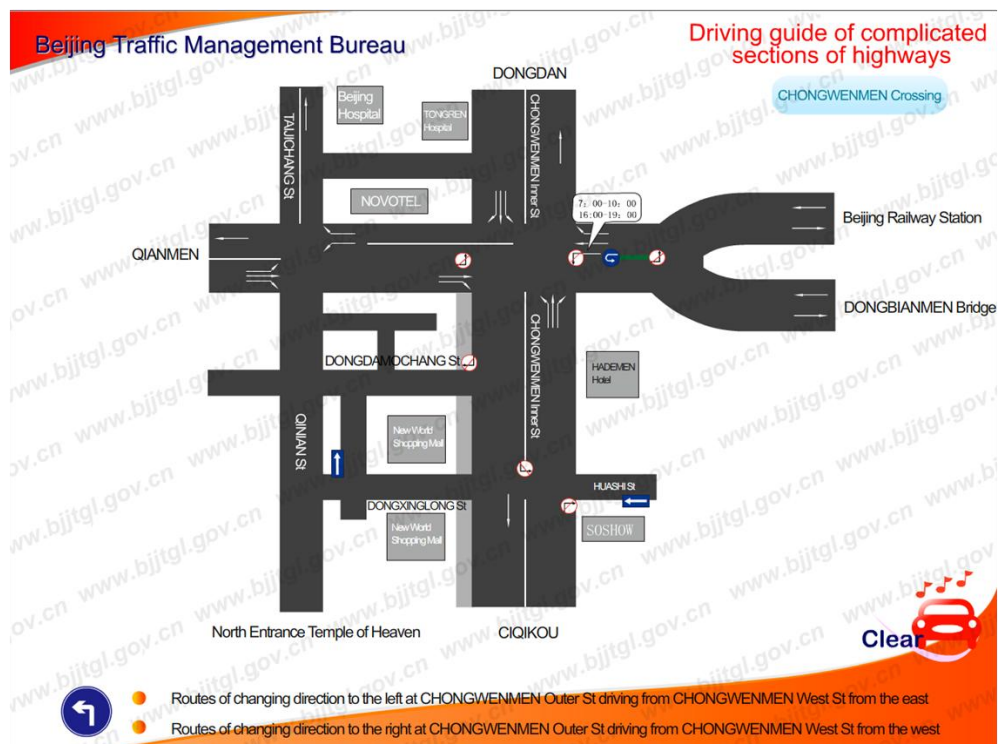
Figure 2.4: Common guide for direction in China, excerpt from Beijing Traffic Management Bureau, 2010. Driving guide of complicated sections of highways CHONGWENMEN Crossing [image online]. Available at http://www.bjjtgl.gov.cn/Portals/1/flash/cwmlk.swf [01 June 2011]

These studies on individual differences would have diminished the societal effects found in drivers' interaction behaviour (Heimgärtner et al., 2007), and the nationalism factor in route direction research (Daimon et al., 2000; Davies and Pederson, 2001). Therefore, knowledge of individual differences should

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have been considered with cultural findings at a societal level. Hence cultural needs that have been proven significant at individual level such as age (Heimgärtner, 2007b) and gender (Carpenter et al., 2004) would have been situated under control variables when exploring cultural influences at national level.

2.3 Overview of Home vs. Foreign Environment

A look into architectural research shows that environments have been perceived by the inhabitants as environmental images which had attachment of meaningful cues and often associated with past experiences (Lynch, 1960). Therefore a cross-cultural investigation in the context of using IVNS would need to consider drivers and road environments. This is given that the perceived images of the environment and the embedded cultural values are theoretically part of drivers' cognition defined as the action or faculty of knowing (Neisser, 1967; Oxford English, March 2011). This is in parallel to those of Golledge (2003) where way finding tools are mental representations of environments imprinted in drivers from cognitive process. The strategies applied in way finding could be an important source in understanding cultural differences across national boundaries given the distinct variations in environmental images (Featherstone, 2004; Edensor, 2004).

2.3.1 The role of road environments in navigation

The effort to move from one geographical are to another often involved the road environment, of which had been transformed vividly into pictorial chunks of meaningful information (Golledge, 2003; Klippel et al., 2003), in accordance with drivers' perceptual abilities. While in the absence of

automation such as vehicle navigation systems, movement in novel areas would also be relying onto other tools such as published paper maps or information (verbal instructions, sketched map or written directions) from the local people. Despite the assisted tools used in navigation, elements from the environment such as salient buildings, road signs and junction types were information perceived as 'good' to the local inhabitants, of which helped in assisting successful direction-giving to others. The local community and it corresponding environments have shared public images of their living area, of which could be identified in its physical forms as paths, nodes, landmarks, districts and edges (Lynch, 1960). Therefore, the environment where people have been living in has been the basic resources for developing strategies and skills for navigation (Golledge, 2003; Featherstone, 2004).

2.3.2 The influence of road traffic

Importantly, drivers' perceptual knowledge of their local environment were not limited to environmental elements, instead driving culture of a particular area were also influenced by the general rule of traffic conduct and social norms of the community (Zaidel, 1992). In particular, the influence originated from the collective drivers' attitudes towards acceptable behaviours. For example, high level of awareness in road safety had resulted into more regulated behaviours amongst drivers from USA as opposed to drivers in China (Huang et al., 2006). Differences in traffic environment across national boundaries were reportedly causing more unexpected driving situations to foreign drivers (Huang et al., 2006; Zhang et al., 2006).

As an example Zhang et al. (2006) reported that drivers in China have to share their rights-of-use on roads with pedestrians and cyclists. Due to this, the USA participants in this study rated the traffic conditions in China as filled with unexpected driving situations. Zhang et al. (2006) argued that drivers in China perceived skilful driving being more important than maintaining road safety (use of turning lights) when compared with drivers in the USA (a more detailed description of this study is given earlier in section 2.2.3 of this chapter).

Traffic behaviours that increases the risk of accidents could have benefitted from theorisation of driving culture (Moeckli and Lee, 2007) whereby efforts was made at changing the social behaviour of driving. Moeckli and Lee (2007) argued the influence of societal perceptions which later constructed acceptable unsafe driving behaviour within a community. Such perceptions were argued as effects of culture whereby a collective of opinions were shared amongst members of a community. For example, a culture of accepting an action of driving over the posted speed limits.

According to Moeckli and Lee (2007), the effort to increase road safety should not only access driver's ability at individual level, instead requires greater understanding towards what governs driver's beliefs and values. Hence, adhering culture to driver's needs is important in understanding conditions of road traffic in a community.

2.3.3 Navigating environments from a cultural perspective

Cultural factors affecting in-vehicle navigation systems (IVNS) were first noted by Hamahata and Liaw (1995) who reported a difference in the provision

of route directions between the Japanese and the North Americans. In Japan, drivers were accustomed to routing system based on map configurations while in the North Americans drivers were expecting a turn-by-turn navigation system (Hamahata and Liaw, 1995). The authors stated this difference has enabled Japan in employing 'simple' technology to develop IVNS as opposed to the United States (US) where 'complex' component technologies is required to structure a turn-by-turn system. The authors further proclaimed Japan being the first country to produce IVNS to the mass market.

The key problem with the latter statement is that there are other exceptions that contributed to limited in-vehicle navigation systems (IVNS) availability in every nation, such as government policies and revenues. As an example, maps for IVNS require submissions to relevant Malaysian authorities for clearance, which affected IVNS market penetration (Ng, 2007). Consequently, IVNS in Malaysia was only available late 2004 (Ng, 2007)

However, a crucial issue was highlighted in this case study where technologies were outlined being dependent on local environments (Hamahata and Liaw, 1995). This suggests a weak link between drivers' acceptance of products and the road environments. The infrastructure (such as road layouts and road street names) has driven drivers in expecting systems such as IVNS, being constructed according to local environment (Hamahata and Liaw, 1995).

It was clear this case study has showed disparity in conceptualising designs for IVNS (Hamahata and Liaw, 1995). In the initial stage of development, not withstanding other factors such as government policies and revenues, IVNS has experienced cultural differences in the design process at its infancy age,

between the map oriented and the turn-by-turn navigational displays (Hamahata and Liaw, 1995).

2.3.4 Home environment – its impact on navigation

Exploration into the imprinted cultural values in drivers requires critical analysis of their behaviours while navigating in the environment. The spatial organization of the environment includes road layouts, city buildings, and road furniture (Featherstone, 2004) were claimed to affect driver's expectations, in which shaped their styles in direction-giving exercise (Daimon et al., 2000). When manoeuvring vehicles turn into regularity in drivers, the environments (in which the drivers live) were the spatial platform that provided drivers with a sense of familiarity (Edensor, 2004).

This scenario is often experienced by residents whereby the spatial environment is regarded as home. Stern and Leiser (1988) argued driving regularly in home environment increases drivers' experiences and progresses their spatial knowledge through three stages, 'landmark', 'route' and 'survey' as described in Table 2.3. This study was focussed on the development process of drivers' spatial knowledge for an environment. Nevertheless, there have been other overlapping issues and views concerning the description of these stages in relation to spatial cognition (Werner et al., 1997).

Interestingly, Edensor (2004) argue that the familiar features such as post boxes and road signs found locally are generically built within the national borders, in which forms national identity. This is achieved when the governing body approves the built of similar structures throughout the nation. The literature within vehicle navigation systems however does not emphasize on

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the environmental images that have been abstracted from home environment and developed in drivers' perception. There are potential of exploring these images, in particular from comparing between 'home' environments, across national culture (Daimon et al., 2000).

Table 2.3: A view of describing spatial knowledge (Stern and Leiser, 1988)

Initial stage	**Landmark knowledge** *Memory for distinctive objects*	Drivers are not able to link landmarks
Middle stage	**Route knowledge** *Memory for procedural linking of landmark including order, inter-landmark distances and required actions*	Drivers are capable of producing route directions
Final stage	**Survey knowledge** *Memory in which landmark and route knowledge is integrated into a configurable-map-like*	Drivers are able to sketch map with landmarks and associated route

2.3.5 Foreign environment, adapting to unfamiliarity

Uniformity was evident in the work of Davies and Pederson (2001) where way finding behaviours differed when comparison was made across two grid pattern cities, between inhabitants in Milton Keynes, England and another similar-sized city, Eugene, USA. Milton Keynes, built in 1960s is the only city in England that used grid characteristics (Davies and Pederson, 2001) for their urban development. Other English towns have town centres where settlements and business activities are centralised within the town (Hillier, 1999). Despite populating a grid pattern city, the residents of Milton Keynes, England were found to use more landmarks than participants from Eugene, USA in providing direction for navigations (Davies and Pederson, 2001). 32 participants from England and 24 participants from the USA were recruited for this study. Participants were asked to complete a series of tasks which were confidence

ratings, pointing to invisible landmarks, drawing sketch maps and verbal route directions (Davies and Pederson, 2001).

In the confidence ratings task, participants were asked to rate their confidence in directing a stranger to 40 local locations. Meanwhile, in the pointing and directions task, participant had to stand and point as accurately as possible to 10 well-known places and provide directions to these places within the cities of Milton Keynes and Eugene. The findings of this study have in part supported the views of Moeckli and Lee (2007) about culture not entirely being in a static form or state, given the accounts to drivers that have an ability to adapt and learn through experience, particularly in accommodating in-vehicle technology such as navigation systems.

Importantly, study on route guidance behaviour (in which aimed to signify drivers' behavioural characteristic) between local and immigrants sharing similar spatial space inferred differences in driver's preferences when providing directions and deducing sketch map drawings (Daimon et al., 2000). The immigrants were found to apply knowledge learned in their home environment. However, when restricted with resources from the current environment, the immigrants had to adapt in the effort to navigate successfully.

The study was mirrored on the work of Lynch (1960) where the environment was segmented into paths, nodes, landmarks, edges and districts. These were the navigation elements claimed as legible (readable) to the local people asked to think of their home city (Lynch, 1960); similarly in desired route (Daimon et al., 2000) and in choice of elements from the environment (Burnett, 1998).

Lynch (1960) defined the normative environment (from the perspective of local residents) as an environmental image that has structure, identity and meaning. Structure is given as viewing the environment with clear image of the surrounding area, in which serve as a broad frame of reference. While identity serves as good communicator (Lynch, 1960) amongst residents, for example a post-war tower that marked the junction where a left turn is required to go the eastern part of the city. Lastly, environmental image also has a sense of emotional security which creates a harmonious relationship between navigator and the outside world (Lynch, 1960).

2.4 Overview of navigational interface

In the effort of exploring cultural needs for in-vehicle navigation systems (IVNS), a review of driver's cultural values and road environment raised the importance of reviewing current literature on navigational interface. This is the third part of four on the overall review of driver's cultural needs for IVNS. The behavioural differences in providing directions across region (Daimon et. al., 2000; Davies and Pederson, 2001) have increased a need to have greater understanding of driver's cultural needs of a navigational interface. Such understanding could potentially provide more knowledge on underlying usability issues in designs of IVNS.

2.4.1 Influence of culture onto navigational interfaces

As reported in the work of Heimgärtner et al. (2007) navigation systems dominated drivers demands while on the move, requiring more attention with its high interactivity between the display and drivers. Hence the systems were chosen as a study case to accommodate the analysis of potential cultural

characteristic for culturally adaptive navigational interfaces (Heimgärtner, 2007b).

Generally within the context of vehicle navigation systems there are three types of interfaces: the voice interface (spoken guidance messages); the visual interface (display of guidance information); and the control interface (mechanism for entering to system) (Burnett et al., 2004). The review here focuses on the visual and voice interfaces of vehicle navigation systems. This is because drivers interact more frequently during journeys with visual and voice interfaces compared to the control interface.

More importantly, complex visual representations and unnatural spoken guidance messages result in increased time for processing information (Burnett, 2000; Heimgärtner et al., 2007). In the work of Blanco et al. (2002), the navigational instructions were demonstratively demanding when formatted in paragraph or table display using a low density colour scheme. Therefore, representations on navigational interface should consider limitation in driver's working memory at different road situations (Heimgärtner, 2007b).

The most demanding interaction process for drivers as claimed by Heimgärtner (2007b) were destination input, interpretation of maps and manoeuvre guidance. Heimgärtner (2007b) had explicitly evaluated cultural values that affected drivers' interaction behaviour using an application tool named Intercultural Interaction Analysis (IIA). The IIA tool had been claimed reliable in running test task to measure cultural indicators of interaction behaviour (Heimgärtner et al., 2007; Heimgärtner, 2007a). Further, the IIA tool had been distributed at national level on the basis argument that the cultural distance is

comparatively higher than other cultural levels (such as ethnic) (Heimgärtner, 2007a). Hence, the IIA tool was applied in users' native language for participants from China, Germany and USA (including Canada).

In the work of Heimgärtner (2007a), IIA tool was developed to determine interaction patterns of participants with different cultural backgrounds with a navigation system. The IIA tool offered 118 potential cultural parameters such as speed of interactions and point of interest (POI). This IIA tool is an offline software which requires participants to download the system onto their personal computers and run the tool which comprises of five parts, demographic data, test tasks, VSM94 (developed by Hofstede, 1994), evaluation of results and debriefing of questionnaire. This study had a total of 2,969 potential respondents from China, Germany and the USA (including Canada) who downloaded the IIA tool however only 1,018 respondents were considered for analysis due to incomplete data sets.

Significant cultural interaction indicators were speed, message distance, POI, multiple tasking, information speed and number of characters. Example of Halls high context culture was found whereby 30% more pre advices were noted in the Chinese participants (Heimgärtner, 2007a). Whilst, the German and USA cultural groups were reflecting monochromatic time culture in this study due to their behaviour of not having more than one task running on their desktop while interacting with IIA tool (Heimgärtner, 2007a). Interestingly, the tool had used Hofstede's Value Survey Module 1994 (VSM94) Questionnaire (Hofstede, 1994) to determined participants' cultural dimensions while referring to Hall's cultural dimensions (Hall and Hall, 2001) in designing the

test tasks (Heimgärtner, 2007a). The findings from the work of Heimgärtner had been fruitful in classifying the vast subject of culture into cultural needs of users in interaction. Given these knowledge, it would be beneficial to conceptualise further the robust nature of culture from a different perspective, of which had not been explored in Heimgärtner's research.

Importantly, the literature has found discrimination in drivers' evaluation of different navigation systems; rotary-push, touch screen and I-DIN radio navigation systems across national boundaries (Roessger and Hofmeister, 2003). The comparison study was conducted locally in USA, Japan and Germany with 24 to 32 participants in each location. Rotary-push navigation systems were highly rated in Germany and USA while the touch screen system was preferred by the Japanese participants (Roessger and Hofmeister, 2003) [The author was not able to retrieve other papers written by the same author which described in detail comparison between touch-screen and rotary-push systems despite several communication efforts]. Nevertheless, the findings of Roessger and Hofmeister (2003) were parallel to Honold's argument about the influence of culture on users' expectations and functions of technical systems (Honold, 2000) (a more detailed description of Honold's work is available in section 1.8 of Chapter 1). More importantly, all participants in the study were expecting consistency in the chosen systems (Roessger and Hofmeister, 2003). For example systems with rotary-push mechanism were expected to not have any touch screen feature within the navigation systems. Drivers in general rated for consistency in the workflow of a system (Roessger and Hofmeister, 2003).

2.4.2 Issues associated with globalisation

Internationalisation of navigation systems brings together the ideology of universalism in designs, in particular pertaining to the display of information within the interface. This concept of universal product for global user has been challenged recently due to safety issues (Daimon et al., 2000; Honold, 2000; Heimgärtner et al., 2007; Roessger and Hofmeister, 2003). The arguments for most were pertaining to drivers' behaviour, drivers' perceptual knowledge and driving styles. Further, universal products have been one of the issues associated with globalisation which had resulted into low ratings for products' usability and user's satisfaction.

In the case of navigational interface, drivers were forced to follow the products mental models, in which have been argued as not necessarily suitably for every road users. Common examples that emerged in the literature were products manufactured with mental models of the Western countries do not satisfy the Asian end users (Honold, 2000; Zhao et al., 2006; Knapp, 2007; Lindgren et al., 2008). This is due to the difference in patterns of thoughts, beliefs, and norms between the East and the West inhabitants (Allwood, 1985; Hall and Hall, 2001; Hofstede et al., 2010).

2.5 Overview of culture

There has been relatively little research concentrating in behavioural adaptations from the perspective of culture in drivers' behaviour (as illustrated in part in Figure 2.5), of which is essential in developing good navigational instructions and good interface designs. In research areas other than vehicle navigation systems, yet pertaining to interaction between human and computer,

users' cultural values as defined by Hofstede (2010) were found to affect the interface designs of Web sites (Marcus, 2005).The design of interface uses mental metaphor that serves to represent a meaningful reasoning to users' perceptions. In the effort to generate good interface design, Shen et al (2006) argues on a need to adapt user's cultural values into commonly used mental metaphor. This adaptation was found positively affecting users' experience (Shen et al., 2006).

This notwithstanding the fact that drivers are also subject to acculturation (Berry, 2008) whereby the original culture (of which has been known since birth) has been altered by the newly encountered culture. For example, a Swedish driver who has been living in Japan for the past five years would have grown accustomed to the driving environment in Japan (issue noted by Daimon et al. (2000) and Davies and Pederson (2001)). Acculturation is part of culture change (Berry, 2008) where some values are assimilated and negotiated between two cultural groups (referring to nationality) to achieve harmony living within an environment (Khaldun, 1969).

Culture (particularly investigating drivers' behaviours)

How was culture applied in relevant research?

Studies reporting comparison across nations for example,

(Daimon et al., 2000; Michon and Denis, 2000; Lindgren et al., 2008; Davies and Pederson, 2001; Özkan et al., 2006)

Studies reporting driving culture for example,

(Zaidel, 1992; Moeckli and Lee, 2007; Heimgärtner, 2007a)

Studies reporting published cultural dimensions for example,

(Allwood, 1985; Hall and Hall, 2001; Hofstede et al., 2010; Honold, 2000)

Studies reporting human computer interaction (HCI) for example,

(Roessger and Hofmeister, 2003; Heimgärtner et al., 2007; 2011a; 2011b)

Why national culture?

Studies reporting comparison across nations for example,

Studies in this area were not limited to the list above. It was clear that exploring drivers' behaviour comparatively according to their nationality showed promising cultural needs

Studies reporting driving culture for example,

Several fundamental theories in modelling driver behaviours were found in the studies above. The issues raised in these papers suggest the need to consider drivers behaviour with other relevant elements such as road traffic and surrounding environments.

Studies reporting published cultural dimensions for example,

Culture was defined extensively by these authors in other research fields. Their published cultural dimensions have been applied in many research fields hence exploring cultural needs for this thesis using the published dimensions seems promising.

Studies reporting HCI for example,

These studies also reported differences across national culture, in interaction behaviours. Furthermore, 'personal freedom' was valued as contributing factor to successful designs of HCI

Potential gaps on cultural needs of drivers for IVNS from driver's values, road environment and navigational interface

Figure 2.5: Research related to culture in the literature

More importantly investigating cultural values in the context of using vehicle navigation systems (Heimgärtner, 2007b) should take into consideration drivers' perceptual limitation, in which referring to drivers' time limit in processing information displayed on interface and making decision on manoeuvring the vehicle (Olson, 2002). The rapid development in technology has surpassed research on drivers' perceptual limitations, following the fast growing market demand. Increasing drivers' satisfactions with various features in navigation systems do not necessarily promote road safety. Given that there has been limited research on the role of culture within this area, the review concentrates on research that argues cultural adaptability in navigation systems.

Following Honold's definition where culture creates 'an orientation of system' (Honold, 2001, p.328), the 'system' in navigation is based on drivers and the surrounding environment. Therefore, exploring drivers' perception of the environment (Daimon et al., 2000) and drivers' geographical knowledge (Edensor, 2004); both forming manifestation of 'cultural models' (Honold, 2001, p.329), are probably the key towards theorizing driving culture into driver's satisfaction research (Moeckli and Lee, 2007) in particular within the context of using in-vehicle navigation systems (IVNS) while driving.

2.5.1 Studies reporting driving culture

Apart from reviews concerning 'cultural models' (Honold, 2001, p.329) of road environment and drivers cultural values, there are another approach which is of importance in the investigation of culturally-aware navigation systems. The said approach was conceptualizing driving as patterns of thoughts and behaviours (Allwood, 1985) and silent language (Hall and Hall, 1990). Zaidel

(1992) argued on the need to understand the relationship between individual drivers and the 'assumed' population behaviour (Zaidel, 1992). This is partly due to claims that population have greater influence on individuals whilst manoeuvring the vehicle. More recently, Moeckli and Lee (2007) suggested on theorizing culture given its effects in shaping drivers behaviour, of which would have the potentials of mitigating road traffic incidents.

2.5.2 Studies reporting published cultural dimension

A growing body of literature has considered researching differences across nations in navigation and drivers' behaviour (Daimon et al., 2000; Davies and Pederson, 2001; Roessger and Hofmeister, 2003; Heimgärtner et al., 2007). These cultural related studies do not necessarily use established cultural dimensions from other research domains as tool to conduct cultural research (Daimon et al., 2000; Davies and Pederson, 2001). While other cultural research within the context of navigation systems have had taken the opposite approach via adapting published dimensions such as Hofstede (2010) as tool in explaining cultural effects (Roessger and Hofmeister, 2003; Heimgärtner et al., 2007). Both approaches have had shown differences and similarities in driving styles with reported limitations. Hence, this PhD research had taken the entry of culture at national level following Hofstede's cultural dimensions of Power Distance Index (PDI), Masculinity Index (MAS), Uncertainty Avoidance Index (UAI), Individualism Index (IDV) and Long Term Orientation (LTO) (Hofstede, 1994, Hofstede and McCrae, 2004).

Shi and Wang (2011) noted that the cultural dimensions of Gert Hofstede were a result of observations he conducted during his working days at a

multinational business organisation, IBM. The observations were followed by a questionnaire survey of values distributed to IBM branches in approximately 70 countries which was conducted twice, in 1968 and 1972. The collected data were statistically analysed and subsequently used to deduce culture into quantified values. These were ultimately named as 'cultural dimensions'. These identified dimensions were attached to index number between 1 and 100. High index number reflected strong values for the said dimension hence given a top ranked whereas low index number infer to weak cultural value with a bottom ranked in the data matrix (Hofstede et al., 2010). These index numbers were illustrated as bipolar poles with high and low ends for each dimension respectively (Jones, 2007). In another subsequent study, Hofstede had introduced the fifth dimensions, Long Term Orientation (LTO) which reflected the teaching of Confucian (Hofstede and Bond, 1988). Apart from Hofstede's theory of culture, other work has been conducted relating to understanding cultural values, such as Allwood (1985) and Hall and Hall (1990). Further explanations of Allwood's cultural 'patterns' and Hall and Hall's 'silent language' of culture were given earlier in section 1.8 of Chapter 1.

Hofstede (2010) argued that high Power Distance Index (PDI) nations would show unequal distribution of power and wealth. This was determined from a hierarchy in workplace whereby a top management authority in decision making was tolerated by relevant subordinates and accepted as a norms by societies. Shi and Wang (2011) comment that PDI was first introduced as a measure of power differential between superiors and subordinates by Mulder (1971) - in Shi and Wang (2011, p. 96). Conversely, nations with high Individualism (IDV) values demonstrated disintegration in collectivism

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whereby achievements were driven by members' strength in being independent. Furthermore, members in IDV group often have close integration with immediate family members and prefer to work independently.

High Masculinity (MAS) values referred to a distribution of roles across gender whereby female members were as tough as male members. On the other hand, male members from low MAS nations were generally more modest and caring in their personalities. Nations with high Uncertainty Avoidance (UAI) values would generally have an explicit set of regulations (either by the governing body or within themselves), in the effort to avoid uncertainties in their daily tasks. Meanwhile, high LTO nations were bound to work hard in life to acquire skills and education. They were claimed to have a dynamic and future-oriented mentality, of which characteristics were reflected on Confucius values.

Nevertheless, it is important to note that this study was conducted in 2006, therefore the recent sixth Hofstede's cultural dimension of indulgence was not considered in the study (Hofstede et al., 2010). Moreover, Shi and Wang (2011) note that Hofstede's cultural dimension was replicated and expanded by a group of researchers (House et. al, 2004) when they introduced another model for culture, the GLOBE model. The GLOBE model has nine cultural dimensions with similarities for PDI and UAI. The other seven cultural dimensions are Institutional Collectivism, In-Group Collectivism, Humane Orientation, Performance Orientation, Assertiveness, Gender Egalitarian, and Future Orientation (House et. al, 2004 - in Wang and Shi (2011, p.99). Despite the existence of these additional cultural dimensions, this PhD research is

focused on exploring cultural needs for in-vehicle navigation systems (IVNS). Meanwhile, other cross-cultural research within this focus compared drivers from different nation. Therefore, Hofstede's Cultural Data Matrix was used as a reference tool in the selection of participant's nationality as cultural group in the studies designed for this PhD research. This tool enabled selection of two or more nations that have had the farthest index number distance in terms of cultural dimensions. The distance depicted variance in their 'collective programming of the mind' (Hofstede and McCrae, 2004, p.58). For example, a nation with high cultural values of individualism would not associate with a high score in power distance, given the opposite nature of both dimensions (Hofstede et al., 2010). Therefore, it was believed that selecting two or more nations that had top ranked from Hofstede's Cultural Data Matrix would have had facilitated this study in investigating for potentials cultural needs or patterns. Furthermore, knowing the characteristics of published cultural dimensions such as power distance and uncertainty avoidance would enable greater understanding in explaining driver's needs in each cultural groups.

Given the robustness of culture, a selection of established cultural values was brought into the study design. Observation from the literature have shown national culture had attributable affects onto drivers' behaviour despite influences that occurred at individual level (such as gender and age). A selection of research have had compared differences according to drivers nationalities, for example in the work of Daimon et al. (2000) where comparison was made between Japanese inhabitants and Swedish immigrants living in Japan; and further contrasted the result with Swedish inhabitants and Japanese immigrants living in Sweden. Similarly, in other study conducted by

Davies and Pederson (2001) have had used two grid-patterned cities (in UK and USA) to compare expectations in urban way finding behaviour. Furthermore, a comparative study of existing navigation systems was conducted in three large automotive markets, Japan, Germany, and USA had shown significant preferences between the Japanese and the German participants for touch-screen and rotary-push system respectively (Roessger and Hofmeister, 2003).

On the other hand, researchers have had applied established cultural dimensions and values as study tools to conceptualize culture and elaborate differences found in their studies. Such research was demonstrated by Heimgärtner (2007a) in his justification towards the construction of offline software tool named Intercultural Interaction Analysis (IIA) whereby Hofstede's questionnaire (Hofstede, 1994) was used together during test runtime and Hall's cultural dimensions (Hall and Hall, 2001) were also put into place in elaborating the findings of the research. This research had compared users from China, Germany and USA (including Canada) using their given language in investigation of interaction behaviour. Meanwhile in another research not pertaining to navigational interface, Allwood's patterns of thoughts and behaviours (Allwood, 1985) were applied as reference in explaining cultural expectations of advanced drivers assisted systems between Chinese and Swedish drivers (Lindgren et al., 2008). It is important to note that video clips of different road situations in China were used in the above-described research. Further, the research had a series of three studies of which have had applied survey and interviews in its methodology respectively (Lindgren et al., 2008).

Additionally, a concept of culture as described from the geography (Mitchell, 2004) was referred to deduce four approaches in theorizing driving culture (Moeckli and Lee, 2007). The highlight in the report was effort of theorizing culture to understand driver's behaviour and later increase knowledge of driving culture, of which could enhance safety and mitigate accidents on roads (Moeckli and Lee, 2007).

Owing to the diversity of cultural references (from psychology, geography, architecture, sociology, and anthropology) the definition of culture was based on human computer interaction perspective and given a context-specific definition found in the work of Honold (2000) for investigation of products' usability. The context-specific definition was given earlier in Chapter 1 as the working culture definition used throughout this thesis.

2.5.3 Studies reporting comparison across nations

Drivers, like any other humans are subject to the growing complexity of driving activities whereby the primary driving tasks (Michon, 1985) are associated with numerous secondary activities (outside and inside the vehicle) such as registering the speed limits, attending to the navigational interface of vehicle navigation systems and many other secondary activities within the moving vehicle environment (Wierwille, 1993; Young et al., 2007).

The importance of studying cultural influences as demonstrated earlier was partly given by the growing concerns over safety issues. The growth of information systems have had widened the gap between technology and drivers' limitation. Further, advances in communication technology has had trained drivers to be more adaptive towards drivers information systems, some

of which have had reports of adverse affects (Young et al., 2007; Gray, 2008; Precey, 2009). For example, the mass media had reported concern raised by the British Cartographic Society on drivers' reliance on navigation systems would reduce map-reading skills (Gray, 2008). Correspondingly, children also would be affected from little knowledge of navigation skills due to automation (Gray, 2008). More importantly, drivers were reported to accommodate vehicle navigation systems by adapting their driving styles. Cnossen et al (2004) highlighted the effect of map display onto driving styles at intersection whereby drivers had chosen to reduce their driving speed to compensate for the time looking away from the headway.

The drivers seem to have accepted the workflow and displays of navigation systems as a 'package' designed by the manufacturers. Apparently, research into advanced technology and drivers' performance has been facilitating the inclusion of additional functions onto navigation systems, of which have had increased the complexity of the navigation display. Moreover, the designs were driven by the fast growing market opportunities which had resulted in a shorter turn-over time given for researching drivers' capabilities. Internalization of these technical products has added more risks to drivers when variation in drivers' attitudes, norms and communications were not accounted. The reviews from literature have had observed the potentials of considering national and regional factors in research of drivers behaviour, particularly in the context of using navigation systems. Therefore given the existence of gap in knowledge of drivers' cultural values whilst on the move, this study was design to enumerate potential cultural values from driver's perceptual knowledge of the road environments.

2.6 Conclusions and recommendations

The literature has showed more than one combination of method used to examine drivers' behaviours and cross-cultural navigation research. These studies have been fruitful in designing a series of studies exploring driver's cultural needs for in-vehicle navigation systems (IVNS). More importantly, the research methodologies have given an insight in structuring the thesis framework. Table 2.4 showed a summary of mixed methods applied in selected key references for consideration in this thesis. The author believed that an application of a mixed method is required to ensure driver's cultural needs for in-vehicle navigation systems (IVNS) were addressed appropriately.

The literature showed that drivers developed necessary driving skills from increasing number of driving experiences. Driving experience involves interaction with the road environment. Many authors have managed to explore differences in driver's behaviour in their navigation skills (Daimon et al., 2000) and differences in describing the surrounding/road environments (Davies and Pederson, 2001). However, such behaviours were given its due to individual differences (Burnett, 1998) or differences across nation (Zhang et al., 2006 and Lindgren et al., 2008) with no generic suggestions as a potential effect of driver's cultural needs. Many other studies relating to road environment were concluding on road traffics and road infrastructure (Lindgren et al., 2008). One of the key references did argued on differences in users' interaction patterns with an interface for a navigation systems (Heimgärtner, 2007a) based on its Intercultural Interaction Analysis (IIA) tool. However, elements of road

environments, such as those described in Burnett (1998) and Lynch (1960) were not considered in the work of Heimgärtner (2007a).

Table 2.4: Summary of mixed methods for behaviour related research

Author	Methodology	Participants
Roessger and Hofmeister, 2003	1. Questionnaire 2. Interview 1. Video record	USA, Japan and Germany
Heimgärtner, 2007a	1. Offline software 2. VSM94 Questionnaire 3. Questionnaire debriefing	China, Germany
Burnett, 1998	1. Video record (direction-giving exercise) 2. Paper map 3. Questionnaire	UK
Daimon et al., 2000	2. Map sketch 3. Verbal protocol	Japanese natives and Swedish immigrants in Japan road environment Swedish natives and Japanese immigrants in Sweden road environment
Davies and Pederson, 2001	1. Pointing and directions task 2. Map sketch	Long-term residents of Milton Keynes, England Long-term residents in Eugene, United States
Lindgren et al., 2008	1. Questionnaire 2. Video footage 3. Expert interview	Participants in China and in Sweeden
Zhang et al., 2006	1. Questionnaire 2. Interview	Participants in China and in USA

Based on this literature review, there seemed to be a gap in understanding drivers' perceptual knowledge of the road environment. The majority of drivers in the world do not frequently drives (five to seven days a week) in foreign environment (countries). Thus, it may be appropriate to hypothesize drivers'

perceptual knowledge are localised to their home environment (country of origin or residence country – which ever annual mileage were most driven). Moreover, having known the potential culturally sensitive parameters in interaction patterns between a user and an interface (Heimgärtner, 2007a) motivated the author to explore for cultural influences of road environment. This motivation was in part constructed from learning about claims of cultural differences in route guidance behaviour (Daimon et al., 2000) and different preferences of direction-giving between residents in two grid pattern cities, Milton Keynes, England and Eugene, the USA (Davies and Pederson, 2001).

Nonetheless, current literature review is limited in discussing designers' cultural values and its affect to the present in-vehicle navigation systems (IVNS). Instead, the review has taken a generic approach by concluding that limited number of global product manufacturers had resulted into established few international brand names of IVNS. These brand names place pride in their systems functionality and more often advertises newly built system's capability, such as receiving emails and plays MP3 songs. Such products are identical in design across the international market. The current IVNS manufacturers have not been able to address the needs of localising their products according to the targeted local market. Therefore, the author believed there is a gap in understanding potential effects of driver's cultural needs for IVNS. The author also believed such gap requires exploration research of drivers providing direction-giving instructions in their respective home road environment; and later contrasting this combination with a combination of driver's interaction with foreign road environment in a direction-giving task.

Chapter 3: Direction-giving study across four national cultures

3.1 Introduction
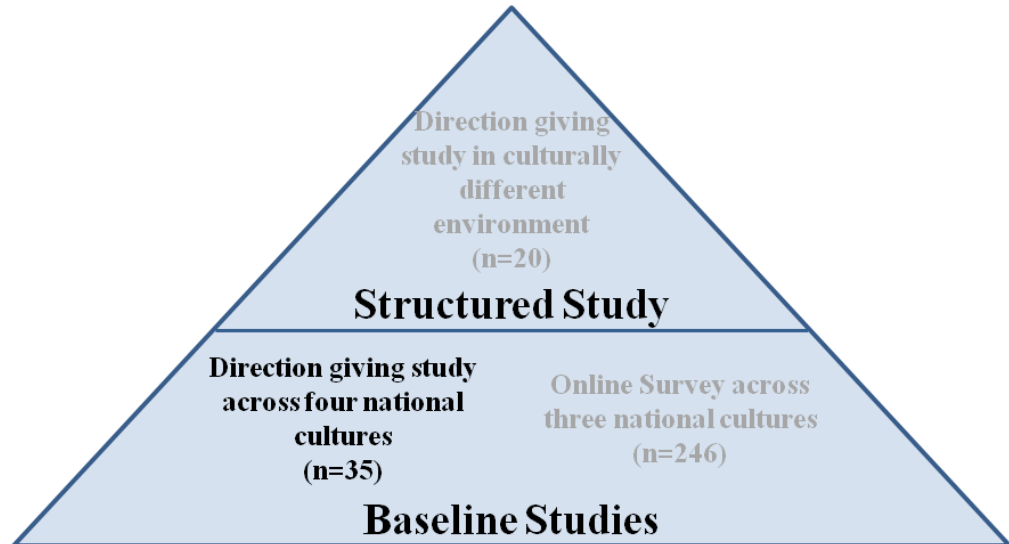
Figure 3.1: The placing of the non-structured direction-giving study within the thesis framework

The thesis has two studies designed as foundation to lay emphasis on the investigation of cultural influences drivers' behaviour (as illustrated in Figure 3.1). The first part is reported in this chapter and the study aimed to compare cultures of Malaysia, United Kingdom (UK), Japan and China in a direction-giving exercise.

The second study can be found in the Chapter 4. It was expected that the exercise of providing directions for self-use at a later day would encourage the abstraction of good and reliable information from the road environment. It was further expected that a comparison across pre-selected nations with established cultural dimensions would reveal an initial formation of patterns for writing out preferred navigational instructions.

For this study, Hofstede's (2010) cultural dimensions were used as a tool to select nations which were 'different' from a cultural perspective. Importantly, a paper questionnaire conducted after completing the direction-giving task aimed to understand participants' self-rated navigation skills. Another aim of the study was to evaluate the reliability of using a categorisation scheme developed in other PhD work (Burnett, 1998) as a tool to quantify cultural differences in navigation instructions produced by participants for this study. This information would be needed to design study at the second level of the thesis framework.

In summary, this first study used paper-based direction-giving task and a paper questionnaire across four culturally different nations to locate potential cultural needs, of which knowledge would be beneficial in understanding the needs in constructing navigational interfaces for in-vehicle navigation systems (IVNS).

3.2 Aim, objective and activity

Table 3.1: Summary of Overall Aim, Objective and Activity for Chapter 3

Overall Aim To explore potential cultural needs within the design of in-vehicle navigation systems				
Code	**Objectives**	**Code**	**Activities**	**Chapter**
O1	To generate an understanding of cultural needs using elements deriving from drivers navigating in a road environment across national cultures	**A1**	A direction giving study across UK, Malaysia, Japan and China	**3**
O2		**A2**		**4**
O3		**A3**		**5**
O4		**A4**		**6**

To achieve the overall aim given earlier in section 1.9 of Chapter 1, the first specific objective (O1) was addressed in this chapter (see Table 3.1 above). A further two sub-objectives were also listed:-

1. This study investigated differences and similarities among drivers in route following behaviour across national culture by measuring the en-route information extracted from urban road environment;

2. Furthermore, this study enumerated drivers' abilities in navigation and preferences for paper-based directions from self-report paper survey.

Hence, the first activity (A1) as given in Table 3.1 is reported in this Chapter.

3.3 Methodology

3.3.1 Justification for paper-based direction-giving study

Review of the literature relating to 'navigation' and 'macro' entities showed that direction-giving studies have been used to explore drivers' cross-regional values (Collett and O'Shea, 1976), to investigate driver's choice of 'good' navigational information (Burnett, 1998), to highlight the effect of grid-patterns on drivers in map sketches and 'pointing-to-landmarks' across nations (Davies and Pederson, 2001) and to explore driver's ability in adapting to different types of reference (Ishikawa and Kiyomoto, 2008).

Therefore, the researcher opted for a direction-giving study as an initial tool in an exploration for cultural needs at national level. However, the direction-giving exercise in this study was not conducted on UK roads due to safety constraints, particularly in drivers' licensures. Moreover, one of the study's

requirements was for participants to own their nation-state driver's licence; hence participants from Malaysia, Japan and China in this study did not own a full UK driving licence.

For this study, the participants were required to complete two tasks, create their preferred paper-based navigational directions using a video and a paper map, and complete a paper survey. However, given the wide ranging definitions and concepts for culture (Kroeber et al., 1952), several pre-conditioned measures were taken in selecting nations and potential participants, in the effort to eliminate bias due to acculturation (Berry, 2008).

3.3.2 The process of selecting national cultures
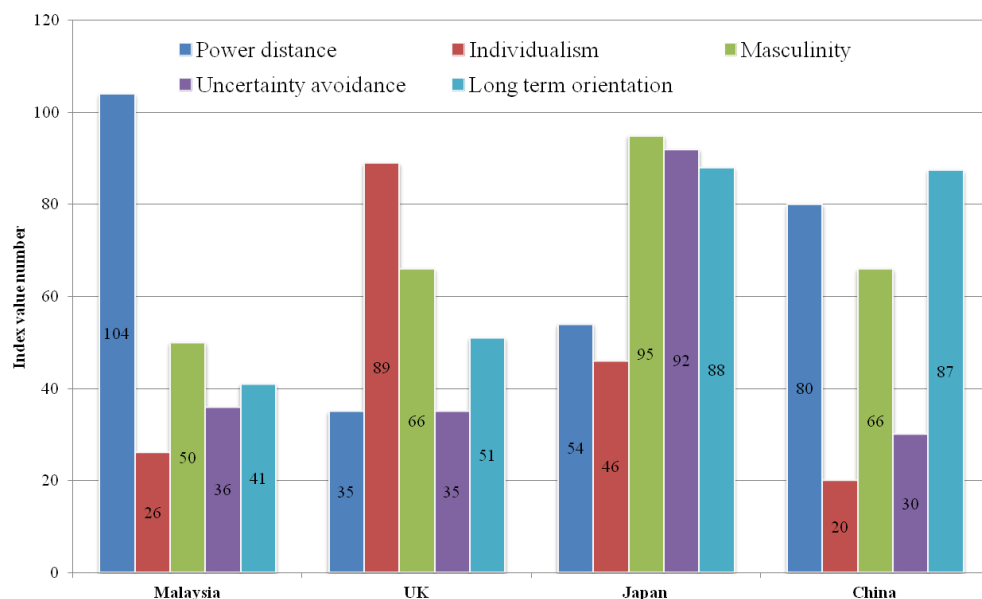
**Figure 3.2: Cultural values in Malaysia, UK, Japan and China
(Hofstede et al., 2010)**

In this study consideration was made for a high index value for every dimension. Hence, the following four nations as illustrated in Figure 3.2, with their associated high index value were chosen; Malaysia – Power Distance (PDI) (ranked first out of 76 countries); United Kingdom – Individualism

(IDV) (third ranked from a list of 76 countries); Japan – (Masculine) MAS (ranked second out of 76 countries) and Uncertainty Avoidance (UAI) (twelfth ranked with 92 index value out of 100 score); and China – Long Term Orientation (LTO) (fourth ranked from a list of 76 countries)(Hofstede et al., 2010).

3.3.2 Choice of participants

It is important to note that a set of stringent rules had to be applied with respect to the selection of participants:

1. They must have obtained their driving licence from their country of origin;
2. They must have been living away from their home country for no more than three years with an average of 50% or more mileage driven were in their respective home environment; and
3. They must not be local to the road environments used in the video footage to create unfamiliarity in the road journey.

Eligible participants were students from the University of Nottingham (including exchange students) – 18 females and 17 males (8-9 participants for each nation). It is important to note that the exchange students had taken English course prior to their placement at the University, which conformed to their literacy in English language. Other University students had passed the University's requirement of 6.5 score band for listening, reading, writing and speaking in their International English Language Testing System (IELTS). Additionally, this study has received an ethical approval from the Faculty Research Ethics Committee, University of Nottingham.

3.3.3 Study Procedures

The potential participants were briefed on tasks requiring completion for this study. Then, participants were seated at a desk that have a desktop computer, a 17 inch monitor, a mouse, blank A4 papers, a paper-map with highlighted route, a written scenario of study, a pen and a consent form. Participants were given a time to familiarise themselves with the control buttons of the software player used in the video task. Next, participants were asked to watch a video clip of a road journey and create a paper-based direction-giving based on the video. Participants were told that to facilitate the process of creating their paper-based direction-giving instructions, they were given the allowance to pause and rewind the videos at any time during the task. Upon completion of creating their navigational instructions for direction-giving, participant were given a paper questionnaire about their driving norms. Participants were required to provide an answer for every question. At the end of the tasks, participants were informed to leave a contact detail if they wished to learn the outcomes of the study.

3.3.4 Paper-based directions (Video task)

In order to extract a driver's actual requirements for navigation information whilst on the move following a designated route, paper-based directions were elicited in this study. The approach allowed drivers to think and write down their perceptual knowledge without any restrictions such as limited options in a built-software or limited representation of information in simulated driving conditions. The participants were asked to highlight information they believed would be useful to have for navigation purposes. In order to have more control

over the road environment, a video footage of a fixed route in the city of Derby, UK was created with a handheld video camcorder. The device was placed midway above the vehicle's hand brake between the passenger seat and the driver's seat. Furthermore, the device was positioned at driver's eye level perpendicular to the hand brake. The journey was recorded on a clear day for approximately 15 minutes (distance of 3 miles). The selected route offered a variety of road layouts and road furniture as given in Table 3.2 below:

Table 3.2: Main road features in the video footage

Type	Total	Types of roads
Junctions	11	6 residential roads 5 city roads
Lanes	5	5 city roads
Landmarks	14	5 in residential area 9 in city area
Roundabouts	3	2 in residential area 1 in city area

Figure 3.3: Snapshots of Derby, UK environment from the video footage

Prior to the start of the task, the participants were given a scenario which asked them to imagine that their paper-based directions would be used at a later date to navigate the given route successfully, without assisted help. Thirty five participants watched the video on a 17' inch desktop monitor (samples of snapshots from the video are given in Figure 3.3). The video had playback functions, whereby participants were allowed to control the video. They were allowed to pause, rewind and fast-forward the video in order to retrieve any navigational information that they would like to put in their paper directions.

A paper map of Derby that contained the highlighted route of the entire journey was also given to provide the participants with an overall sense of direction of the entire journey (as shown in Figure 3.4). Importantly, the paper map provided additional information of the study area such as Road Street names and road classifications which were not visible in the video footage. The said route was enlarged from A5 into A3 paper size. On average, participants took approximately 25 minutes to write their paper-based directions.

Figure 3.4: Map of Derby showing highlighted route for video task

3.3.5 Questionnaire

After completing the direction-giving task, participants had to complete a paper-based questionnaire that had twenty seven questions. The questions were divided into four categories; personal details, unfamiliar journeys, abilities at finding one's way and choice of paper direction. The questionnaire was adapted from the work of Burnett (1998) and was applied in this study design to investigate further demographic details from participants, their driving experiences and self reported abilities in navigation. Moreover, participants were given in the questionnaire, eight styles of direction-giving for a fixed route. Participants were asked to rank their preferences from one to eight where one representing their first choice and the least preferred was given an eight. The information collected from the questionnaire was used to help justify the findings from the paper directional task (a copy of the questionnaire is included in Appendix 3-1).

3.3.6 Dependent variables

3.3.6.1 Paper-based directions

There were 22 dependent variables under six categories (Burnett, 1998), as listed below:

- Directions: *Ego*, *Local*, *Global*

- Distance: *Absolute, Relative, Cost-based*

- Environment – (Path): *Class, Geometry, Lanes, Road rules, Prior turns*

- Environment – (Nodes) Junction types: *Angle, Junction type*

- Environment – Landmarks: *Name, Descriptors, Locators, Reference*

- Environment – Road/Street signs: *Place name, Point of interest name, Road number, Road Street name, Junction name*.

More detailed information about these variables is included in Appendix 3-2.

3.3.6.2 Styles of information representation

There were three dependent variables,

- mostly written representations,

- mostly schematic representations, and

- an approximate mixture of written and schematic representations.

3.3.7 Methods of analysis

The data quantified from the video task for every paper-based direction was analysed with non-parametric, Kruskal-Wallis test due to violation in normal distribution. A section of the questionnaire namely 'choice of paper-based direction' was also analysed with the similar tool. Meanwhile, the data collected from another section of the questionnaire, 'abilities in finding ways', was analysed with parametric, Analysis of Variance (ANOVA). Then, the result from this analysis was further tested with post-hoc statistical tool, Tukey's HSD test. Data from any other parts of the video task and the questionnaire such as total density of information and unfamiliar journeys were presented in percentages.

3.3.8 Driver's profile: gender distribution and annual mileage

18 females and 17 males participated in the study. Further distribution of participants according to age group is given in Figure 3.5. On average, the

annual mileage ranged from 100 to 12,000 kilometres (km) across UK, Malaysia, Japan and China (Figure 3.6). The average days the participants had used cars in a week varied from one to six days across the cultural groups (Figure 3.6).
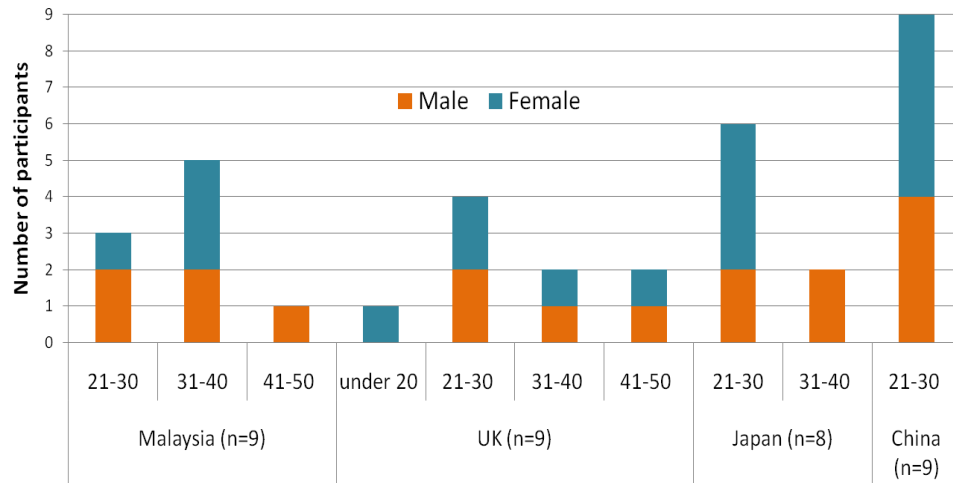
Figure 3.5: Age distribution and gender of respondents (n=35)
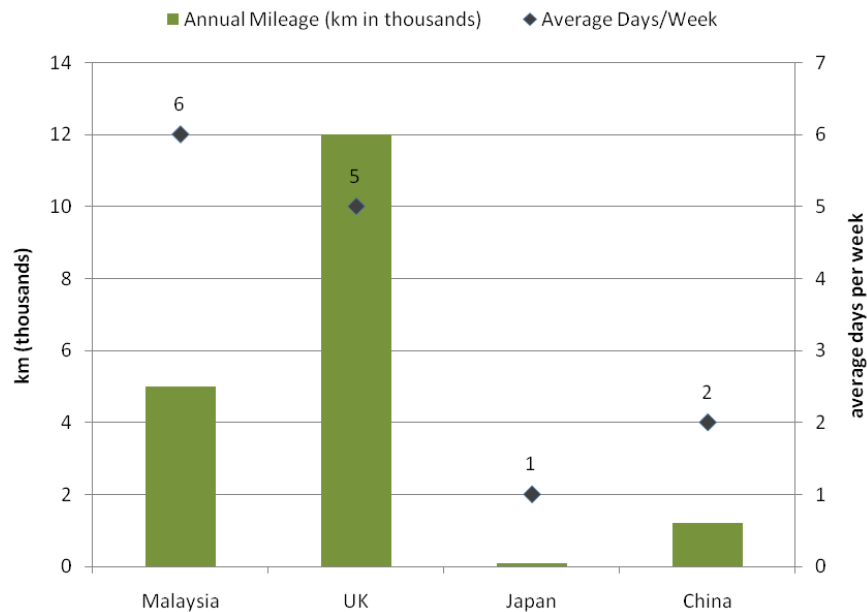
Figure 3.6: Annual mileage and corresponding driving days/week

More detailed information about driver's cultural profile is included in Appendix 3-3.

3.4   Results: Video task

3.4.1 Paper-based directions

Each participant created their paper-based directions onto a maximum of two pages from the paper directional task. These paper-based directions were later quantified based on its context-of-use following the guidelines/descriptions in the categorisation scheme (see Appendix 3-2), developed in the work of Burnett (1998).

The quantification process involved scanning participants' paper-based directions for navigational elements and coding the information accordingly by its meaning in context within appropriate categories (Table 3.3, full version of the categorization scheme is included in Appendix 3-2). For example, the phrase *"Church is on the left-hand side"* was counted as an element of '*locator*' from the category *'Environment – Landmarks'* given that it provided information that would have helped in locating the said landmark whilst in a journey.

The total number of occurrences for each navigational element was counted. Then, further analysis was conducted with the coded data in the statistical software, SPSS Version 16. The study opted for non-parametric statistical tests due to violation of normal distribution within each nation. The study found that seven out of twenty two navigational elements were significant ($p<0.05$) when analyzed with Kruskal-Wallis test (Table 3.4).

Table 3.3: Showing part of the categorisation scheme (Burnett, 1998)

Category	Element	Description
Direction	Local	Direction is defined in relation to an external reference point
Distance	Relative	Distance given relative to some other marker
Environment – Path (road)	Road rules	Information about the road along the path
Environment – Node (junction)	Angle	Indication of angle of junction
Environment – Landmarks	Locators	Information that would help in locating a particular landmark
Environment – Road/Street signs	Place Name	References to a place name (on or likely to be on a road sign)
Environment – Road/Street signs	Point of interest name	References to a point of interest (on or likely to be on a road sign)

Table 3.4: Influence of national culture (Kruskal Wallis test)

Navigational Elements	χ^2	df	Asymp. Sig.	Mean rank scores			
				Malaysia	UK	Japan	China
Direction - Local	8.629	3	0.035	24.11	20.89	11.25	15.00
Distance - Relative	9.186	3	0.027	16.50	22.33	16.50	16.50
Path - Road Rules	9.086	3	0.028	16.33	25.44	12.69	16.94
Node - Angle	8.061	3	0.045	16.17	25.39	16.44	13.83
Landmarks - Locators	8.856	3	0.031	23.78	21.94	11.81	13.78
Road Street Name - Place Name	10.043	3	0.018	20.17	24.94	13.38	13.00
Road Street Name - Point of Interest Names	9.208	3	0.027	16.50	22.33	16.50	16.50

3.4.2 Styles of information representation

Following the quantification of participants' paper-based directions, the styles of how information was represented were assessed using visual observation method. This exercise was included to observe for any apparent different in styles of representing navigational information across the four nations. The styles were categorized into three – mostly written representations, mostly schematic representations and an approximate mixture of written and schematic representations.

The study found that the Japanese participants in particular were prone to sketch their choice of navigational information as opposed to other cultural groups. The Japan group also showed repetitiveness in representing information at critical points where changes in the course of directions were required. For example, at one point where the car was turning right, the majority of the Japan participants (50%) placed a written arrow, a symbol and graphical arrow to indicate the turning point (as shown in Figure 3.7). Moreover, all information were arranged in a matrix format whereby information for the same turning point were arranged in columns and the subsequently actions were in rows. On the other hand, the UK, Malaysia and China groups had constructed their paper-based direction linguistically with only occasional use of self-created symbols for rights, lefts and traffic lights. Importantly, the styles of navigational representations were particularly distinct for the Japanese group when compared against other cultural groups. Five out of eight Japanese preferred the schematic representation whilst eight out of nine participants of the UK group had opted for the written navigational instruction (Table 3.5). Examples of the differences were given in Figure 3.7.

Table 3.5: Styles of paper-based directions by nation (n=35)

Style of directions	Malaysia (n=9)	UK (n=9)	Japan (n=8)	China (n=9)
Mostly written representation	8	8	3	7
Equal mixture of written and schematic representation	1	0	0	1
Mostly schematic representation	0	1	5	1
TOTAL (n=35)	**9**	**9**	**8**	**9**
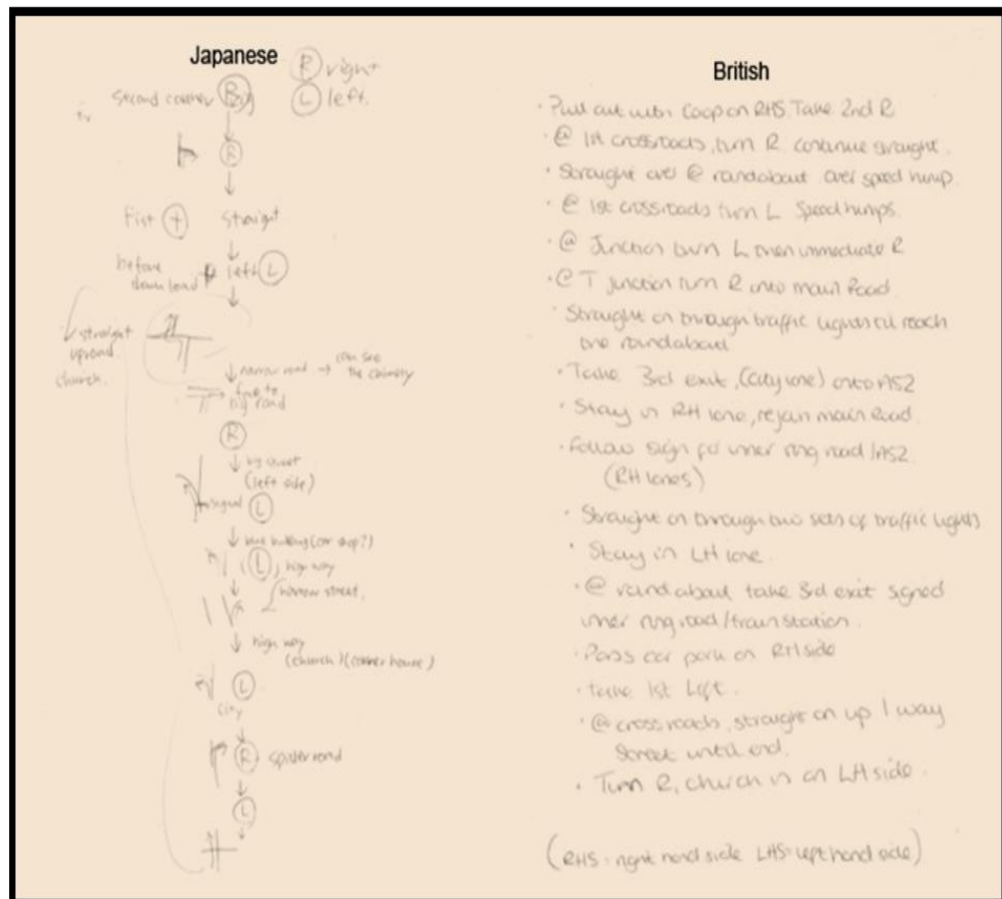
Figure 3.7: Examples of different styles in paper-based directions between a Japanese and a British in this study.

3.4.3 Density of navigational information

The categorisation scheme had twenty two elements in total and the UK group used 91% of these elements (twenty two elements in total) to create their paper-based directions. Each UK participant constructed their paper-based directions differently, particularly in placing 'good' navigational elements into context, which resulted in the use of a variety of elements for the same context. For example, in describing the turning point where there was a visible landmark, participants used more than one way to place it in the navigational instructions, such as *"...tower on the left..."*, *"Turn right at the tower*, and *"...high building"*. Moreover, one of the UK participants had opted to sketch the

entire journey and highlighted important landmarks, direction of turns and junction types. However, the remaining of the UK participants (eight out of nine) chose to create their paper-based direction in words (linguistically). There were two elements from the categorization scheme that were not used by all four cultural groups in this study. The omitted navigational elements were *global – direction* such as *"Head north"* and *absolute – distance* for example *"Turn right in 50 meters"*.

On the contrary, the other three cultural groups, Malaysia, Japan and China had more restricted use of elements from the environment. They opted to structure most of their navigational instructions with elements from these categories – directions and landmarks (environment). Furthermore, their instructions were unpopulated (less than one percent) with two distance elements, *relative* and *cost-based*. One example of *relative* distance given by a participant from the UK group as shown in Figure 3.7 was *"Straight on through…until reach one…"* Additionally, the Malaysia, Japan and China groups were not able to use local information, such as *points of interest names* and *junction names* in the context of their paper-based directions. Comparatively, the UK group was able to use *points of interest names* and *junction names* in structuring their paper-based direction, 4.1% and 0.2% respectively (Table 3.6). Moreover, as illustrated in Figure 3.8, *ego directions*, *junction type*s and landmarks (*name*, *descriptors*, *locators* and *reference*) were commonly use by participants across the four nations. *Locators, descriptors* and *name* were the populated landmarks for every nation (see Table 3.6) with higher use of *locators* in the Malaysia and UK groups, as compared to the Japan and China groups.

Table 3.6: Overall density of navigational information for UK, Malaysia, Japan and China (n=35)

Direction	Malaysia (n=9)	UK (n=9)	Japan (n=8)	China (n=9)
Ego	99 (24.5%)	63 (15.3%)	90 (36.6%)	84 (31.7%)
Local	23 (5.7%)	21 (5.1%)	5 (2.0%)	11 (4.2%)
Distance				
Relative	-	28 (6.8%)	-	-
Cost-based	2 (0.5%)	3 (0.7%)	4 (0.4%)	1 (0.4%)
Path (Road) [Environment]				
Class	4 (1.0%)	13 (3.2%)	8 (3.3%)	2 (0.8%)
Geometry	18 (4.5%)	26 (6.3%)	14 (5.7%)	18 (6.8%)
Lanes	20 (5.0%)	31 (7.5%)	10 (4.1%)	10 (3.8%)
Road-rules	6 (1.5%)	17 (4.1%)	2 (0.8%)	6 (2.3%)
Prior turns	18 (4.5%)	11 (2.7%)	4 (1.6%)	6 (2.3%)
Node (Junction) [Environment]				
Angle	4 (1.0%)	13 (3.2%)	7 (2.8%)	5 (1.9%)
Junction type	40 (9.9%)	36 (8.7%)	22 (8.9%)	19 (7.2%)
Landmarks [Environment]				
Name	37 (9.2%)	28 (6.8%)	18 (7.3%)	24 (9.1%)
Descriptors	32 (7.9%)	24 (5.8%)	28 (11.4%)	35 (13.2%)
Locators	56 (13.9%)	39 (9.5%)	11 (4.5%)	20 (7.5%)
References	12 (3.0%)	16 (3.9%)	7 (2.8%)	14 (5.3%)
Road/street signs [Environment]				
Place name	11 (2.7%)	17 (4.1%)	2 (0.8%)	2 (0.8%)
Point of interest name	-	3 (0.7%)	-	-
Road number	5 (1.2%)	7 (1.7%)	-	2 (0.8%)
Road/street name	17 (4.2%)	15 (3.6%)	14 (5.7%)	6 (2.3%)
Junction name	-	1 (0.2%)	-	-
Overall Total	**404 (100%)**	**412 (100%)**	**246 (100%)**	**265 (100%)**
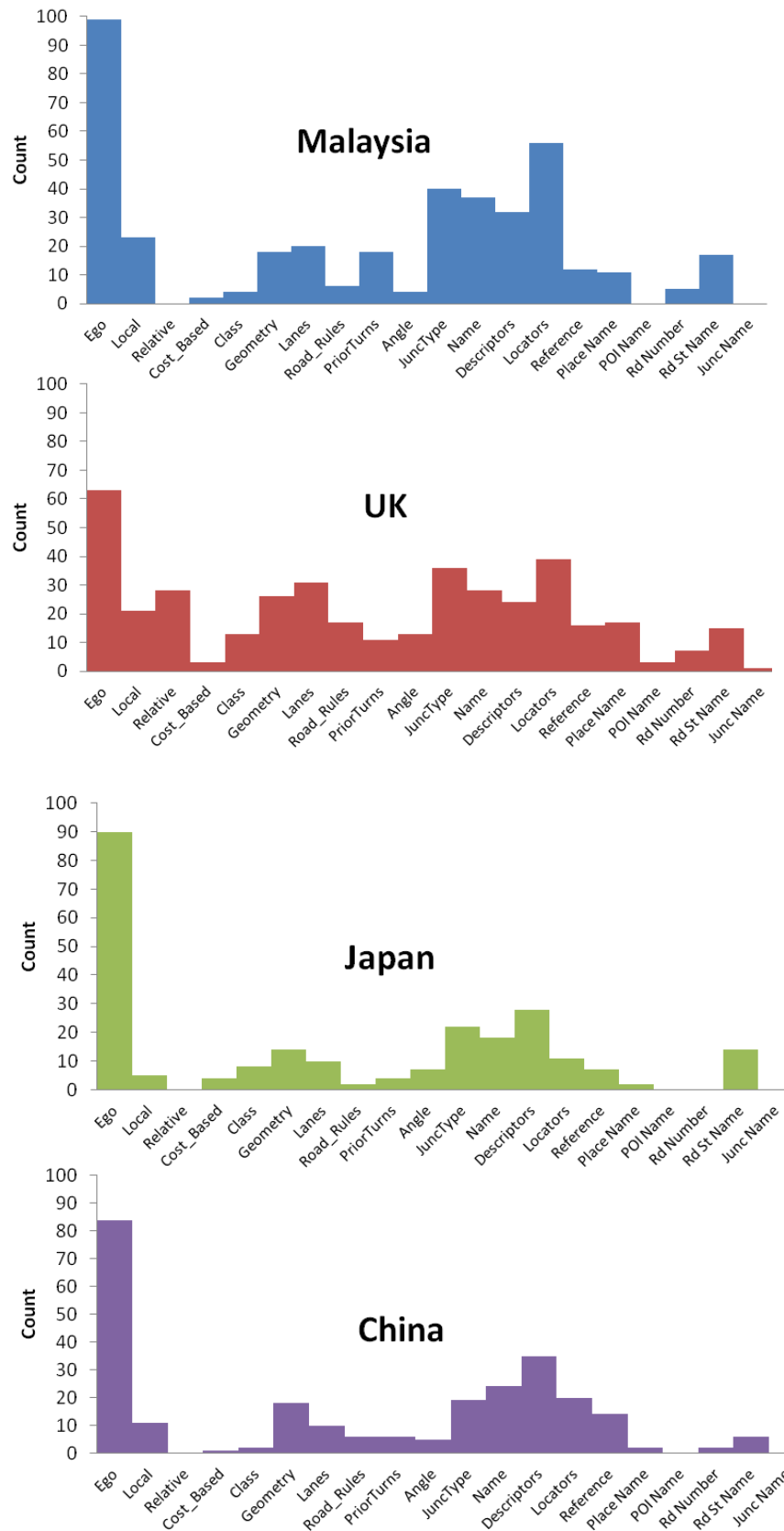
Figure 3.8: Showing two patterns of overall density of information, high (Malaysia and UK), low (Japan and China)

Importantly, the illustration also showed two patterns, high and low in the overall density of information. Malaysia and UK both showed a high overall density of information (404 and 412 respectively). Meanwhile, the Japan and China groups reported a low figure in the total density, 246 and 265 respectively (Figure 3.8).

Road Street names were also included by some participants as part of their paper-based directions. However, the percentage in each cultural group was noted as lower than 10%. Most of these *Road Street names* were not extracted from the study environment. Instead the information was taken from the paper map, given that these names were not visible or legible in the video. Nevertheless, *Road Number* and *Points of Interest Names* (which were clearly signed posted as part of road furniture in the video) were used by some participants to construct their paper-based directions.

Apart from the two patterns of high/low overall density of information, a consistent pattern of high use for *ego direction* and landmarks – *name, descriptor, locators* and *references*) were also noted across the four cultural groups (Figure 3.8). However, each pattern did not amount to similar number in occurrences (for example the Malaysians used more *ego directions* compared to the China group).

3.5 Results: Questionnaire results

3.5.1 Unfamiliar Journey

Part of the questionnaire also aimed to understand the purposes in undertaking unfamiliar journey amongst participants in each cultural group. In this study, most participants did not embark on unfamiliar journeys as part of their work or business, of which occurred maximum of 6 times a year (from the Malaysia and China groups) and minimum once as reported in the UK and Japan groups (Figure 3.9). Journeys made to unfamiliar places often took place during holidays – for leisure purposes as illustrated in Figure 3.9 for the UK, Japan and China groups. The Malaysians experienced more unfamiliar journeys as part of non-work purposes such shopping which reportedly occurred every month (Figure 3.9).

Unfamiliar journey is...

part of work or business	2 to 6 times a year	once a year	once a year	2 to 6 times a year
non-work purposes such as shoppping	12 times a year	2 to 6 times a year	2 to 6 times a year	2 to 6 times a year
for leisure purpose such as holiday	2 to 6 times a year	12 times a year	12 times a year	12 times a year

□ Malaysia　□ UK　□ Japan　□ China
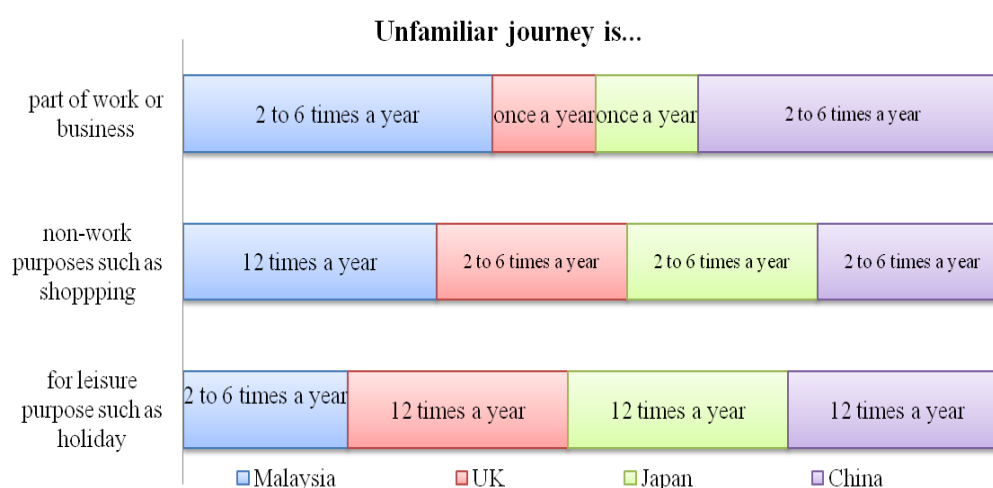
Figure 3.9: Frequency of unfamiliar journey according to purpose (n=35)

3.5.2 Abilities in finding ways

The participants were asked to rate themselves between the scale of 1(either very good, never or very easy) and 9 (either very poor, always or very difficult) in their abilities to navigate successfully. A set of parametric statistical tools, Analysis of Variance (ANOVA), followed by post-hoc Tukey's HSD test were used to analyse the data. The results showing means and standard deviations for every cultural group is given in Table 3.7. Further illustrations for significant results among the four nations are given in Figure 3.10, Figure 3.11 and Figure 3.12.

Table 3.7: Differences among the cultural groups (n=35)

Your navigation ability...	Malaysia (N=9) (a)		UK (N=9) (b)		Japan (N=8) (c)		China (N=9) (d)		Variance		Groups having differences
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	F	P	(Tukey's HSD test)
Abilities to find your way - in an unknown area	3.33	1.94	4.22	2.64	5.25	3.06	4.11	1.27	0.99	0.41	Non significant
Sense of direction	3.33	2.12	3.89	2.47	4.63	2.72	3.56	1.13	0.56	0.64	Non significant
Navigating for someone else when acting as passenger	3.44	2.24	2.67	1.80	3.88	1.55	3.56	1.51	0.70	0.56	Non significant
Navigating for someone else when providing them with directions (either written or over the phone)	3.67	2.35	4.11	2.03	3.88	2.42	4.56	2.51	0.24	0.87	Non significant
How often do you get lost	4.89	1.62	4.33	2.00	4.88	2.10	3.67	1.50	0.89	0.46	Non significant
How often do you get lefts and rights mixed up	3.78	1.79	1.67	1.00	4.38	2.26	1.89	0.78	6.57	0.001*	a-b, c-b, c-d
How good are you at remembering an unfamiliar route after you have driven it for the first time	4.00	2.00	3.56	2.40	4.75	2.12	4.44	1.67	0.55	0.65	Non significant
How easy to locate a particular street name on a published map	3.33	2.24	2.78	1.56	5.38	2.26	3.00	1.66	3.09	0.04*	b-c
How easy to plan a route using a published map	2.78	2.33	2.44	1.33	5.00	2.51	2.67	1.41	3.09	0.04*	Non significant
How easy to establish your current location using a published map	3.22	2.73	3.11	1.76	4.75	2.92	2.56	1.33	1.44	0.25	Non significant
How much do you like reading a published map to find your way	3.78	3.03	3.33	1.66	3.88	2.70	3.44	2.83	0.09	0.97	Non significant

Note: * p<0.05

The results showed that the majority of participants rated themselves as good with an average below five (the mid-point on the scale). However, there were several exceptions in the Japan group in locating a particular street name on a published map (Mean=5.38, SD=2.26), planning a route on published map (Mean=5.00, SD=2.51) and always mixing between lefts and rights (Mean=4.38, SD=2.26). These were the three out of eleven items from 'abilities

95

in finding ways' that were significant according to one-way ANOVA test (as shown in Table 3.7).

Interestingly, further post-hoc analysis with a Tukey's HSD test showed the significant difference for 'How easy to locate a particular street map on a published map' was between the Japan group and the UK group (Figure 3.10).
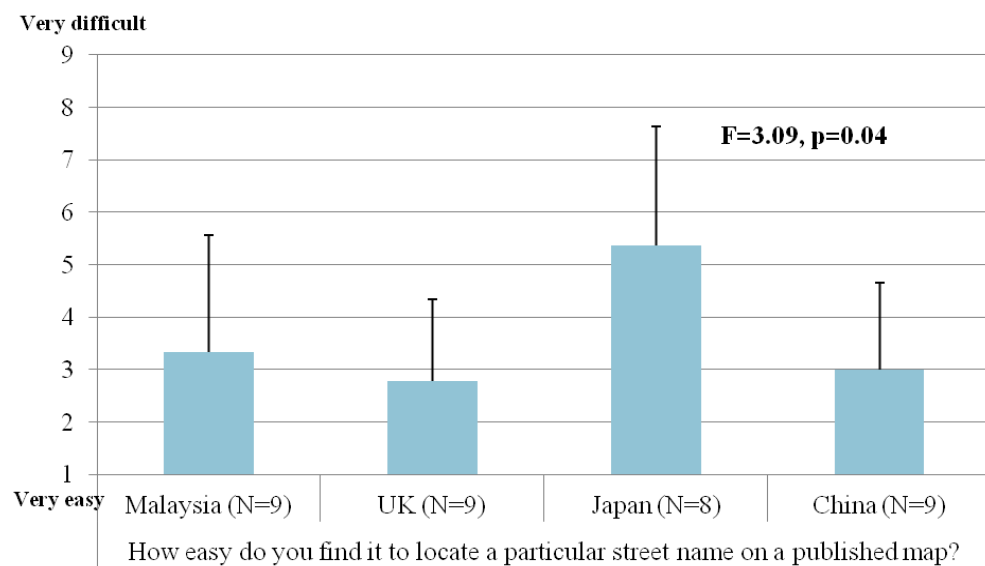
Figure 3.10: Meaningful differences across Malaysia, UK, Japan and China according to one-way ANOVA test (n=35)

For question 'How often do you get your lefts and rights mixed up?', participants from Japan and Malaysia both reported themselves as always mixing their directions. Nevertheless, a post-hoc Tukey's HSD test showed the differences were between the UK and the Japan, and between the China and the Japan group. Meanwhile, the Malaysia group was found significantly different from the UK group only (as shown in Table 3.7 and illustrated in Figure 3.11).

96
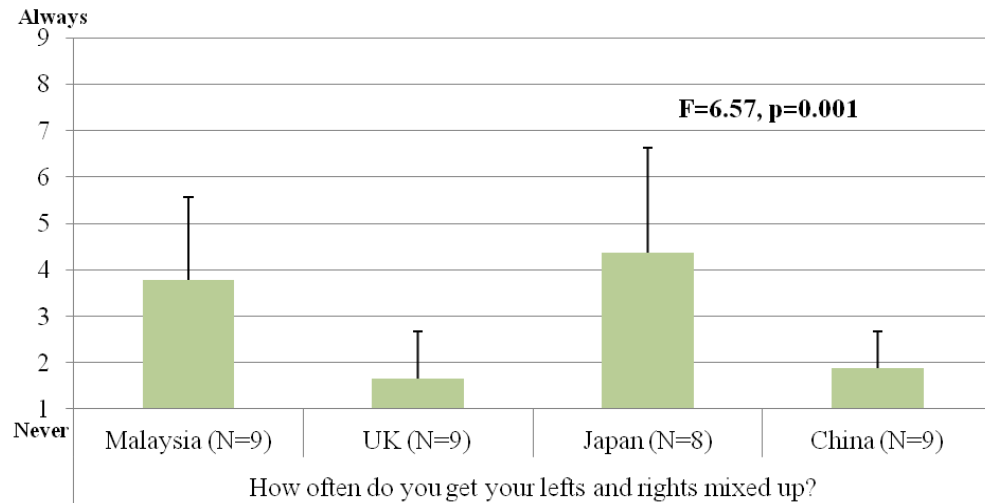
Figure 3.11: Meaningful differences across Malaysia, UK, Japan and China according to one-way ANOVA test (n=35)

Moreover, the Japanese self-rated abilities for easiness in planning routes using published maps were found to be significantly different from other cultural groups according to the one-way ANOVA test (F=3.09, p=0.04) (Figure 3.12). However, in the Tukey's HSD post hoc analysis, no further significant differences were detected between the Japan group and other cultural groups (refer to Table 3.7 of this thesis).
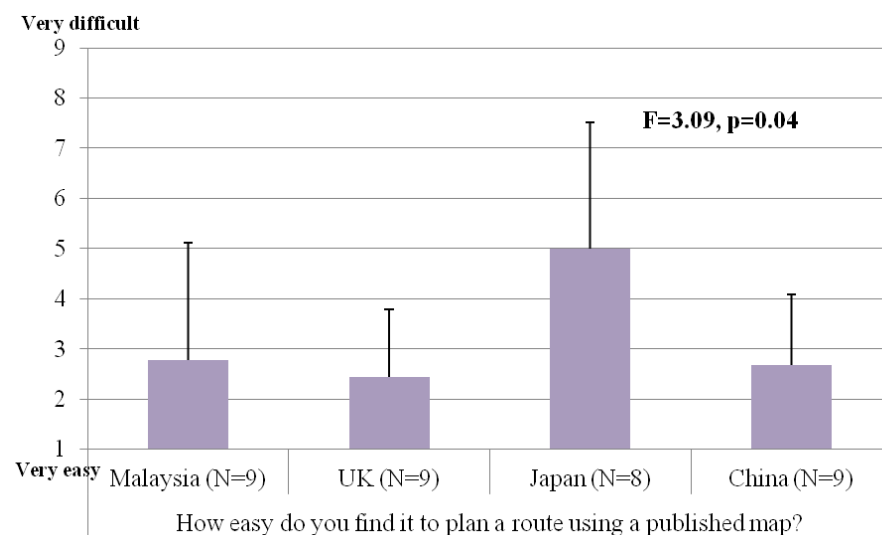
Figure 3.12: Showing meaningful differences in easiness of planning a route using a published map according to one-way ANOVA test across culture (N=35)

97
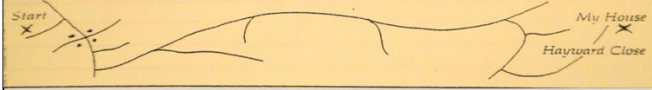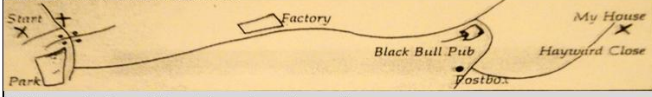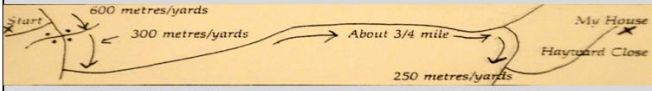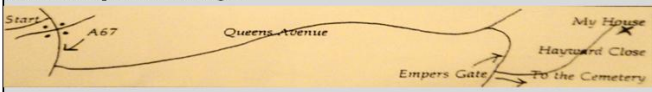
3.5.3 Choice of paper-based direction

The last part of the questionnaire asked for participants' preferences in paper-based directions (from the perspective of the receiver of information). Eight different paper-based directions were presented in a table format where participants had to rank their choice between 1 (most preferred) and 8 (least preferred). The majority of participants (twenty three out of thirty five) chose *'sketched map with landmarks'* as their most preferred paper-based direction (Table 3.8). Meanwhile, the next preferred paper-based direction was *'written with reference'*, with ten participants selecting it as their second choice of paper-based direction.

Interestingly, this type of paper-based direction was the first (1st) choice for four Japanese people in this study (Table 3.8). More interestingly, sketched map with navigational arrows and absolute distance were selected by six other participants as their second (2nd) preferred choice of paper direction (Table 3.7). Nevertheless, none of the participants in this study chose *'written with absolute distance'* such as *"...follow the road for a while (about half a mile) and then turn right"* as their first (1st) or second (2nd) choice for preferred paper-based direction (Table 3.8).

Similar results were observed in the option for *'sketched map with start/end points'* (Table 3.8). Furthermore, five out of nine participants from the China group opted for the sketched map with Road Street signs as their second (2nd) choice of paper-based direction. When analysed with Kruskal-Wallis test for the influence of national culture, no significant differences were found.

Table 3.8: Participants' first (1st) and second (2nd) choices for paper-based direction

Written with reference	1st	2nd	Group
• Turn right at the end of the road by the church • Then drive past the crossroads (with traffic lights) and then turn left at a park • Follow the road for a while past a factory and then turn right at the Black Bull pub • Then turn left into Hayward Close by a postbox. My house is on the right	1 - 1 1	2 3 4 1	Malaysia (n=9) UK (n=9) Japan (n=8) China (n=9)
Sketched map with start/end point 	- - - -	- - - -	Malaysia (n=9) UK (n=9) Japan (n=8) China (n=9)
Written absolute distance • Turn right at the end of the road • Then drive for about 600 metres/yards until you go past the crossroads (with traffic lights) and 300 metres/yards after this turn left • Follow the road for a while (about 3/4 miles) and then turn right • Then after 250 metres/yards turn left into Hayward Close. My house is on the right	- - - -	- - - -	Malaysia (n=9) UK (n=9) Japan (n=8) China (n=9)
Written, prior turns • Take next turning right at the end of the road • Then drive past the crossroads (with traffic lights) and then take second turning left • Follow the road for a while and take the fourth turning on the right after the left-hand bend • Then take second left into Hayward Close. My house is on the right	1 3 - -	1 - - -	Malaysia (n=9) UK (n=9) Japan (n=8) China (n=9)
Sketched map with landmarks 	5 4 6 8	1 1 2 -	Malaysia (n=9) UK (n=9) Japan (n=8) China (n=9)
Written with Road Street signs, junction nodes • Turn right at the end of the road onto the main A67 • Then drive past the crossroads (with traffic lights) and then turn left onto Queens Avenue • Follow this road for a while and then turn right onto Empers Gate • Then turn left into Hayward Close signposted to the Cemetery. My house is on the right	- 2 - -	- 2 1 1	Malaysia (n=9) UK (n=9) Japan (n=8) China (n=9)
Sketched map navigational arrow absolute distance 	2 - 1 -	2 1 1 2	Malaysia (n=9) UK (n=9) Japan (n=8) China (n=9)
Sketched map road street signs 	- - - -	3 2 - 5	Malaysia (n=9) UK (n=9) Japan (n=8) China (n=9)

3.6 Discussion

3.6.1 Participant characteristics

3.6.1.1 Drivers' gender and age

One crucial consideration in the investigation of cultural values was the control of potential influential factors. Given that gender has been reported in the literature to have had an effect on driving behaviours such as navigation (Carpenter et al., 2004, Baldwin, 2009), a control was put in place emphasizing the gender distributions in each cultural group to be near equal (eighteen females and seventeen males). Moreover, the study aimed to explore drivers' perceptual knowledge of the environment. In order to achieve this in the

context of culture, preliminary screening of participants' characteristics is a necessity. This approach would then shift the platform of investigation from non culture-specific to culturally sensitive study.

Another potentially important influential cultural factor would be age (Horberry et al., 2006, Zhao et al., 2006). While $21 - 30$ years old was the most represented age group in this study, participants from the age band of $31 - 40$ years old were included (no representation from the China group). However, the age factor was not felt to have a strong effect on drivers' perceptual knowledge, given that the tasks involved were not measuring motor-abilities such as testing drivers' reaction times in creating navigational instructions, at particular points in the video.

3.6.1.2 The influence of drivers' annual mileage and driving experience

It is believed that annual mileage would be an influential factor, as it is positively correlated to drivers' experience, which would affect drivers' perceptual knowledge. In this study the Japan group had the lowest annual mileage (113 km/current year) on average, with the least number of driving days in a week when compared against other group members. The low averages observed in the Japan, China and Malaysia groups were largely due to the immense reduction of their normal driving days upon arrival in the UK. All non-UK participants in the study were students (including exchange students) of the University of Nottingham (undergraduates and postgraduates). When asked for the length of time they had been living in Nottingham, most participants indicated between one month and three years.

The majority of the non-UK participants (19 out of 26) did not own vehicles in UK. There was an exception to the Malaysia group where seven out of nine participants had owned cars in UK. However, most of the mileages claimed by the Malaysians in this study were driven in Malaysia. This was confirmed by the fact that eight of nine participants had lived in Nottingham for less than six months prior to being part of this study. Given that the question was to state annual mileage in the last twelve months, eight of the participants had driven most of the mileage whilst in Malaysia. Furthermore, despite owning a vehicle in UK, their daily driving experiences were limited to the local area, near the University of Nottingham.

Importantly, a relatively small percentage of participants had five years driving experience or less while 74% reportedly had more than six years of driving experience. This would have influenced the quality of paper-based directions produced in the study, given that drivers would have more knowledge of a road environment.

3.6.1.3 'Styles' in personal paper-based directions for different cultural groups

Given the high percentage claimed across all four cultural groups for travelling in journeys with no assistance (refer to Figure 3.5a in Appendix 3-3), the majority of participants recruited for this study could be taken as drivers which have familiarise themselves with driving environment, or drivers that frequently travel a dedicated area in which directional assistance and use of maps are unnecessary.

Should these percentage be weighted as a reflection of drivers' perceptual knowledge, then their personal paper-based directions (which were constructed

in the video task), would have had a 'style' in its navigational instructions. For example, in an environment where salient landmark is available, drivers (of different cultural backgrounds) would have used the said landmark differently in their navigational instruction for others (as *name, descriptor, locator* or *reference* – as described in Burnett (1998).

Conversely, this 'style' of structuring navigational instructions could also have similar elements across the cultural groups in delivering paper-based directions. What is required from such written paper-based directions would be to explore for potential cultural needs, given that the cultural groups for this study were pre-selected according to Hofstede et. al (2010) cultural dimensions.

Reflecting on the work of Heimgärtner (2007b) which elaborated about the amount of interaction that had occurred between a driver and a corresponding environment, a prediction of potential cultural indicators from their paper-based directions would have been true. This prediction is in parallel with those of Lynch (1960) and Lovelace et. al (1999) which argued that drivers have assimilated information from the environment and stored into their perceptual or spatial knowledge inasmuch that it influenced their 'style' of navigation.

Nevertheless, navigating the environment with assisted tools such as maps or local passenger could also lead towards similar outcomes in enhancing drivers' internal representations of the environment. Arguably, when automated assisted tools such as in-vehicle navigation systems (IVNS) were used, there is a possibility that culture could influence drivers' satisfaction and IVNS's usability, with the system's navigational instructions (both graphical and

verbal). The debate about the influence of culture in driver's navigational preferences was highlighted in the literature as one of the future concerns over distributions of global products (Daimon et al., 2000, Roessger and Hofmeister, 2003, Heimgärtner et al., 2007). However, very little information was reported about the characteristics of these cultural values in drivers.

3.6.2 Exploration of cultural needs

Participants in this study were required to structure their paper-based directions in a non-restrictive (freestyles) condition (from the video task), and state their preferences over fixed options of paper direction (from the 'choice of paper-based directions' section in the questionnaire). Comparatively, both exercises have shown persistent similarities and interesting differences, which are believed to have accounted for cultural values imprinted in drivers' perceptual knowledge of good navigation strategies (as illustrated in Table 3.4 and Table 3.8). This belief was based on the designs of study which have utilised 'local' drivers as participants. Moreover, these participants were representing at least one of Hofstede's (2010) cultural dimensions.

The similarities and differences found in this study (Table 3.4 and Table 3.8) were deduced after the application of Burnett's (1998) categorising scheme (another PhD work described earlier in section 2.2.5 of Chapter 2). Based on the scheme, *ego* directions were commonly used by every participant in this study, despite a variation of elements for directions (from *ego, local, global*). This finding did not support Hofstede's explanation for high power distance (Malaysia) when compared with high long term orientation (China). Theoretically, given the distinctions of high cultural profile across the four

nations, there could have been different 'styles' of describing directions, as demonstrated by Beijing Traffic Management Bureau, 2010 in China (refer to section 2.2.7 of Chapter 2). There are two possible explanations for such inconsistency,

1. The video task was limited in depicting global directions in the recorded environment as UK roads do not use global directions as part of road signs (such as "…from the West")

2. The paper map which was enlarged from size A5 to A3 did not have any global indications (such as a compass icon showing the North).

Another finding which contradicted with Hofstede's dimensions was the wide use of landmarks (a selection of four types, *name, descriptors, locators,* and *reference*) across Malaysia, UK, Japan and China. There were no clear patterns as to which types of landmarks were preferred by a particular nation in this study. Despite the apparently distinct cultural profile across the four national cultures, all participants demonstrated a need for landmarks to construct their navigational instructions.

Nevertheless, this finding was in parallel to those that have discussed the role of landmarks for navigation in the literature (Burnett, 1998, Lovelace et al., 1999, Steck and Mallot, 2000, Burnett, 2000, Burnett et al., 2001, Davies and Pederson, 2001, Montello et al., 2001, Burnett and Porter, 2002, Goodman et al., 2005). Given the importance of having landmarks in navigation (as demonstrated in this study and other studies from the literature), Hofstede's dimensions were not able to describe participants' choice of landmarks across culturally-different groups. Alternatively, the application of Burnett's (1998)

categorisation scheme was able to quantify the types of landmarks participants selected for their navigational instructions.

It is important to note that the studies on the role of landmarks in navigation from the literature were not focused on culture, and very little information was reported on the influence of culture in navigation. Therefore, given the slight difference in the 'choice-of-types-of-landmarks' across the four nations as shown in Table 3.6 of this chapter, it is believed that further exploration is needed to understand landmarks characteristics when cultural considerations are taken into consideration.

Table 3.9: Findings from the paper-based directions and questionnaire

The differences found in this study (Table 3.4, Table 3.8 and Table 3.9) were compared with the descriptions for Hofstede et al. (2010) cultural dimensions and Hall and Hall's (2001) communicative cultural concepts. These known cultural dimensions/concepts were used as a reference to explain the results. In the effort to understand these findings, Honold's (2000) definition of cultural models (as described in section 1.8 of Chapter 1) were applied, to group the emerging cultural values (as discussed in the following section) according to its attributes.

3.6.3 Suggestions for potential cultural values
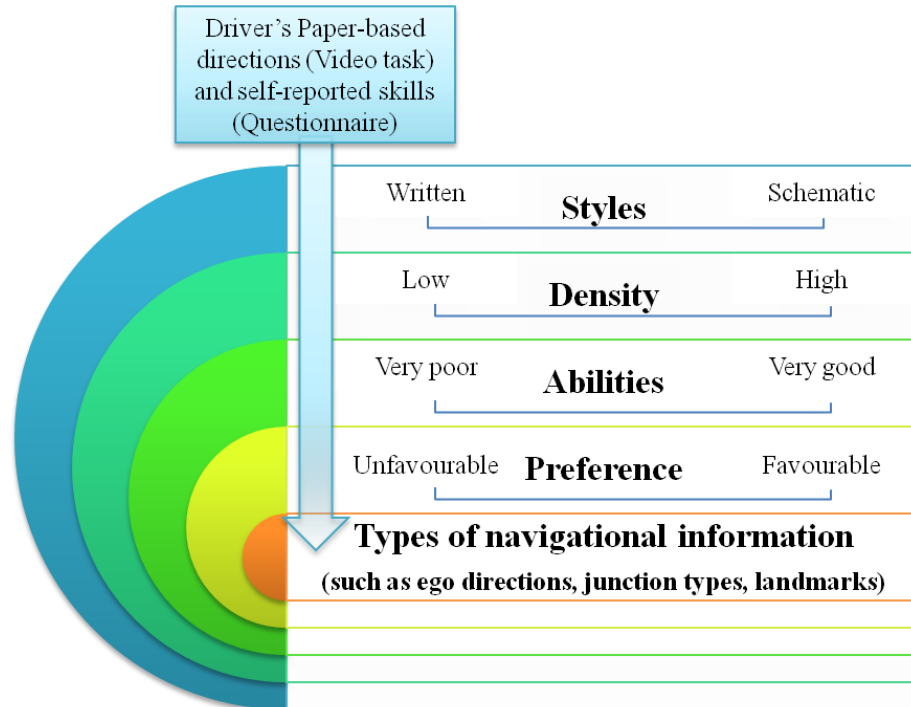
**Figure 3.13: Stacked Venn diagram showing inter-relationship of
potential cultural needs in navigation**

It is suggested that cultural values deduced from this study could have an

overlapping five characteristics,

1. Navigational styles (between written and schematic),

2. Density of information (between high and low),

3. Self-rated abilities (between very poor and very good),

4. Drivers' preferences (between unfavourable and favourable) and finally,

5. Types of navigational elements (as illustrated in Figure 3.13).

It is featured as overlapped due to potential connections of every characteristic

to, driver's interactions with a corresponding road environment. Such

interactions (between drivers and a user interface) were argued in the literature

been influenced by culture (Curzon et al., 2002, Marcus, 2005, Heimgärtner, 2007a).

3.6.3.1 Navigational styles

According to Klippel at al. (2003), paper-based directions that were constructed by predominantly graphical ways (such as drawing of sketch-maps or pictorial arrow) to indicate turning point, it is inferred as 'mostly schematic representations'. Conversely, paper-based directions that were linguistically constructed with words for representing turning arrows and landmarks, is referred as 'mostly written representations'. Meanwhile, an approximate combination of both is inferred as 'schematic and written representations' (Klippel et al., 2003).

For this study, the Japanese group had a mixture of paper-based directions styles within participants. However, the majority (five out of eight) opted for 'mostly schematic representations' for their paper-based directions. This depicts the value of a high context from the perspective of cultural communication (Hall and Hall, 2001) whereby their navigational instructions were created with limited choice and restricted information (Marcus and Gould, 2001). An example of this situation is given in Figure 3.5 of this chapter. Groups communicating at a high level of context do not require much information as part of their message (Hall and Hall, 2001). In relation to this study, the Japanese held information in each line of their navigational instruction to be sufficiently minimal, utilising 'mostly schematic representations' yet filled with redundant information.

According to Hall and Hall (2001), communication in high context culture contained fewer codes referring to the process of coding real information into spoken language. Hall and Hall (2001) stated that members would constantly update themselves with surrounding events which resulted in the need for less code.

Moreover, most of the Japan group's paper-based directions also depicted redundancy of information, particularly for places where a change in the course of direction was due. This is parallel to the influential aspects derived in the work of Marcus and Gould (2001) on user interfaces for high *uncertainty avoidance* (UAI) cultures. Following the Hofstede et al. (2010) definition, people with high UAI have low tolerance for ambiguity, which has resulted in the implementation of strict laws and rules.

Marcus and Gould (2001) subsequently argued that high UAI cultures would prefer a user interfaces with clear metaphors, limited choice, restricted amounts of data and redundant cues in an effort to reduce ambiguity. Reflecting on the outcome of this study, this 'suggested' interface for UAI group would have utilised metaphors that are known to members of the group. The UAI's interfaces would only allow display of data with stringent rules in an effort to avoid users from selecting unnecessary information. Furthermore, Marcus and Gould (2001) stated that the navigation schemes embedded in user interfaces would prevent users from becoming lost. These transformations of cultural values (of high context and high uncertainty avoidance (UAI)) were present in the majority of the Japanese participants' paper-based directions in this study.

This finding suggests a need to consider the influence of culture in the designs of current navigational interfaces.

However, due to limitation in published literature about culture, further exploration is needed to learn more about cultural characteristics in navigation. For example as found in this study, 'mostly schematic representations' are not necessarily associated with values of high context and high UAI. One participant from UK and one from China used 'mostly schematic representations' in their paper-based directions, which information-in-context did not display values of high context or, high UAI. The said UK participant utilised a bird's eyes schematic maps to represent the entire journey with associated navigational arrows, whilst the participant from China produced paper directions with more landmark drawings that were attached to a string of words in each line of the navigational instructions. Based on informal interviews at the end of the video task, the China participant was believed to have experienced the cultural values at an occupational level and transformed the 'learned' architectural knowledge as preferred structure of paper-based directions.

Conversely, the 'mostly schematic representations' styles were less prevalent in other cultural groups (one out of nine in each the UK and the China groups, and none in the Malaysia group). Participants from Malaysia, UK and China have selected 'mostly written representations' to construct their paper-based directions (Table 3.5 of this chapter).

3.6.3.2 Density of information

The UK group was more expressive than the Malaysia and the China group in their use of words to place information from the environment into context. This resulted in all nine participants in the UK group using most of the navigational elements to represent information from the video task, apart from *global* (use of cardinal directions) and *absolute distance* (dictating exact distances).

Conversely, the Malaysia and the China groups used mainly ego-direction and landmarks (particularly *name*, *descriptors* and *locators*) to build their preferred paper-based directions, for the exact given route in the video. Due to this, the UK group had the highest cumulative number of information when compared to the other three nations, Malaysia, China and Japan. Interestingly, the total density of information for Malaysia was almost similar to those of the UK group, despite the published difference in cultural characteristics (between high 'power distance' and high 'individualism').

According to Hofstede et al. (2010) data matrix, the Malaysia's cultural profile was high power distance value (104) and low individualism value (26), while the UK's cultural profile was vice versa, 25 index values for power distance and 89 index values for individualism. The finding was also contradictory to those of Heimgärtner (2007a) which reported higher density of points-of-interest (POIs) in the China group when compared to the German and the UK groups.

One possible explanation for this was the categorisation scheme used in this study to quantify participants' paper-based direction was developed in the UK road environment by UK participants (Burnett, 1998). This could have an

impact on results given that the scheme was developed according to UK mental models. Further investigation pertaining to cultural issues of the categorisation scheme is addressed in another study from the thesis (please refer to Chapter 5 of the thesis).

Another explanation for this disparity could be, the fact that Hofstede's (2010) cultural dimensions are described as a set of index values on a bipolar axis (between 0 [low] and 100 [high]). Therefore, there is a possibility that for Malaysia and UK, Hofstede's (2010) *power distance* and *individualism* are inadequate to explain cultural influence on the overall density of information in navigation.

Nevertheless, the above-described differences and similarities were evident between participants according to their membership in each group, which suggests the existence of patterns in thoughts and behaviours (Allwood, 1985) that served as each group's silent language (Hall and Hall, 2001). Interestingly, these patterns were similar in shape (referring to Figure 3.8) yet had different information density. This is displayed between the UK and the Japan whereby the latter group had 166 less elements compared to 412 elements recorded for UK participants (see Table 3.6). Marcus and Gould (2001) stated that high individualism culture would have a rhetorical style user interface that exhibits tolerance or encouragement of extreme claims, which is reflected by one of Hofstede's values for individualism – nurturing strong private opinions (Hofstede et al., 2010). For this paper-based direction exercise, the UK group being the culture with high individualism had potentially shown their 'private

opinions' in placing information from the environment into perspective, according to their perceptual knowledge.

Moreover, the UK participants had the advantage in using a lexical approach to structure their paper-based directions given that English is their native language. Conversely, the Japanese had restrictions in structuring their route direction linguistically, given the difference in sound and writing systems between English and Japanese language (the Roman alphabets and Japanese characters), which has been claimed as contributing towards intercultural communication (Allwood, 1985). Furthermore, the Japanese were accustomed to receive and providing route direction in blocks according to conventional maps (Daimon et al., 2000), given that Road Street names were not available in Japan map (Hamahata and Liaw, 1995). This could have influenced the Japanese in being more schematic-oriented with use of words in Japanese characters (hiragana and katakana).

Importantly, the Malaysia group also recorded a high number of total elements (402 − second highest after the UK group). However, the Malaysians had mostly concentrated on the use of *ego* − direction, *junction types* − nodes and *locators, name* and *descriptors* − landmarks to compose their navigational instructions. This pattern was also visible in the China and the Japan group (total elements of 265 and 246 respectively).

When given a visual inspection, most of these paper-directions (particularly from the Malaysia group) were highly structured in hierarchies, whereby the navigational instructions were sequentially formatted depicting tall (in-depth) structure. This is parallel with views given in Marcus and Gould (2001),

whereby high *power distance* culture as defined by Hofstede et al. (2010) would influence the design of user interface resulting in highly structured features with mental models arranged in hierarchy. Similarly, these high structured paper-based directions were also noted (however not frequent) in the China group and the Japan group; both of which had *power distance* index of 80 and 54 respectively (Hofstede et al., 2010).

3.6.3.3 Abilities in navigation and preferred paper directions

Contradictory to the claim that Japanese are more map oriented (Hamahata and Liaw, 1995, Daimon et al., 2000), participants in the Japan group rated their abilities 'to locate particular Road Street names' and 'plan route direction from published maps', to be relatively low which resulted in significant difference (p<0.05) between Japan and other cultural groups. Despite this discrepancy, the findings in this self-rated questionnaire may denote to the values of *uncertainty avoidance* whereby any unfamiliar items are not tolerated. This is considering the fact that the Japanese are not used to have Road Street names as part of their navigation needs, as argued in Hamahata and Liaw (1995) and Daimon et al. (2000).

Similarly, the low self-rated abilities to 'plan route direction from published maps' could be explained from the potential amount of uncertainty in planning a journey with only published maps as a reference. Moreover, their high values in uncertainty could have influenced the Japanese participants to rate themselves as 'always' experiencing a mixed up between lefts and rights during navigation. Conversely, the other three cultural groups did not report any difficulties in locating Road Street names, mixing up their lefts and rights and

planning journeys with published map (see Figure 3.10, Figure 3.11 and Figure 3.12 of this chapter).

It appears that participants with high values of uncertainty avoidance (UAI) and high contextual communication require a specific assistance in their navigational interfaces, in an effort to increase drivers' satisfaction with its usability. The exercise of self-rated abilities in navigation suggests a further need to explore the effect of culture on drivers' behaviour.

Despite the differences in self-rated abilities in navigation, all four nations showed similar preferences in placing favourable ranks on eight named paper-based directions (see Table 3.8). 'Sketched map with landmarks' and 'written direction with reference landmarks' were highly ranked as first or second choice in paper-based directions. These unanimous patterns may conclude that participants perceived the importance of landmarks in navigation, which are in parallel with views of Burnett et. al (2001).

Surprisingly, more than half of the Chinese participants had ranked 'sketched map with road street signs' as their second choice for navigation. Should this paper-based directions be taken as a display of an interface, then it could reflect the long term orientation value held within the China group given that their choice would require them to be patience to achieve the desired goal as emphasized in the work of Marcus and Gould (2001).

3.6.3.4 Types of navigational elements

Participants in this study were able to make use of twenty two navigational elements to structure their paper directions. From these elements, seven were

significantly different in their occurrence between the study groups according to the Kruskal-Wallis test. While *local* – direction, *road rules* – paths, *angle* – nodes, *locators* – landmarks and *place name* – road street signs were noted in all study groups, *relative* – distance and *point of interest* were the two elements found only in the UK group paper directions. This was believed to have had the influence of culture given that this study used a UK road environment as materials in the direction-giving exercise. Furthermore, it may also be due to the quantification tool, as the categorisation scheme itself was developed with British drivers and a UK road environment.

More importantly, the elements recorded across Malaysia, UK, Japan and China displayed a pattern in constructing the majority of navigational instructions, which consisted of *ego* direction, landmarks *geometry*, *lanes* and *junction types*. The pattern was almost identical for each group (Figure 3.8 of this chapter) with *ego* direction and landmarks recording higher occurrences than the other three common elements. While types of navigational elements used have the potential of being cultural needs in drivers' perceptual knowledge, *ego* direction and landmarks (*name, descriptor, locators* and *reference*) on the other hand could have passed the 'goodness-of-fit' of elementary elements in navigation. Having these basic elements would be seemingly useful for drivers' travelling in foreign environments. From this study, it appears that drivers are able to produce 'rich' paper-based directions in their nation-state environments. This was exemplified by the UK group in this study. However, this study also demonstrated that drivers have to select basic navigational elements to ensure successful navigation and later create reliably good route directions.

In spite of the above-described rules, there were limitations in standardizing the participants' experiences in navigation. First, there were differences in participants' driving education whereby their learner's school would have taught them in national language which could influence culture (Boroditsky, 2001, Boroditsky and Gaby, 2010). Secondly, the video showed restricted with vision of the front headway only. Furthermore, the annual mileage driven by participants would have been made up by various driving experiences (urban vs. rural driving experiences), which require the findings in this study to be interpreted with careful considerations.

3.7   Implications for design

Reflecting the difference found in the choice of navigational elements, such as relative distance between the UK participants and the other three national cultures onto current designs of navigational interfaces (see Table 3.3 and Table 3.4), current design may have underestimated driver's cultural needs.

To illustrate this, an example of current nomadic in-vehicle navigation systems (IVNS) for the UK market shown in Figure 3.14 has displayed distance to next turning in absolute distance (i.e. 0.2m). Based on the finding in the direction-giving exercise, participants of different cultural backgrounds may have demonstrated their cultural needs. These needs supported the potential influence of a road environment on driver's driving experience.

Figure 3.14: An example of current nomadic IVNS for the UK market[2]

Moreover, applying Hofstede's cultural dimensions onto the selection process of national cultures were fruitful in justifying significant cultural patterns. The effort to generate an understanding of cultural needs using elements deriving from drivers navigating in a road environment across national cultures was achieved when significant cultural patterns were found.

3.8   Conclusion and key findings

The study has proven that established cultural dimensions such as Hofstede et al. (2010), Hall and Hall (2001) and Allwood (1985) can extract significant differences in a driver's choice of navigational elements. Furthermore, a preliminary selection of nation according to established cultural dimensions has facilitated the exploration of potential cultural needs within paper-based directions.

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[2] The image was last assessed on the 23 September 2011. Source of image:

http://pda-gpsnav.bestproductsreview.net/2010/07/12/garmin-nuvi-265w-gps-navigator-review/

According to the categorisation scheme (Burnett, 1998), the nations under study were significantly different in their choices of navigational information. The influence of road environment was seen in particular within the British group who made wider use of the navigational elements in the scheme. Such a finding could be due to the fact the scheme itself was developed with British drivers and a UK road environment. Nevertheless, the study also reported similar navigational preferences among drivers regardless of their nationalities. These contradictory findings may be due to Hofstede's dimension properties which exist on a bipolar axis. Every nation used in the study has all five dimensions within them with one dimension more prominent than the remaining four dimensions – thus allowing the shared similarities.

Furthermore, the 'mostly schematic representations' as shown in the Japan group was believed to be a reflection of uncertainty avoidance and high context values. This format of representations allows the placing of precise information on the navigational display, for example a 3D-display of road environments. It is also apparent that *ego* directions and landmarks form the basic navigational elements required for navigation in all contexts, given the high frequency of occurrences in paper directions for this study and elsewhere (Burnett et al., 2001). Five characteristics of culture in navigation proposed in this chapter were, styles of navigational directions, total density of navigational information, self-rated abilities in finding ways, preferences in paper-based directions and types of navigational elements used in navigation. The next study of the PhD has aimed to target a collective response through the application of an online questionnaire.

Chapter 4: Drivers' perception in navigation at different road traffic

4.1 Introduction
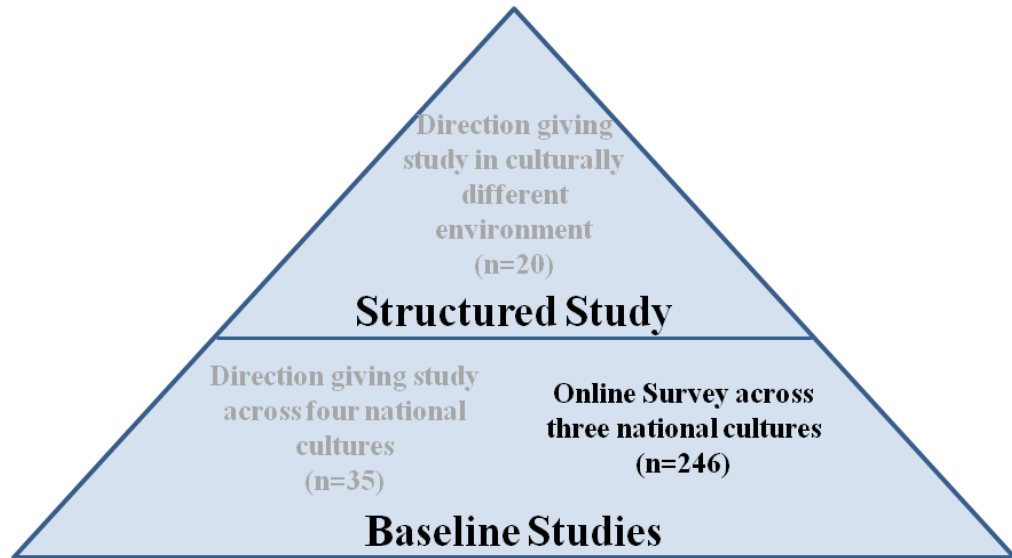
Figure 4.1: Showing the excerpt of the thesis framework highlighting the online study

This chapter reports an online survey of 246 drivers across different cultural background which informed the second part of two baseline studies (as illustrated in Figure 4.1). The two studies are as a whole aimed to understand drivers' perceptions of behaviours whilst undertaking a journey. The first part was written in Chapter 3 of the thesis. It has been noted in the literature (Chapter 2) about the complexity of the driver's task (Michon, 1985), notwithstanding the influences of their cultural background in navigation (Daimon et al., 2000). Given the navigation strategies exemplified by some drivers whilst in another national culture (Daimon et al., 2000, Davies and Pederson, 2001), it is critical to understand drivers' behaviour from cultural perspective in relation to navigation (Zaidel, 1992, Heimgärtner et al., 2007). Furthermore, abilities to adapt secondary tasks whilst driving (such as

destination entry for navigation systems)(Chiang et al., 2004, Lansdown et al., 2004) have raised concerns over drivers' behavioural adaptations with advance technologies. Such understanding would be useful in addressing globalisation issues raised in an in-vehicle navigation system (IVNS), particularly when the product is being used in more than one road environments across the regional borders.

The survey focused on issues relating to perceived usefulness of elements from road environments (comparing between home and foreign country) for drivers based in Malaysia, United Kingdom (UK) and Japan. It was expected that local drivers (residing in their respective home countries) would be a good pool of information to understand drivers' overall behaviour in navigation. Furthermore, a comparison across the selected nations would assist in revealing social norms in their home environments as perceived by its inhabitants.

4.2 Aim, Objective and Activity

Table 4.1: Summary of Overall Aim, Objective and Activity for Chapter 4

Code	Objectives	Code	Activities	Chapter
Overall Aim To explore potential cultural needs within the design of in-vehicle navigation systems				
O1		A1		3
O2	To understand cultural needs via perceptions of local drivers from different national cultures about differences in driving behaviour	A2	Online questionnaire across UK, Malaysia and Japan	**4**
O3		A3		5
O4		A4		6

To achieve the overall aim given earlier in section 1.9 of Chapter 1, the second specific objective (O2) was addressed in this chapter (see Table 4.1 above). A further three sub-objectives were also listed:-

- Driver's perception about driving styles in culturally different road environment;
- Driver's evaluation of usefulness of different tools (for example, written paper directions, sketched maps, published maps and vehicle navigation systems) to navigate in an unfamiliar environment; and
- Self-rated confidence level and important items for travelling in novel places at home environment and foreign environment

Hence, the second activity (A2) as given in Table 4.1 is reported in this Chapter.

4.3 Hypotheses of study

Four hypotheses were drawn based on assumption that drivers (regardless of their nationalities) were sharing similar perceptions and would behave in a similar manner while in a navigation. The four hypotheses were,

1. Respondents from Malaysia, UK and Japan were expected to agree with having similar driving styles with other nationalities,

2. Respondents from Malaysia, UK and Japan were expected to disagree with the influence of road traffic and local road environment on general driving behaviours,

3. Respondents from Malaysia, UK and Japan were expected to show similar patterns for usefulness of navigation tools, and

4. Respondents from Malaysia, UK and Japan were expected to indicate similar choice of items to navigate novel places in home and foreign environments.

4.4 Methods

4.4.1 Choice of nations

Given that this online study was the second part of two baseline studies (as illustrated in Figure 4.1), the choice of nations has followed the cultural groups selected in the first part as described earlier in Chapter 3. However, there was an exception for the China group. China was not included in the choice of cultural groups understudy for this questionnaire survey. For the first part of the baseline work, China's participation was justified by the need to represent the long term orientation dimension as defined in Hofstede et al. (2010). Notwithstanding the importance of this dimension in conceptualising culture, the traffic system in China was not consistent with Malaysia, UK and Japan, whereby Chinese drivers keep to the right-hand side of the road compared to the left-hand side driving rule practiced in the other three nations.

Furthermore, over the last decade China reportedly has several underlying issues in relation to national driving culture due to rapid motorization (Zhang et al., 2006). For example, issues such as aggressive behaviours (Lindgren et al., 2008), mixed road users (pedestrians, cyclists competing for rights-of-use on roads)(Zhang et al., 2006), little awareness of road safety behaviours and many other transportation issues (Zhao et al., 2006, Zhang et al., 2006, Knapp, 2007, Lindgren et al., 2008).

Given that this online study focused on opinions in drivers' behaviour collectively at societal level, inconsistency in traffic system and issues within community as listed above which may influence culture were not tolerated.

In summary, the selected nations for this online survey were Malaysia, UK and Japan. Despite the close relationship shown between Malaysia and the UK group in the overall total of density information (as stated in section 3.4.3 of Chapter 3), further exploration is needed to investigate the influence of culture across 'local' drivers residing in their nation-state environments.

4.4.2 Justification for conducting online questionnaire

It has been noted that drivers' perceptual images are derived from their local living environment (Lynch, 1960, Daimon et al., 2000) and the acceptable norms of social behaviours (Huang et al., 2006). Also, following the methods of verbal protocol and map sketching in the work of Daimon et al. (2000), an investigation of cultural influences in drivers' behaviours at a larger scale (total participants of more than ten per cultural group) would have not been feasible. The online questionnaire approach was chosen because of the success in exploring cultural needs for drivers' interaction behaviour in the work of Heimgärtner (2007a, , 2007b).

Furthermore, cultural research to understand drivers' requirement in the design of Advanced Driver Assistance System (ADAS) has successfully employed multiple methodology approach in three iterative studies (Lindgren et al., 2008). The first study in the work of Lindgren et al. (2008) used a questionnaire to gain insight into the nation's driving culture. Reflecting on the above-mentioned research, the current study needed a greater understanding

concerning driving habits. Despite claims from secondary sources (such as travel blogs[3] and travel information[4]) on differences in driving styles due to nationality, the issue was not considered quantitatively in research from cultural perspective.

However, the issue was raised as a factor inducing car accidents and near misses in the work of Huang et al. (2006) that compared qualitatively dual driving experiences between USA and China. Therefore, it was decided that an online questionnaire was the best method to adopt to explore claims of national driving styles or manners, and gain insight in local drivers' opinions.

4.4.3 Study procedures

Potential participants were sought after via email invitations. The call to participant was written in an email format and disseminated to potential local respondents in Malaysia, UK and Japan. Participants will then find a link to open the online questionnaire in their email invitations. The online questionnaire consists of five pages. The first page contained a brief description about the study and types of questions used in the online questionnaire. Participants were required to provide an answer for every question. After completing the questionnaire, respondents were given the Researcher's contact details if they want to learn about the outcome of the questionnaire.

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[3] Sourced from http://www.kyleandrach.com/2011/01/29/driving-in-malaysia/ [last accessed 2 June 2011]

[4] Sourced from http://www.discover-japan.info/generalinfo_driving.htm [last accessed 2 June 2011]

4.4.4 Questionnaire structure
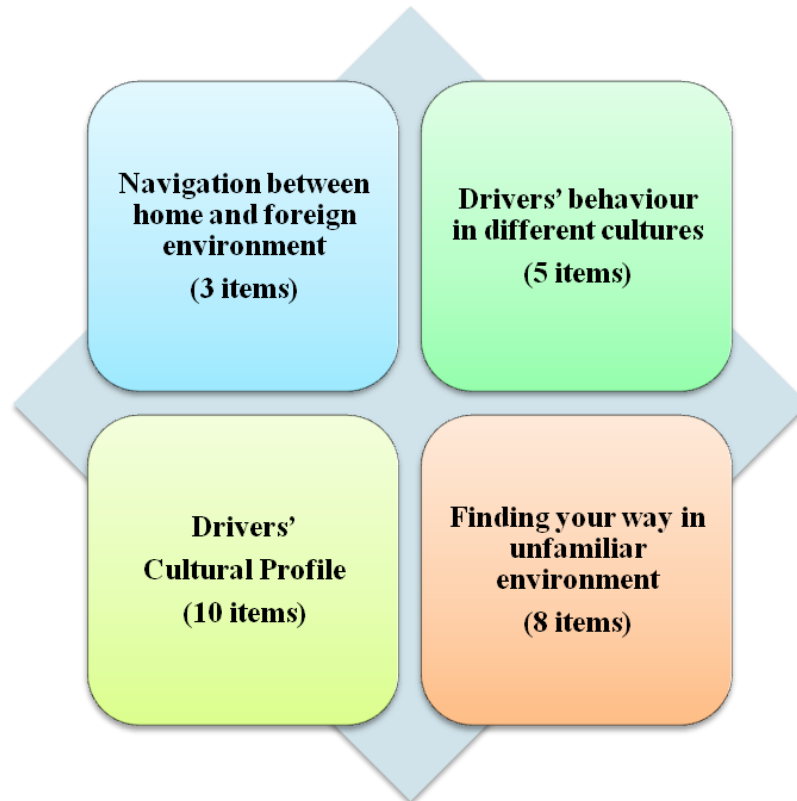
Figure 4.2: Showing four categories within the online questionnaire

The questionnaire was split into four sections: driver's behaviour in different cultures; finding your way in unfamiliar environment; driver's cultural profile; and navigation between home and foreign environments (as illustrated in Figure 4.2). The questionnaire was defined by 26 items which were believed to lead towards greater understanding of the basic necessities in navigation, in particular information relating to driving styles due to national culture. The navigation between home and foreign environment had interval data and qualitative responses from respondents. This section had direct question about drivers' confidence level in a nine-point scale end anchors: between 1 – not confident at all and, 9 – very confident in navigating within novel places.

Furthermore, the qualitative responses required in this section concerned naming three useful items for navigating in home and foreign environments. Descriptive analysis was conducted for data obtained from this section. Next, the drivers' behaviour in different cultures which used Likert attitude-scale (agree-disagree) concerned differences in driving styles across nation, influence of road traffic and likelihood of changes in natural driving behaviours, all of which were ordinal data. Finding your way in unfamiliar environment section collected interval data with a nine-point scale between 1 – Useless and 9 – Very Useful. The scale was not given any other word apart from "Useless" and "Very useful", hence it was assumed that each interval was equal for scale of useless-very useful.

However, the data was not analysed with parametric statistics due to violation to normality and unequal variations across the national groups. This was a collective opinion concerning views in finding one's way, particularly when placed under a situation where the environment is relatively new. The questions however, did not emphasise the geographical location of the environment, instead they were intended to understand the public's rating on a selection of media or devices which are often related to navigation. This selection ranges from a scale between the least technical media to the most current technical devices. The named items are paper direction; navigational arrows on paper; written instructions with navigational arrows; a sketched journey on paper; a paper map; local passenger in the car; passenger in the car reading a paper direction; and a vehicle navigation system with audio and graphics.

The last section in the questionnaire addressed drivers' cultural profile which had a mixture of nominal, ordinal and ratio data. The ordinal level variables concerned respondent age, nationality, gender, country where driving licence obtained, experience driving in other country, experience using vehicle navigation system and frequency of using vehicle navigation system. The ratio level concerned annual mileage, years driving licence held and percentage of driving in other country. The complete questionnaire can be found at Appendix 4.

4.5 Design and distribution of the questionnaire (English version)

The questionnaire was built with the online survey software, Survey Gizmo Plc. Participants were given two types of questions; open ended questions whereby flexibility of text input were allowed, and radio button questions with a selection of specific answers (five or nine points scale), placed next to a button. The questionnaire was formatted into five pages of 'forward-design', where each page held one category, respectively. Upon completing the relevant questions in one category, respondents were required to click the 'click-to-next-page' button in order to move to the next category. All of the questions were made compulsory, such that failure to leave an answer resulted in a dysfunctional 'click-to-next-page' button. An introduction about the study and instruction on how to leave an answer for the questions were placed on the first page, while the last page contained contact information for respondents who wished to learn the outcome of the study.

Prior to distribution, questionnaire went through piloting process. During the piloting session, the link to the questionnaire was distributed to researchers within the Human Factors Group at the University of Nottingham for constructive comments. In the piloting phase, ten researchers took part in the pilot study and two researchers have provided their inputs to improve the structure and display of the questionnaire. The questionnaire then undergoes changes in the structuring of sentences for several items in an effort to increase transparency and clarity to the questions. All items were also checked for simplicity in the use of words. Finally, the questions were also re-arranged between categories to strengthen the flow from one section to another.

Later, the questionnaire was distributed via email invitations to various agencies in Malaysia (universities, government agencies and private sectors), while respondents in UK were mainly from students and staff of the University of Nottingham. Also, the questionnaire was posted through social networking services such as Facebook and Yahoo Groups. Additionally, this online study has received an ethical approval from the Faculty Research Ethics Committee, University of Nottingham.

4.5.1 Length of study (UK and Malaysia version)

The questionnaire was active online, collecting data for approximately thirty days, following amendments made after pilot testing which had taken place for seven days.

4.6 The translation process of the questionnaire (Japanese version)

A year after the original questionnaire had been completed, a decision was made to distribute the questionnaire to Japanese drivers to compare results with the two cultural groups from Malaysia and the UK. The further data collection was considered a necessity given the maturity in Japan, for use of in-vehicle navigation systems (IVNS) and the known cultural differences. Furthermore, the questionnaire was designed in the Japanese language to provide greater strength in capturing the confidence of the targeted cultural group (Vatrapu, 2002).

The questionnaire in Japanese went through a series of iterations, with few adjustments made in the cultural profile category, to suit the targeted cultural group. Facilitation was made in having more radio button questions with Yes-No pairs of answers. A good example relates to the question about nationality, whereby an open text question of "What is your nationality?" took a radio button approach with a question of "Are you Japanese?" The iteration process involved several discussions with a visitor from Nihon University, Tokyo, Dr Yukiyo Kuriyagawa, Associate Professor in Mechanical Engineering. The essence of the discussion was to ensure the original essence of the questionnaire was preserved. Upon completion, the questionnaire (Japanese version) was distributed via email to staff and students of Nihon University in Tokyo.

4.6.1 Length of study (Japanese version)

The questionnaire was launched and receivied respondents for approximately 30 days. Prior to that, a pilot test to examine the status of the survey link, navigation buttons and the overall presentation of the questionnaire was conducted by Dr Yukiyo Kuriyagawa.

4.7 Limitations in translating the questionnaire into Malay language

The questionnaire in this study was not distributed in the first language for the Malaysia group given that,

1. The choice of word in the English version were simple and commonly used in everyday spoken language in Malaysia;

2. The words in Malay normally have almost identical spelling and meaning to English words, for example the word traffic in English when translated into Malay is *'trafik'*;

3. Malaysia is a commonwealth country that gained independence from the UK 54 years ago. Due to that, the road signs in Malaysia used to be in English language and remain in use after Independence Day, particularly in Penang, a city which was the former capital during the British Settlement;

4. English language has been taught as second language since the age of seven, therefore, the language is generally understood by many Malaysians;

5. Malaysia is populated with three major ethnic groups – Malay, Chinese and Indian, whereby English language has been the normal spoken language between the ethnic groups.

4.8   Drivers' cultural profile
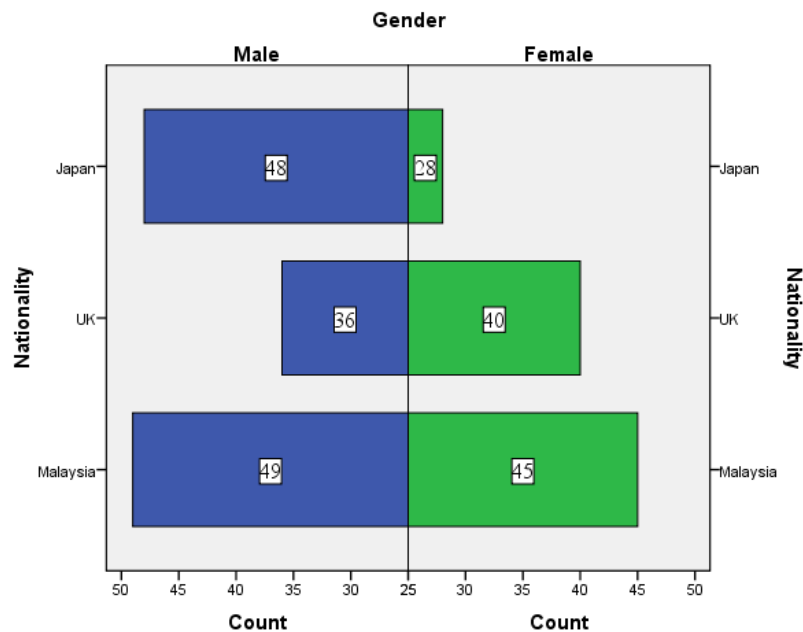
Figure 4.3: Gender distribution for Malaysia, UK and Japan groups

The study collected responses from 246 participants across three cultural groups, Malaysia (n=94), UK (n=76) and Japan (n=76). The mean age for the Malaysian respondents was 35 years old (range 23-63); the UK group mean age was 36 years old (range 19-63) and the mean age for the Japan group was 30 years old (range 20-68). The gender distributions were near equal in two cultural groups - Malaysia and UK. However, the Japan group had more males with a ratio of 2:1 (Figure 4.3).

4.8.1 Mean age of participants vs. gender

Despite the small number of females in the Japan group, their mean age was generally higher (33 years old) compared to the Japanese males (28 years old) in this study (Figure 4.4). Relatively, the UK group also had similar situation (mean age for females 37 years old while males were 35 years old) while the Malaysia group had on average females who were 4 years younger than the males (Figure 4.4).
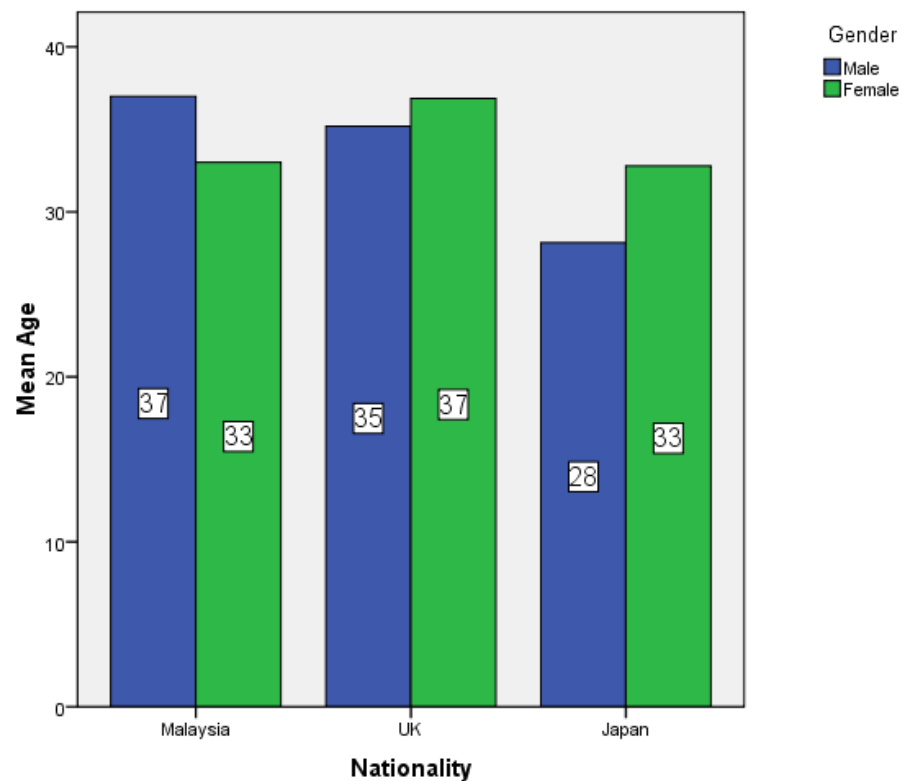
Figure 4.4: Mean age between gender for Malaysia, UK and Japan groups

4.8.2 Mean annual distance of participants vs. gender

The annual distance driven in the last year, in kilometers (km) for participants in this study ranges from a minimum of 10,000 km to a maximum of 100,000 km. Despite the high figure recorded for the maximum annual distance, more than half participants (76%) travelled less than 20,000 km in a year. Forty nine

participants (20%) travelled between 20,000 and 49,999 km in the recent year,

while the remaining 4% travelled more than 50,000 km last year (Figure 4.5).
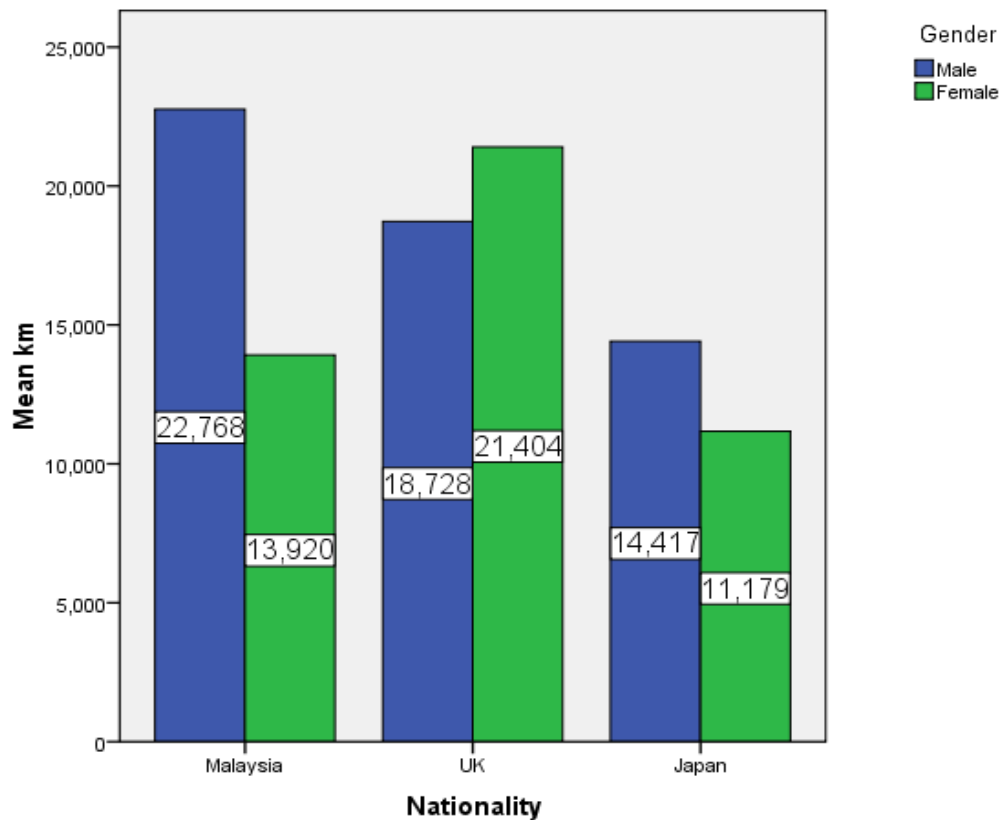
**Figure 4.5: Mean annual distance driven (km) between gender for
Malaysia, UK and Japan groups**

4.8.3 Mean years of driving licence of participants vs. gender

The mean years of driving licence between male and female, across the three

groups are 17 and 13 years; 16 and 17 years; and 10 and 12 years for Malaysia,

UK and Japan respectively (Figure 4.6). The participants have a range between

1 to 50 years of holding a valid driving licence from their country of origin

namely - Malaysian Driving Licence for the Malaysia group; full UK driving

licence for the UK group; and Japanese Driving Licence for the Japan group.
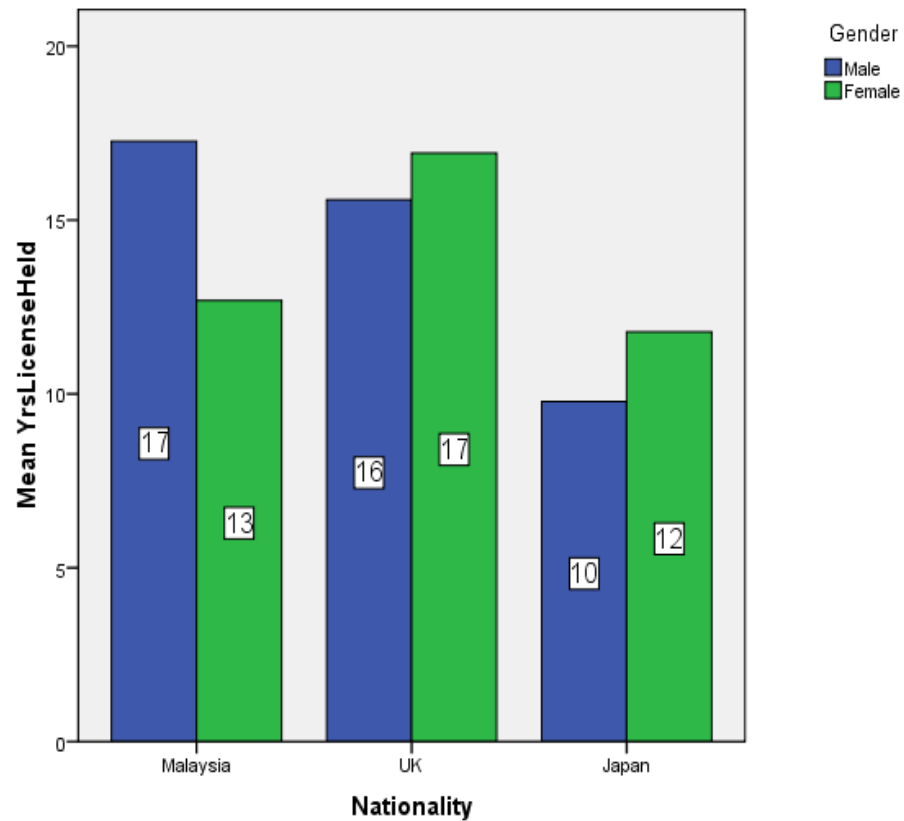
Figure 4.6: Mean licence held (years) between gender

4.8.4 Methods of analysis

Data management and analysis was performed using SPSS 16.0 (2007). Statistical significance was analysed using non-parametric Kruskal-Wallis test as appropriate, particularly for ordinal data and interval data that had violated the normal distribution and unequal variance between groups. Every Kruskal-Wallis test was followed with several post-hoc analyses, Tamhane test or Bonferonni test, as part of further statistical practice. Apart from that, a Spearman Rho test was executed in an effort to understand the relationship between two variables that were not distributed normally.

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4.9   Results

4.9.1 Drivers' behaviour in different culture

In order to access driver's perception about driving styles in culturally different road environment, statistical comparisons were conducted between the cultural groups. Table 4.2 shows the results obtained from the Kruskal-Wallis analysis for five items in the questionnaire that measured drivers' behaviour in different culture. It is apparent from this table that cultural differences exist in two items (as illustrated in Figure 4.7 and Figure 4.8). Further statistical test (post hoc Tamhane test) revealed that the Japan group was more likely to disagree with *"Drivers from my home country drive differently from drivers from other countries"* than the other two cultural groups. Meanwhile, the Malaysia group was more likely to agree with *"Generally, it is common for drivers originating from the same country to drive in a SIMILAR manner or styles"* in the post hoc analysis than the UK and the Japan groups.

Table 4.2: National influence in drivers' behaviour on Kruskal-Wallis test

Drivers' behaviour in different culture	χ^2	df	Asymp. Sig.	Mean rank scores			Groups having differences (Tamhane test)
				Malaysia, a (N=94)	UK, b (N=76)	Japan, c (N=76)	
Drivers from my home country drive differently from drivers in other countries	9.15	2	0.01	136.55	125.45	105.41	a-c, b-c
Generally, it is common for drivers originating from the same country to drive in a SIMILAR manner or styles	46.50	2	0.00	159.52	111.46	90.99	a-b, a-c
Road traffic DOES have an impact on driving behaviour in general	2.93	2	0.23	128.41	127.91	113.01	non significant
Drivers' behaviour on the road is generally influenced by the local road traffic/environment	3.61	2	0.16	128.37	111.76	129.21	non significant
Drivers would normally change their natural driving behaviours in different road environments	4.04	2	0.13	134.14	116.92	116.91	non significant
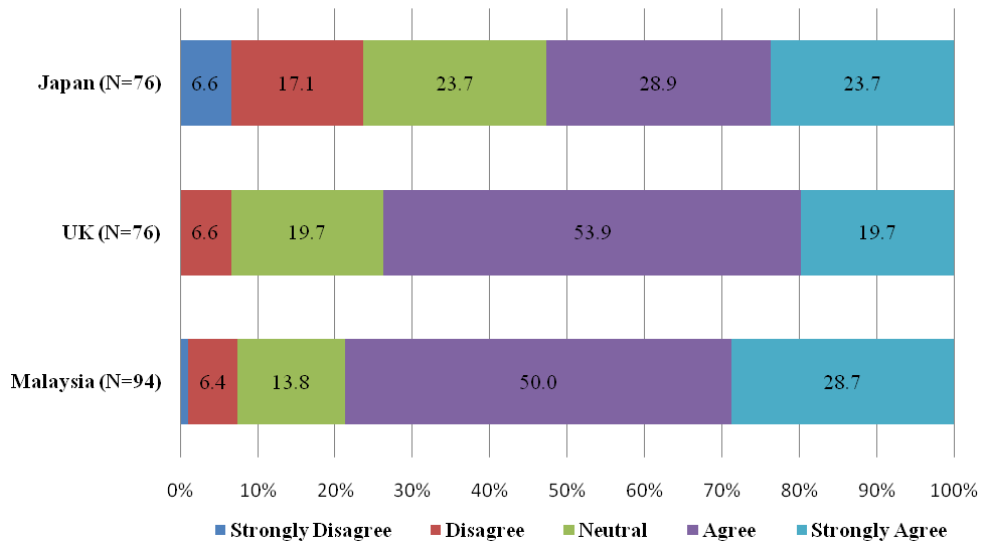
Figure 4.7: Distribution of respondents (%) for *"Drivers from my home country drive differently from drivers from other countries"*
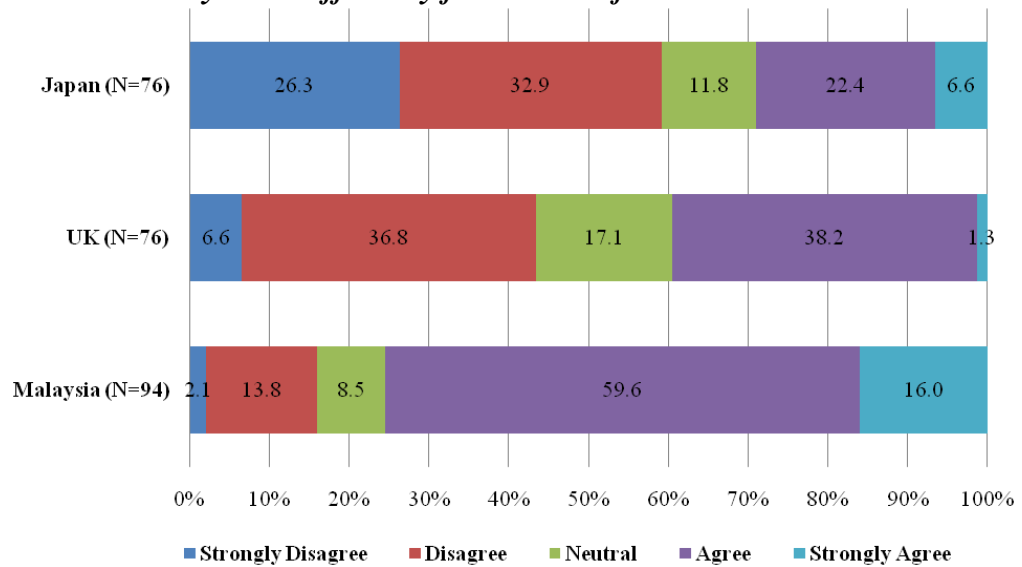
Figure 4.8: Showing distribution of respondents (%) for *"Generally, it is common for drivers originating from the same country to drive in a SIMILAR manner or styles"*

The majority of those who responded to *"Road traffic does have an impact on driving behaviour in general"* felt that road traffic impacted driving behaviour in general resulting in no significant difference across the cultural groups. Importantly, over half of the respondents reported that drivers had been influenced by the local road traffic environment. Finally, all three cultural

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groups were more likely to agree with "*Drivers would normally change their natural driving behaviours in different road environments*" where no significant difference was found in the analysis.

4.9.2 Finding your way in unfamiliar environment

Eight items on the questionnaire measured the extents to which tools in navigating were considered as useful across respondents defined by their nationality. Respondents from each cultural group were asked to rate the named navigation tools using a nine-point scale of usefulness. Table 4.3 shows the significant results obtained from the Kruskal-Wallis analysis. It is apparent from this table that cultural differences in opinions of usefulness were given in the following five items.

Table 4.3: National influence on usefulness ratings of navigational tools according to Kruskal-Wallis test

Finding your way in unfamiliar environment	χ^2	df	Asymp. Sig.	Mean rank scores			Groups having differences (Bonferroni test)
				Malaysia, a (N=94)	UK, b (N=76)	Japan, c (N=76)	
Paper direction written in full sentence	22.44	2	0.00	124.74	149.80	95.66	b-c
Just navigational arrows	13.29	2	0.00	133.72	99.01	135.35	a-b, b-c
A sketch map of the journey	6.39	2	0.04	133.23	106.89	128.07	non significant
A passenger in your car reading written instructions to you	8.63	2	0.01	113.01	142.95	117.03	a-b, b-c
A vehicle navigation system using both audible and graphic-based directions	18.30	2	0.00	142.72	101.61	121.62	a-b, b-c

Further analysis with Bonferroni tests showed that the UK group rated *paper direction written in full sentence* as more useful than the Japan group. The histogram in Figure 4.9 indicates that 42% of respondents from the UK group rated p*aper direction written in full sentence* useful compared to 19% in the Japan group. Also, the UK group rated *a passenger in the car reading written*

directions to you as more useful for navigation compared to the other two groups (as illustrated in Figure 4.10).

Conversely, the histogram in Figure 4.11 indicate that the UK group reported j*ust navigational arrows* as less useful than both Malaysia and Japan groups with 28% respondents rating it very useless compared to 10% and 9% respectively.
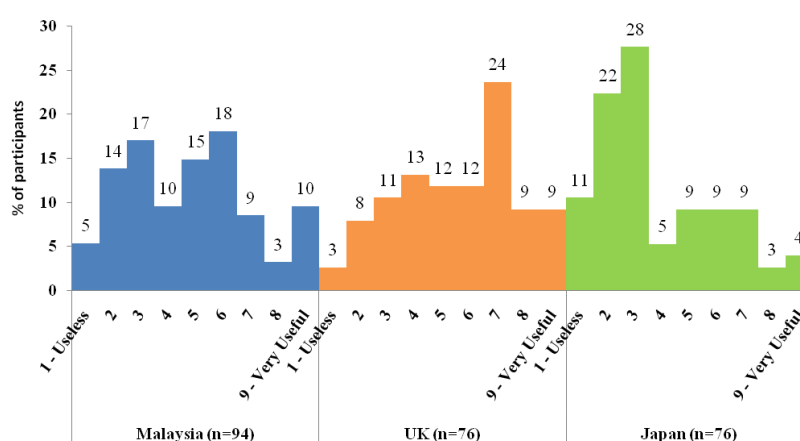
Figure 4.9: Distribution of respondents (%) over usefulness scale (1 − 9) for "*Paper direction written in full sentence*"
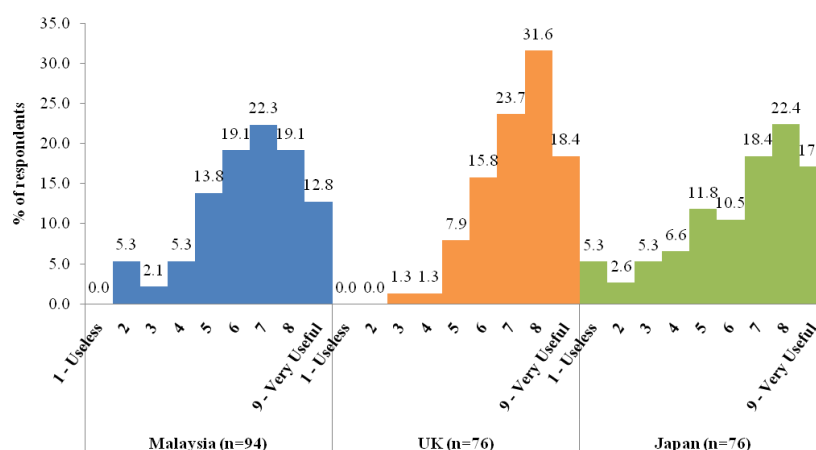
Figure 4.10: Distribution of respondents (%) over usefulness scale (1 − 9) for "*A passenger in the car reading written instructions to you*"
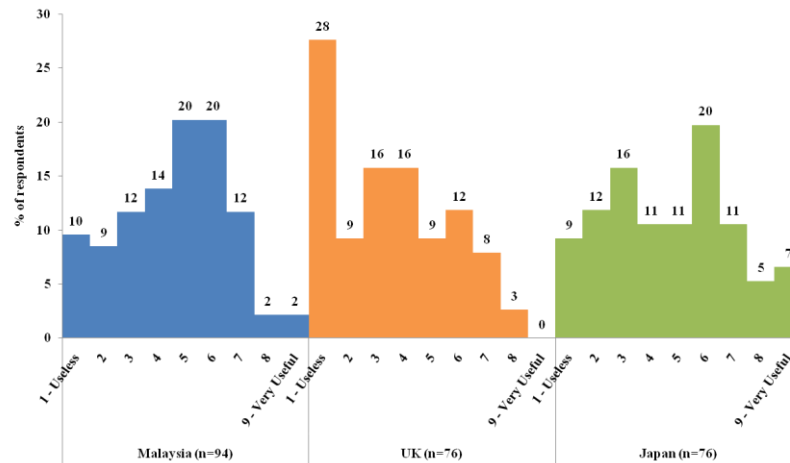
**Figure 4.11: Distribution of respondents (%) over usefulness scale (1 – 9)
for *"Just navigational arrows"***

In Figure 4.12, there is a clear trend for high usefulness ratings in all groups for *vehicle navigation system, using both audible and graphic-based directions*. Further analysis showed that the UK group reported that they found navigation systems to be significantly less useful than the Malaysia and the Japan groups (with 44.7% rated this tool as very useful compared to 76.6% and 55.3% respectively).
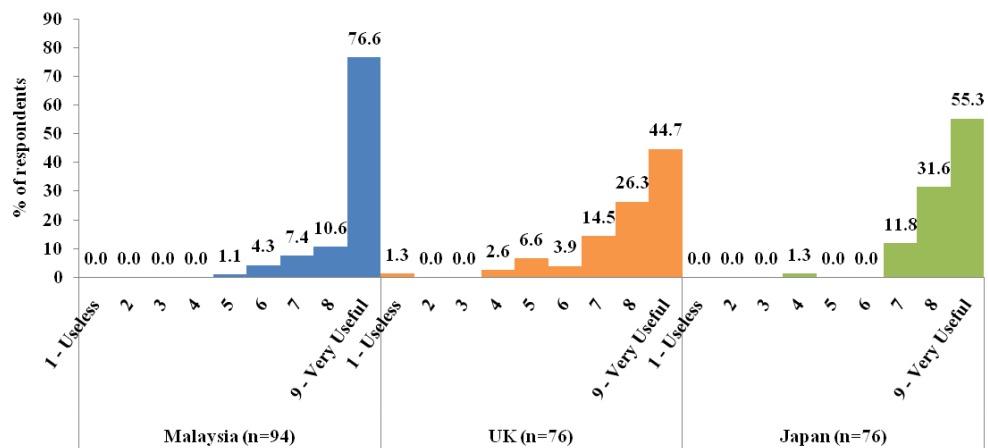
**Figure 4.12: Distribution of respondents (%) over usefulness scale (1 – 9)
for *"A vehicle navigation system using both audible and graphic-based
directions"***

Post-hoc Bonferonni test revealed that there was no significant mean-difference between the cultural groups for the usefulness of *a sketch map of the journey* (as illustrated in Figure 4.13).
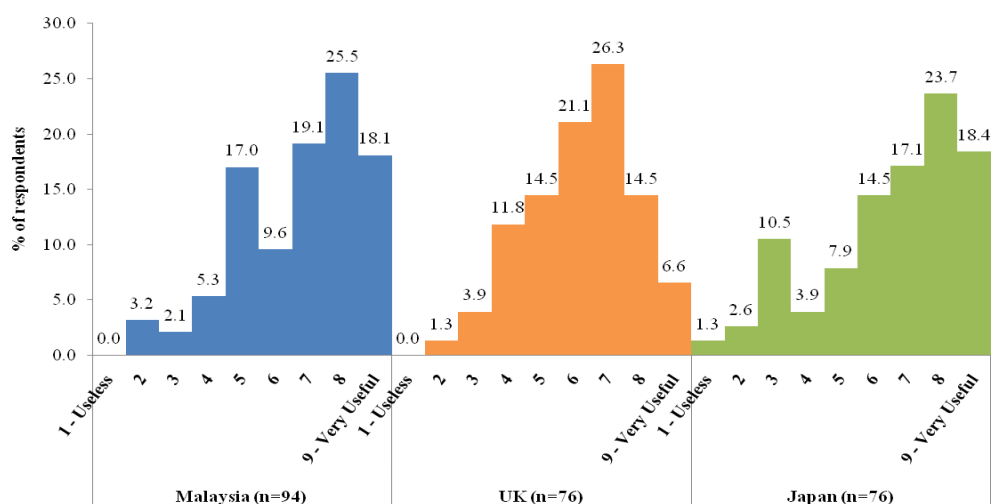
Figure 4.13: Distribution of respondents (%) over usefulness scale (1 – 9) for *"A sketch map of the journey"*

Overall, the Kruskal-Wallis test did not show any significant differences between the cultural groups in usefulness ratings for the remaining three named tools, *written paper direction together with navigational arrows, a road atlas and A-Z map book* and, *a passenger in your car that has local knowledge of the area*.

Further exploration with Spearman's rho has shown that there was a significant positive correlation between *a road atlas and A-Z map book* and respondent's age, r_s (244) = 0.142, P = 0.03. Relationship between *a road atlas and A-Z map book* and respondent's licensure age was also found positively significant, r_s (244) = 0.127, P = 0.05. However, there were no correlations found in the other two conventional tools, *written paper direction together with navigational arrows,* and *a passenger in your car that has local knowledge of the area* with respondent's age and licensure age.

Moreover, there was no significant relationship in any of the three conventional navigational tools with drivers' self-rated confidence to navigate in novel places with different road systems according to Spearman's rho test.

4.9.3 Navigation between home and foreign environment

In response to the question *"Imagine that you are on holiday and the road system is different from your home country, for example, you have to drive on the opposite side of the road and, in the car, the controls are on the opposite side of the car (e.g. left hand drive instead of right hand drive). Please rate how confident would you be driving in that environment?"* , the majority in the Malaysia and UK groups felt confident with their driving ability as illustrated in Figure 4.14.
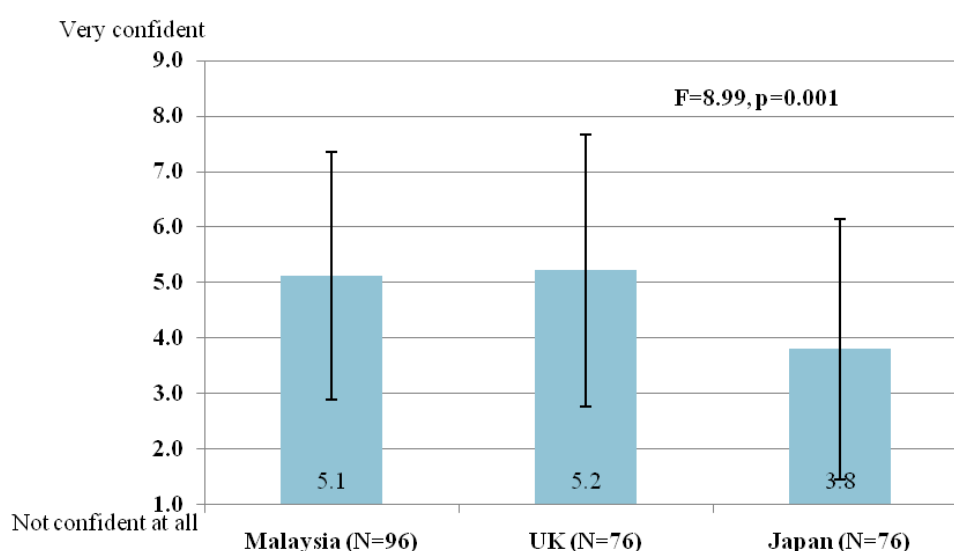
Figure 4.14: Differences in mean values and standard deviation for confident level across three cultural groups according to one way ANOVA

In order to access cultural differences, one way ANOVA was used. A Levene test for the equality of variances among the cultural groups was not significant, which suggested homogeneity in variances. The histogram in Figure 4.15

indicates that the Japan group felt less confident driving in environments with different road system than the other two groups, where according to a one-way ANOVA, a significant value was obtained, $F(2, 243) = 8.99$, p=0.001.

Post-hoc tests of pair-wise mean differences using Tamhane statistic indicated that significant differences existed between the Japan group and the Malaysia group, and between the Japan group and the UK group. Surprisingly, *paper direction written in full sentence* was the only navigational tool showing positive correlation with drivers' self-rated confidence to navigate in novel places with different road systems according to Spearman's rho, $r_s (244) = 0.196$, P = 0.002.
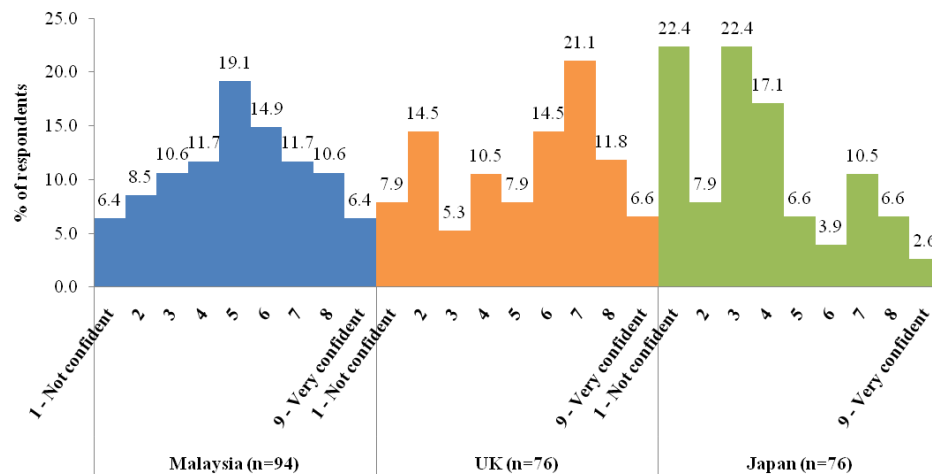
Figure 4.15: Differences in mean values and standard deviation for confident level across three cultural groups

When the respondents were asked to name three important items that they would bring with them for a journey to unfamiliar places in two different places, their home country and any foreign country, non-navigational items were perceived as important items inasmuch as navigational items. Examples of useful non-navigational items preferred by respondents were dictionaries,

tourist books, money and beverages. This was most apparent in the Japan group, as illustrated in Figure 4.16.

Published maps were found to be a little more popular than in-vehicle navigation systems (IVNS) amongst respondents in the Malaysia and the UK groups as the first useful item for travelling to novel places, either in home or foreign environments. Interestingly, mobile phone (including smart phones) was named as the most useful item for navigation, almost equivalent to published maps and vehicle navigation systems within the Malaysia group, in contrast to the UK group. When compared between home and foreign environment between Malaysia and the UK groups, there was little difference for navigation tool such as published maps and vehicle navigation systems being named as their first and second choice of important items for a novel journey.

On the other hand, the Japan group had mixed perceptions about the most useful items for navigating in novel places. Four items that received high percentages as the first choice in the Japan group for navigating in home environment were mobile phones (25%), money (22%), IVNS (20%) and published maps (17%). These percentages experienced changes for foreign environment, whereby the most named items were map (25%) and money (21%) in the Japan group. Importantly, there was a drop of 18% for usefulness of IVNS in foreign environments.
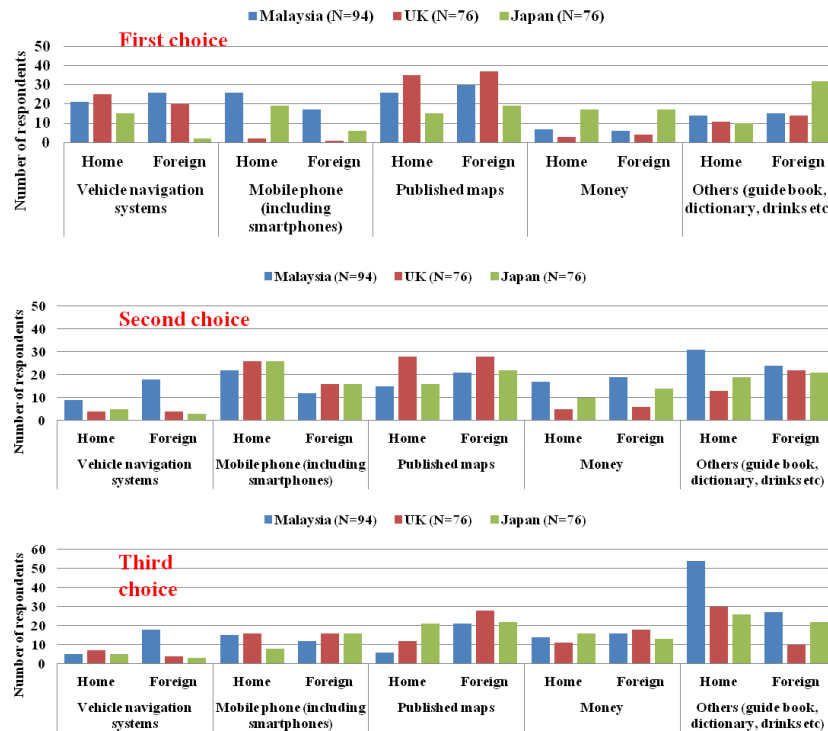
Figure 4.16: Differences in mean values and standard deviation for confident level across three cultural groups

4.10 Discussion

The present study aimed to determine the effect of national culture on driving styles within varying road traffic environments. Importantly, this study explored navigation preferences across national culture, particularly in usefulness of different tools and items for navigation. The main result was the acknowledgement of perceived differences in driving styles due to nationality and varying road environments.

The finding is in parallel of those argued by Zaidel (1992) on drivers' perceptual knowledge as described earlier in section 2.2.3 of Chapter 2. Similarly, Huang et al. (2006) found a correlation between regulated behaviours and level of awareness in road safety across nations (as described in in a research on awareness in road safety had resulted into more regulated

behaviours amongst drivers from USA as opposed to drivers in China (Huang et al., 2006).

The experience that drivers have while on a road journey has seen rapid changes, with increasing number of roads being built (Iaych et al., 2009) and multiple technology features adapted in new vehicles. In an effort to increase drivers' satisfaction and road safety, greater understanding of driving styles is desirable. The knowledge would also benefitted navigational products such as in-vehicle navigation systems (IVNS) in an increase of usability within drivers of different cultural background.

4.10.1 Perceptions about different road environments

The findings of the survey demonstrate the existence of a belief in 'national' driving styles, with more than 50% of the total respondents agreeing to there being a difference in driving styles between countries. There are similarities between the perceptions expressed by the cultural groups in this study and those described by Zaidel (1992). According to Zaidel (1992), drivers are sensitive towards changes in the behaviours of few other drivers which would amplify changes in the traffic environment.

Comparatively, the current online survey did not measure driving styles based on this eight main factors as published in the work of Taubman-Ben-Ari et al. (2004). Nevertheless, the belief in the existence of culturally-different driving style was collectively reported by 'local' drivers of Malaysia (n=96), UK (n=76) and Japan (n=76) of this study.

A possible explanation for this is that the driving styles described in Taubman-Ben-Ari (2004) were focused on driving habits, directed towards explaining drivers' involvement in accidents.

Therefore, the relationship between differences in driving styles may be explained in part by the illustration in Figure 2.3 (described earlier in section 2.2.3 of Chapter 2) where national culture has affected driving styles. However, this has not been considered in most published research on driving styles due to different focus and objectives. The present findings were supported by those of Lajunen et al. (2004) which discovered that some part of the questions in the Driver Behaviour Questionnaire were culturally sensitive, as described earlier in section 2.2.3 of Chapter 2.

Interestingly, the finding of this survey corroborates the ideas of Moeckli and Lee (2007), who suggested culture as dynamic involving processes of creation, reproduction and justification of values and beliefs amongst drivers. Hence, to understand some of the patterns shown in driving behaviour which were reported to be culturally mediated (Daimon et al., 2000, Roessger and Hofmeister, 2002, Zhao et al., 2007, Lindgren et al., 2008), the current study considered drivers' perceptions between home and foreign environments. Previous research work (Zaidel, 1992, Moeckli and Lee, 2007) reviewed culture through three elements, the drivers themselves, the vehicle and the corresponding environment.

In short, the effect of culture has been inferred to have been first, embedded in drivers; and secondly, grouped by driving behaviours into driving styles, normally when a group of drivers (often in a population) accept and approve 'a

standard of behaviours' at a given time. Importantly, the outcome of the survey has shown that the embedded cultural values were accounted to the respondents' country of origin, given the differences found in the Malaysia group when compared to the other two groups, UK and Japan. However, the survey was not able to determine what constitutes the elements of this 'national' driving style, and how explicit the difference in these styles is across national borders.

One unanticipated finding was that both the UK and Japan groups differed from the Malaysia group, in their opinion about drivers with similar nationality sharing similar manners in driving. The UK and Japan respondents both had mixed opinions on the given statement, with a higher percentage of disagreement (more than 40%). This scenario is believed to have accounted for the variation of levels for culture – similar to the onion metaphor, where each layer has its distinct properties, and mutually co-exist in unity to form one culture.

In this case, most of the respondents believed in the distinction of 'national' driving styles, yet did not deny the value of individual characteristics within drivers which resulted in not sharing a similar manner in driving behaviour, as shown in the result across UK and Japan (refer to Figure 4.8 of this chapter). Nevertheless, given the importance of modelling driving behaviour, as stated by Lee (2008), understanding and theorizing culture within driving behaviour is a worthy effort, particularly in balancing between a driver's perceptual limitation and vehicle technology.

Importantly, the effects of road traffic on driving behaviour were unanimously in agreement regardless of the respondents' cultural background. Consequently, the study found that the number of vehicles on the road at any given time is viewed to affect the overall driving behaviour, with more than 80% in each cultural group supporting the positive statement. More often, reviews of the literature have shown investigations into driver's behavioural changes are focusing on the likelihood of road accidents.

In other words, heavier road traffic is likely to lead to behavioural changes in driving behaviour, which could potentially contribute to increases in the road accidents statistics. Hence, road traffic accidents have been the outcome of non-standard behaviour displayed by drivers. Nevertheless, given that road traffic refers to the number of vehicles on the road, it is also reliable to be taken as a stand-alone scenario, whereby the behaviour of drivers behind their wheels at a given time forms an aggregate of uniformity in driving, eventually emerging as acceptable behaviours on the roads. These behaviours would then be approved by that particular society as 'normal' driving styles.

The concentration of the thesis is on the latter condition of road traffic, whereby characteristics of driving styles have surfaced and govern as normal driving behaviour. The issue that requires further examination is whether this behaviour has any potential to be caused by cultural factors, particularly at a macro level – due to the regional position where most of the distance (in journey) incurred. A review of the literature confirms the existence of driving styles (see section 2.2.3 of Chapter 2). However, none of the studies viewed concluded that driving style was characterized by its locality.

Most research inferred the styles according to aberrant driving behaviour (Reason et al., 1990, Lajunen et al., 2004, Özkan et al., 2006) given its importance in decreasing the numbers of road accidents. Other research in relation to driving styles were more inclined towards demographic variables, particularly in age and gender differences (Shinar et al., 2001, Carpenter et al., 2004, Taubman - Ben-Ari, 2006). Nonetheless, it has been proven in this study on the uniformity in opinions about the affect of road traffic across culture.

Following this, it was evident from the analysis in this study that locality has an influence on driving behaviour across culture. Given a wider spectrum to the roads condition where a journey begins and later reach its ends, the surrounding environment will always be present throughout the journey, adding personal experience to a driver. The experience gathered could be grouped in either one of two categories based on the way the environment is being perceived by the driver – either passive or active.

The passive contribution the road environment has is when a road journey occurs without considering the surrounding situations. In contrast, an active contribution occurs when the road environment is assimilated into useful information for drivers, relative to current contextual situation of the journey. For example, a driver may observe the physical properties of the road environment, perceive the characteristics of the environment, and eventually develop strategies in navigation. In the latter category, the road environment furniture plays a role in shaping the behaviour in drivers, along with other elements experienced on the move.

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The study has also shown an agreement in opinions across the three cultural groups under study, covering the high possibility of changes in their normal driving styles, should the road environment change distinctively. Had the road environments differed in the way vehicles move, for example minimal gaps between cars or in the level of tolerance a driver shows in giving right-of-way, the respondents in this survey viewed supporting the positive agreement to change their normal driving behaviours. Should these distinct features of one road environment to another be visible at a national level, it would have validated the potential of cultural values being embedded in the environment of the roads.

Moreover, differences in the structural properties of roads across nations were also contributing towards national driving styles. The influence of road features/structures, could be explained in part by the *'imageability'* (Lynch, 1960, p.9) of a city, whereby a collection of public images have been shared amongst the locals and used as part of navigation aids within the peripherals of the city. This has been categorised within five elements, namely paths, nodes, landmarks, edges and districts (Lynch, 1960). Nevertheless, Lynch (1960) has argued how the elements deduced were limited in association to history and social meanings and further stressed that every city possesses several unique features as defined by the local inhabitants. Taking this into account, the national culture would not have affected public images of the local inhabitants. A possible explanation for this might be that drivers with similar nationality had expected collective behaviours (Zaidel, 1992), presumably driven by norms and beliefs.

To an extent, it is true that not all cities within one country have been built with similar features such as highlighted in the work of Davies and Pederson (2001). However, findings in Davies and Pederson (2001) supported the idea of nationally driven behaviours (see section 2.2.3 of Chapter 2). Moreover, identical road features throughout the nation is expected from the nation's governing body (Edensor, 2004).

Another example of potential influence of road features is demonstrated in the difference of road features between city roads across national borders. Big cities in Malaysia (for example Kuala Lumpur and Johor Bahru) have varying road networks which were mostly featuring overpass roads with limited number of roundabouts junction. On the contrary, many cities (for example Derby) in the UK have a large number of roundabouts with a given place name – a unique road feature of the UK (Simpson, 2001). Such differences could affect Malaysian driver's abilities in manoeuvring roundabout junctions when they are driving in UK roads.

Furthermore, it could conceivably be hypothesised that a driver's expectation of other road users within the same nation would lead towards changes in driving styles should the road and traffic environment deviate from those experienced in a home environment. Having had the knowledge of local public images, along with their associated social meaning, local drivers (who drive regularly in the area), would have driven accordingly as governed by the society – a style that is accepted and approved. However, in a foreign environment, these local drivers lack of information on the social meaning of the 'newly encountered' environment. Hence, the survey noted that drivers perceived positively the

influence of culturally different (Montello et al., 2001) road environments on driving behaviours (with more than 80% in agreement in each cultural groups).

Similarly, drivers were also in agreement with an average of 72% believing they change their natural behaviour in different road environments. These differences refer to not only the road patterns (Montello et al., 2001) across national borders, but also to differences in driving culture (Moeckli and Lee, 2007). Navigating foreign places with perceptual knowledge and experiences based in home environment may cause undesirable incidents whilst on the move (Simpson, 2001, Lim, 2007). The finding from this section of the current survey suggests for further exploration of drivers' behaviour between home and foreign environments. It seems promising that the exploration could lead towards better understanding of cultural values in navigation. This knowledge would have an impact on global navigational tools such as an in-vehicle navigation system (IVNS), should culture be taken into consideration.

4.10.2 Finding your way in unfamiliar environment

This part of the survey aimed to understand the perceived usefulness of a range of road navigation tools in novel places across the three cultural groups. Very little was found in the literature on perceived usefulness of navigation tools from cultural perspective at a national level. One unanticipated finding was that conventional tools were still rated as positively useful despite the advances in navigational technology. The three tools were *a road atlas and A-Z map book* (average of 75% useful), *written paper direction together with navigational arrows* (average of 54% useful), and *a passenger in the car that has local knowledge of the area* with an average of 95% useful. Further exploration

showed that there was a positive correlation between *a road atlas and A-Z map book* and respondent's age and respondent's licensure age. These relationships suggest that older drivers and experienced drivers have maintained their trusts on conventional road atlas and A-Z map.

Nevertheless, the perceived usefulness of *vehicle navigation system, using both audible and graphic-based directions* was highly positive with an average of 93% across Malaysia, UK and Japan. However, the mean rank between groups indicated a significant difference which is believed was due to the year the product penetrated into the country's consumer market. In comparison to the UK and Japan group, the Malaysia group is still at its infancy stage (Ng, 2007). The product was available for Malaysian consumers in 2004, while Hamahata and Liaw (1995) claimed in-vehicle navigation systems (IVNS) were available in Japan mass market since the 1980s. Similarly, the UK consumers' markets have had IVNS earlier than 2004. Hence, the Malaysians are relatively new to the use of IVNS and, are more likely to rate IVNS as useful in navigating to novel places, than the other two cultural groups.

Interestingly, *a sketched map of the journey* was significantly perceived as a useful navigational tool between groups (refer to Table 4.3 of this chapter). This was despite the simplification process, abstraction and distortion (Lee et al., 2008) in mapping the real environment and the differences across individuals in capabilities to draw (Murray and Spencer, 1979, Thorndyke and Stasz, 1980, Latini-Corazzini et al., 2010),

Surprisingly, no difference was found in the mean ranked data of the three cultural groups after post hoc analysis. A possible explanation for this might be

that every respondent shares similar views of moderately agreeing to the ease of placing meaningful information precisely on the sketched paper map. Some authors have speculated that the information a resident places on a sketched map to aid an imaginary stranger were *directional knowledge*, *way finding information preferences*, *content of residents' mental models* and *language used about the city* (Davies and Pederson, 2001, p.401). More importantly, Davies and Pederson (2001) argued that a *way finding information preference* is a reflection of the cultural norms within that society.

What is surprising is that *paper direction written in full sentence* was the only navigational tool showing positive correlation with drivers' self-rated confidence to navigate in novel places with different road systems (see section 4.9.3 of this chapter). This result may be explained by the fact that the Japanese respondents viewed *paper direction written in full sentence* as less useful for navigation (refer to Figure 4.9 of this chapter) while the other cultural groups indicated otherwise. Similarly, the Japanese respondents rated themselves as having less confidence to navigate novel places with different road systems as opposed to the other two cultural groups.

This finding was in consistent with the Japan group's cultural characteristics from the direction-giving study, discussed in section 3.6.3.2 of chapter 3. The finding in this online survey and elsewhere (from chapter 3) supported Hofstede's (2010) descriptions for *uncertainty avoidance* (UAI) and Marcus and Gould (2001) claimed for UAI's interfaces. These findings have evidently showed that the Japanese group preferred their navigational directions to be 'free' from any unknown features such as different road systems and written in

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full sentences. Instead, the Japan group preferred navigational instructions to be structured predominantly using schematic representations, and redundant numbers of information.

4.10.3 Useful items for navigation between home and foreign environments

This part of the survey was designed to explore the effect of culturally different environments in respondents' preferences of useful items for navigation from the statement, *Imagine you are about to start a journey to an unfamiliar place in your home country/foreign country. Name three important items that you would bring with you for that journey*. In naming the top three useful items for navigation in home environment and foreign environment, the survey did not detect any clear evidence of differences across cultural groups.

Published maps such as road atlas and A-Z map book were named as the most useful tools for both home and foreign environments in the Malaysia and UK groups. Surprisingly, items such as money and mobile phone including smart phone were also named as the most useful items for navigating unfamiliar environment other than vehicle navigation systems and published maps.

The main weakness of this survey was the paucity of useful items named as top three items for navigation. Respondents in this survey perceived non-navigational items such as money, identification card (passport), dictionary and beverages, as useful as navigational items such as published maps and vehicle navigation systems. This is particularly apparent in the responses received from the Japan group. Although the cultural groups did not show any clear differences in their preferences for useful items for navigating novel places

between home and foreign environment, the result should be interpreted with caution.

The low self-rated confidence in the Japan group suggests that a link may exist between the named items and the road environments (between home and foreign). It is possible that in a foreign environment, the Japanese perceived non-navigational items such as money as being more important than in-vehicle navigation systems (IVNS). A likely explanation could be signifying to the *uncertainty avoidance* (UAI) values embedded in the Japanese people recruited in this study and elsewhere (chapter 3 of this thesis). According to Hofstede et al. (2010), high UAI nation is accustomed to stringent set of procedures and regulations in their daily life, in an effort to deter uncertain events.

To illustrate this situation from navigation perspective, a comparison was made between a Japanese resident and a UK resident. The Japan roads are identified with blocks, with little use of Road Street names, and Road numbers (Hamahata and Liaw, 1995, Daimon et al., 2000), while samples of Japan-make IVNS's interfaces showed varying representations of navigational information (as shown in Figure 4.17). On the contrary, a foreign environment such as UK roads use Road Street names as their address system instead of blocks, while samples of IVNS for UK roads are displaying a lesser number of information representations (as shown in Figure 4.18).

Figure 4.17: Samples of IVNS's interface from Japan[5]

Figure 4.18: Samples of IVNS's interface for UK market[6]

Considering the road situations between Japan roads and UK roads, the Japanese people may perceive a foreign environment as not having a right amount of information (lack of redundancy of information). Similarly, the Japanese may also perceive that an in-vehicle navigation system (IVNS) in use at foreign country does not display a clear metaphor with restricted information. Hence, the Japan group in this online survey has named non-

[5] The image was last assessed on the 1 November 2011. Sources of image:
    A. http://www.britishblogs.co.uk/search/tomtom/

[6] The image was last assessed on the 1 November 2011. Sources of image:
    B. http://www.houseofjapan.com/electronics/mitsubishi-bdnav-system

navigational items (such as money and dictionaries) as more useful for than an in-vehicle navigation system (IVNS), in foreign environments. As an example, the Japanese people are able to look-up for more words to assist themselves in asking for directions by having a dictionary in foreign environment.

This situation may have an implication to the perceived usefulness of current designs of IVNS systems, for the Japan group when they are travelling abroad and, for the other cultural groups when they are visiting Japan. It may be possible to suggest for a different set of designs for IVNS systems to cater the influence of culture.

4.11 Summary

The questionnaire method adopted for this present study could only deduce general assumptions to the relationship of national culture (as independent variables) with driving styles and preferences in navigation. Driving is a learning process which either actively or passively utilises the surrounding road environments in building perceptual knowledge to enhance navigation skills. All three cultural groups believed in the existence of national driving styles, whereby each nation practices a shared driving behaviour. However, the UK and Japan groups also perceived that the national driving styles are in part being defined by personal driving habits. In contrast, the Malaysia group agreed to similarities in the general driving habits of every individual within a nation. Despite this dispute, all three cultural groups believed that road traffic will affect their current styles of driving behaviour.

Importantly, in situations where the road environment differed across national border, changes in the 'normal' driving styles are to be expected according to

the results of this survey. Conventional navigational tools have been perceived as useful in finding one's way, similar to *vehicle navigation system, using both audible and graphic-based directions*. Also, published maps such as *road atlas and A-Z map book* were named as the most useful item for both home and foreign environments apart from money and mobile phones.

Furthermore, the differences shown across UK, Malaysia and Japan in their level of confidence to navigate foreign environment with different road system demonstrated a need to explore the influence of culturally-different road environments. This finding and those reported earlier in the first part of the baseline studies in this thesis (chapter 3), was linked to Hofstede's (2010) claimed of Japan as a high *uncertainty avoidance* (UAI) nation. These findings suggest that potential cultural needs across nations for navigation could have originated from a road environment and not just a driver's national culture.

4.12 Implications for designs

The findings of this study have managed to understand cultural needs from perceptions of local drivers in the UK, Malaysia and Japan. One important finding which may have an implication to designs is on driver's differences in their self-rated level of confidence to navigate in a foreign road environment (more detailed explanation about possible relationship between *uncertainty avoidance* and driver's level of confidence can be found in section 4.10.3 of this Chapter).

4.13 Conclusions

The study set out to determine drivers' opinions in behavioural issues relative to home and foreign environment. One of the more significant findings to emerge from this study is that cultural values were believed to have contributed in driving behaviour at both national and individual level when referred to their home environment. The beliefs in 'national' driving styles were embedded in the features of road environment across national border through association of history and social meanings by the local society, which are then embedded in drivers' perceptual knowledge for navigation. This was supported with findings of differences in usefulness ratings of navigational tools across cultural groups together with similarities in useful items named for home and foreign environments. Taken together, these results suggest that drivers experience behavioural adaptations in home environments which affect their perceptual knowledge of the environment. It may be possible that such influences may have been driven by cultural values. An implication of this is the possibility that navigation products will be more satisfactory to road users should driver's cultural needs be embedded in the production process. However, more research on this topic needs to be undertaken before the association between drivers and their cultural needs is clearly understood. Therefore, further studies are needed to establish the influence of cultural values between home and foreign environment.

Chapter 5: Direction-giving study in culturally different road environments

5.1 Introduction
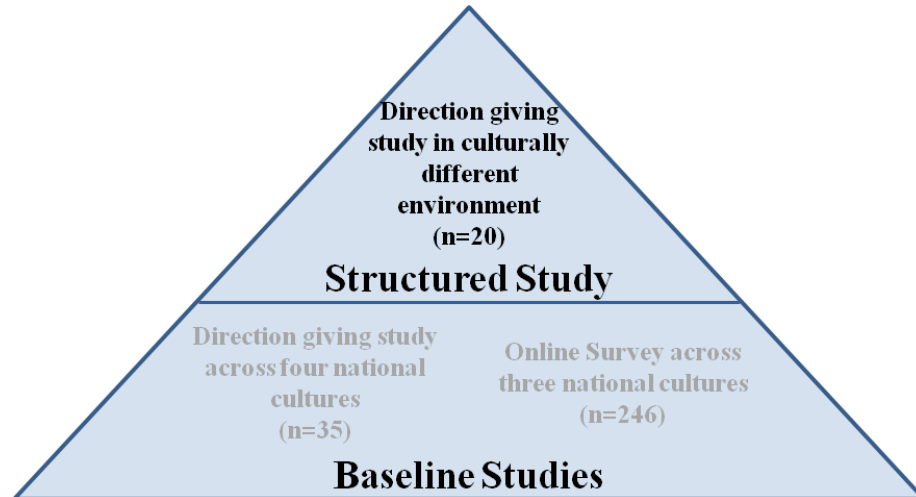
Figure 5.1: Excerpt of the thesis framework highlighting the current study

This chapter describes a second direction-giving study utilising culturally different road environments. Due to the limitations discussed in the first direction-giving exercise (Chapter 3), the present study was structured with three road environments (one home environment and two foreign environments) (Figure 5.1). The study aimed to address drivers' perception about different road environments, particularly in order to generate useful paper-based navigational instructions. The baseline studies (Chapter 3 and 4) indicated the potential links between drivers and road environments. In the present study, two groups were selected based on established cultural categories (Hall and Hall, 2001, Hofstede et al., 2010), while the chosen road environments correspond with participants' nationality and another additional road environment to ascertain navigational styles in their self-created paper-based directions. Burnett's *categorisation scheme* which has six categories over

22 navigational elements was used to quantify participants' paper-based directions (Burnett, 1998).

In the earlier survey (see Chapter 4), the respondents indicated the existence of 'national' driving styles when asked to think about drivers and their home environment. Furthermore, similarities were found in the opinions of traffic conditions between people of different nationality. When the findings from Chapter 4 were reflected on the different styles, density of information, abilities, preferences and types of elements as found in Chapter 3, a similar methodology approach was applied, however with the application of a different design structure. This step was taken in an effort to explore the embedded cultural values within drivers that could affect their overall driving behaviour. Such understanding would then be useful for designers of in-vehicle navigation systems (IVNS) within global markets.

5.2 Cultural factors from the road environment

There is an unambiguous relationship between driver's behaviour and the road environment. In previous research, drivers' behaviour was notably different in structuring direction for other travellers between local residents and immigrants (Daimon et al., 2000). Furthermore, differences were also noted in the formation of direction between residents of two grid-pattern cities in the UK and USA (Davies and Pederson, 2001). More importantly, differences in interaction behaviour between drivers and interfaces were highlighted in an offline software tool, Intercultural Interaction Analysis tool (Heimgärtner, 2007a). Such differences were also noted in drivers' expectations for Advanced Drivers Assisted System (ADAS) (Lindgren et al., 2008). These above-

mentioned studies indicate the potential of cultural influence within driver's behaviours in relation to navigation. Nevertheless, these findings alone are not able to address how culture could be incorporated into high-technology products such as in-vehicle navigation systems (IVNS).

Therefore, further exploration was justified to understand the role of road environment and how culture is affecting navigation and driving behaviour, particularly when drivers' were asked to produced their paper-based direction in two categories of road environment, home and foreign.

5.3   Aim, Objective and Activity

Table 5.1: Summary of Overall Aim, Objective and Activity for Chapter 5

<u>Overall Aim</u> To explore potential cultural needs within the design of in-vehicle navigation systems				
Code	**Objectives**	**Code**	**Activities**	**Chapter**
O1		A1		3
O2		A2		4
O3	To generate a cultural understanding from drivers' navigation strategies in culturally different environment	**A3**	A structured direction giving study across UK and Malaysia in culturally different environments, UK, Malaysia and Japan roads	**5**
O4		A4		6

To achieve the overall aim given earlier in section 1.9 of Chapter 1, the third specific objective (O3) was addressed in this chapter (see Table 5.1 above). A further three sub-objectives were also listed:-

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1. To compare the differences in *styles of direction-giving* between Malaysia and UK drivers from home to foreign environments;

2. To compare the differences in overall *density of information elements* between Malaysia and UK drivers from home to foreign environments;

3. To compare the differences in *types of elements* (such as direction – ego and landmark – descriptor) between Malaysia and UK drivers from home to foreign environments.

Hence, the third activity (A3) as given in Table 5.1 is reported in this Chapter.

5.4 Methodology

5.4.1 Justification for multiple environment direction-giving study

A variety of methods could be used to assess cultural characteristics. Each has its advantages and drawbacks as demonstrated in the literature review (see section 2.6 of Chapter 2). In the earlier baseline studies (as reported in Chapter 3 and 4), cultural values in driver's behaviour were explored in two different ways. First, the direction-giving method was applied across four independent variables (cultural groups) which showed some differences between groups in their styles of information representation, density of information, while similarities within the cultural groups were recorded for some types of elements from the road environment (see section 3.4.1 of Chapter 3). This was followed with the online survey across three independent cultural groups which aimed to understand local drivers' opinions. The outcome of the online survey suggested differences between groups about the extent of effects of national driving styles. It appears that every group has beliefs in having a driving style

by nation. However, such beliefs were also affected by individual perceptions, as demonstrated in the Japan and UK groups. Therefore, in this present study, another direction-giving study with a more structured framework was justified given the successful application of categorisation scheme (Burnett, 1998) in quantifying important information from participants' paper-based directions. The Japan roads were justified as necessary in the effort to introduce wholly foreign environment to the recruited participants.

5.4.2 Study Procedures

The potential participants were briefed on tasks requiring completion for this study. Then, participants were seated at a desk that have a desktop computer, a 17 inch monitor, a mouse, blank A4 papers, three paper-maps with highlighted route of road environment used in the videos, a written scenario of study, a pen and a consent form. Participants were given a time to familiarise themselves with the control buttons of the software player used in the video task. Next, participants were asked to watch a series of three videos and create their preferred paper-based direction-giving for every video onto the blank A4 papers. Participants were told that to facilitate the process of creating their direction-giving instructions, they were given the allowance to pause and rewind the videos at any time during the task. The videos were shown to participants in a balance sequence and no association with name of a country or town names. At the end of the task, participants were informed to leave a contact detail if they wished to learn the outcomes of the study.

5.4.3 Choice of Nationalities

The selected national cultures for this study were Malaysia and UK due to their distinct cultural characteristics. According to Hofstede (2010), Malaysian people show characteristics of high *power distance* and low *individualism* in contrast to the UK group. Furthermore, the UK has always been part of the Western countries while Malaysia on the other hand is part of Eastern countries, thus requiring a different approach in designs (Ahmed et al., 2009). In parallel to Hofstede (2010), cultural communication as described by Hall and Hall (2001) was also argued as having different perceptions and expectations between the Western countries and the Eastern countries, whereby the former reflects a low context culture, while the latter is a high context culture. In the baseline studies, the national culture groups selected for comparison was based on Hofstede's high values nations for *power distance* and *uncertainty avoidance* (Figure 5.2).
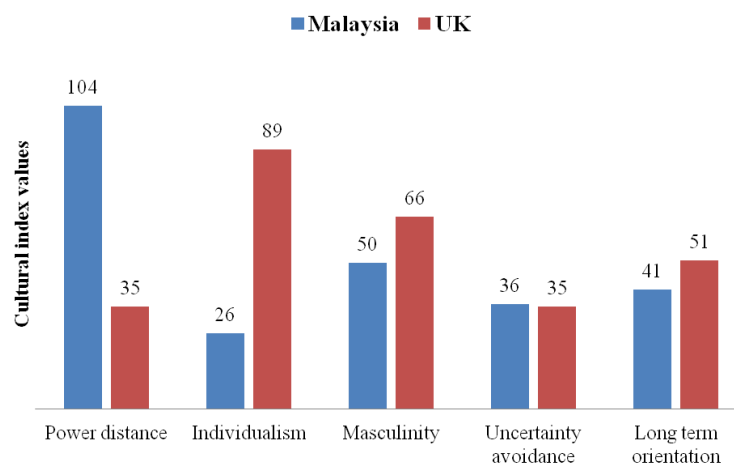
Figure 5.2: Illustration of cultural characteristics distance based on Hofstede et al. (2010) across Malaysia and UK

5.4.4 Choice of participants

Twenty participants were recruited using an email advertisement requesting drivers from the UK and Malaysia who owned a valid UK or Malaysia driving licence. Furthermore, participants in this study were not local to the road environments used in the videos. Also, participants were only selected if they had lived most of their lives in their home country. Importantly, to reduce the chances of influence from other national culture, eligible candidates were asked about their recent annual mileage, and those who had gained (on average) more than 50% of the annual mileage from their home country were selected.

5.4.5 Study Design

Three culturally different road environments were used as study environments, namely Johor Bahru of Malaysia, Derby of the UK and Sendai of Japan. The videos were captured in a clear daylight with time length ranged from five to nine minutes. Participants were required to use the videos shown as if they were part of the video, driving on the road and use the surrounding road environment (as seen from the video) as a pool of information to produce paper-based directions. The participants were given a scenario whereby they were required to imagine that they were going to drive on the same route using their paper-based directions. To help the participants in creating their paper-based directions, maps with a highlighted route were also provided to give an overall perspective of the study areas. The maps were taken from Google Map and were scaled down to show the entire route journey beginning from A (the

start of the route) to B (destination) in each of the study environments (Figure 5.3, Figure 5.4, Figure 5.5 and Figure 5.6).

Additionally, participants were also observed during the video task for different strategies employed using map and video while creating their paper-based directions. This study has received an ethical approval from the Faculty Research Ethics Committee, University of Nottingham.

Figure 5.3: Map of Practice Environment – Kure, Japan
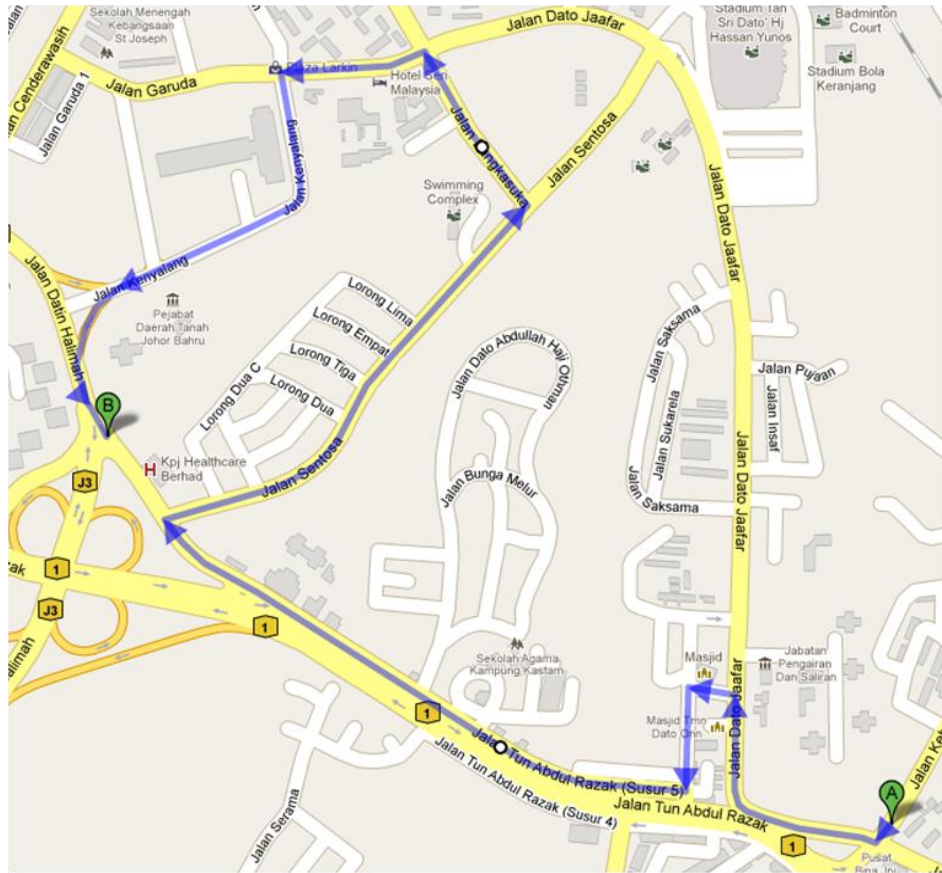
Figure 5.4: Map of Environment A – Johor Bahru, Malaysia
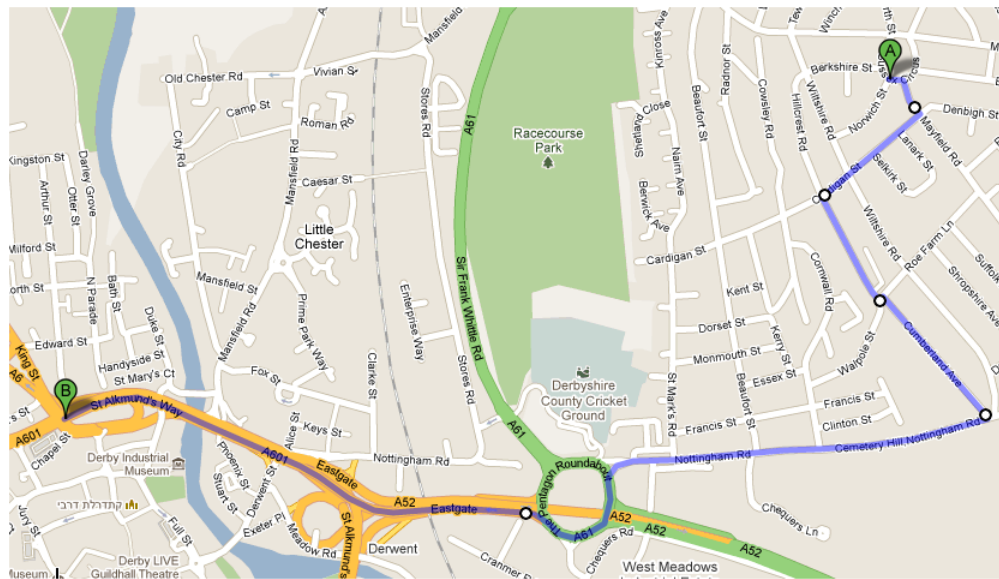
Figure 5.5: Map of Environment B – Derby, UK

Figure 5.6: Map of Environment C – Sendai, Japan

5.4.6 Paper Directional Task

5.4.6.1 Video construction

There were four videos used in this present study, each representing road journeys taken in a different country. In this present study, these four journeys were not labelled explicitly according to their country of origin. Instead, the cities where the videos were recorded were labelled as follows:-

1. Practice environment − this is a sample of a road environment in the city of Kure, Japan. The recorded video of the route following the journey lasted for approximately four minutes.

2. Environment A − this is a sample of a road environment in the city of Johor Bahru, Malaysia. The recorded video of the route following the journey lasted for approximately six minutes.

3. <u>Environment B</u> – this is a sample of a road environment in the city of Derby, UK. The recorded video of the route following the journey lasted for approximately nine minutes.

4. <u>Environment C</u> – this is a sample of a road environment in the city of Sendai, Japan. The recorded video of the route following the journey lasted for approximately five minutes.

The practice environment was the shortest video used in this study due to its purpose for this study as familiarisation session for the participants. This practice environment video was not considered as part of data. Instead participants were shown the video so they could familiarise themselves with the control keys to stop, pause, rewind and forward the video. Despite the discrepancies in the length of the videos used in this present study, every video featured a similar amount of main road features such as landmarks, junction, paths and road signs (Table 5.2). Furthermore, the difference in time was in part due to the number of times the vehicle had to stop for red traffic lights. Every journey was recorded on a clear day using a hard disk drive video recorder.

Table 5.2: Showing main road features in the videos

Type	Environment A Johor Bahru, Malaysia	Environment B Derby, UK	Environment C Sendai, Japan
Junctions	9	7	6
Lane changes	2	2	2
Roundabouts	0	3	0

Participants were allowed to control the videos with the control keys. The three test environment videos were presented to participants in a counterbalanced order, to reduce the chances of treatment order, or other factors which might adversely influence the outcome of the paper-based directions.

5.4.6.2 Implementation of video task

The participants were asked to watch four videos featuring samples of road journeys in three culturally different cities, Kure of Japan, Johor Bahru of Malaysia, Derby of UK and Sendai of Japan, on a 15' inch wide notebook. Snapshots of these videos are shown in Figure 5.7, Figure 5.8 and Figure 5.9. The name of the cities were blanketed, instead, each journey was referred to as Practice Environment, Environment A, B and C respectively. The task in this study was to produce personal paper-based direction onto blank A4 papers for each environment, excluding the practice environment. There was no limitation given in time. The participants were asked to imagine that their personal paper-based direction-giving would be used at a later date to navigate the given route in every environment, without the presence of a navigation device or another passenger in the vehicle. Each road journey was also accompanied with its corresponding maps. The maps provided the participants with additional information of the study area. More importantly, the participants were able to receive an overall sense of direction of the entire journey for each study environment from the highlighted route on the maps.

Figure 5.7: Snapshots of Environment A – Johor Bahru, Malaysia

Figure 5.8: Snapshots of Environment B – Derby, UK

Figure 5.9: Snapshots of Environment C – Sendai, Japan

5.4.7 Driver's cultural profile

The UK group had six males and four females, while the Malaysia group had equal number of males and females participants. The average age of participants was 36.6 for the Malaysia group and 35.6 years for the UK group (Figure 5.10). As for the average years of licenced held, the Malaysia group was reported with 16.4 years of licence compared to 12.6 years for the UK group (Figure 5.10).

The average annual kilometres (km) driven by subjects in the last 12 months were reported higher in the Malaysia group when compared with the UK group with 20,415 km and 9,335 km respectively (Figure 5.10). All participants in the study were students of the University of Nottingham. The reported annual kilometres from the Malaysia group were a mixture of driving experiences in

UK and Malaysia due to their recent transfer to Nottingham, UK for enrolment into postgraduate education.
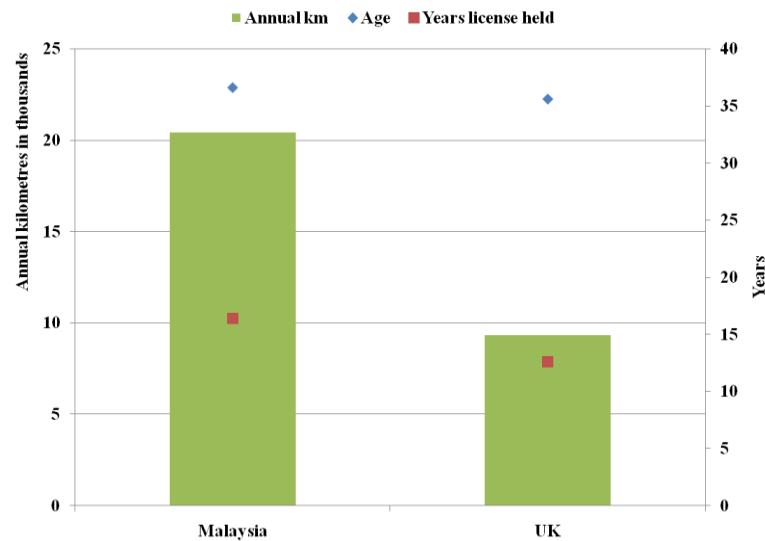
Figure 5.10: Annual kilometres (in thousands), average age and years of driving licence

5.4.8 Analysis of data

Each study environment resulted into one paper-based direction per participant. Given that there were three study environments, a total of 30 paper-based directions were obtained. The navigational information that was within the paper-based directions was quantified following guidelines from the categorisation scheme of Burnett (1998). The analysis then involved a comparison of means in paired (t-test) between the UK and Malaysia groups in each of the study environments. The means were calculated for any navigational elements found in participants' paper-based directions for each study environment. Then, the total number of elements (overall density) used in each study environment was also compared between the two national cultures. This was followed with two-way repeated measures ANOVA between

nationals (UK, Malaysia) and environments (UK roads, Malaysia roads, Japan roads) which formed a 2*3 statistical analysis for overall density.

5.5   Results

5.5.1 Styles of information representations

With reference to the *categorisation scheme* (Burnett, 1998), nineteen navigational elements were noted between the two national groups. These elements were plotted onto graphs to illustrate styles of representing navigational information from the number of counts of each element. Each cultural group had a corresponding road environment as home environment and two foreign environments as tabulated in Table 5.3.

Table 5.3: Direction-giving in culturally different environment analysis

Group (n=10/group)	Home Environment	Foreign Environment	Foreign Environment
Malaysia	Malaysia Roads	UK Roads	Japan Roads
UK	UK Roads	Malaysia Roads	Japan Roads

The blue line indicated the number of elements used for their home environment. The amount of information counted for their respective home environment was different from the amount counted for the two foreign environments. Nevertheless as illustrated in Figure 5.11, these counted numbers showed similarities in types of elements selected for building the paper-based directions in home and foreign environments. However, the numbers of elements found in foreign environments were comparatively smaller than the numbers recorded for their home environment. Participants in the Malaysia group showed preferences for *ego* to form their *direction* instructions rather than structuring the *directions* in *local* format.

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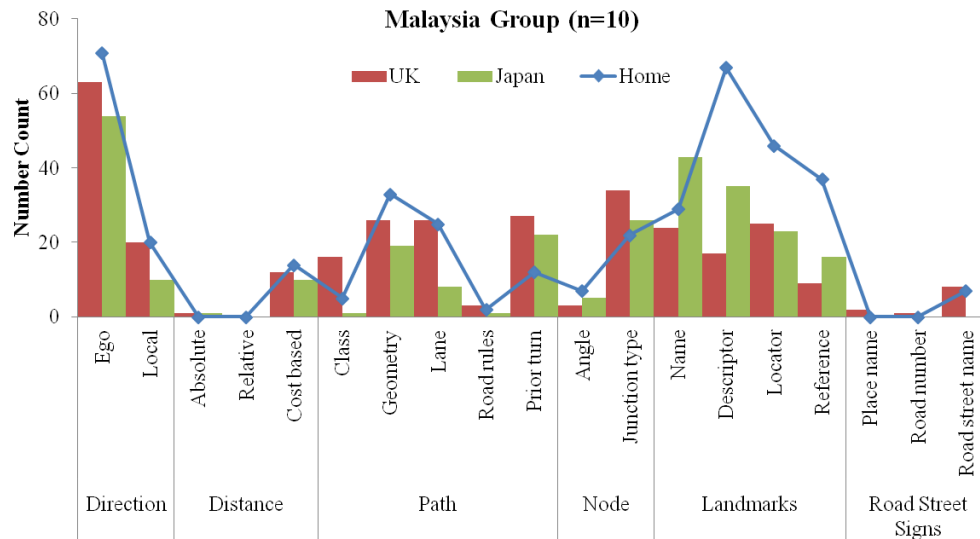
Figure 5.11: Navigational elements used in culturally different road environments for Malaysia

Conversely, the UK participants showed preferences for constructing their *direction* using both *local* and *ego*. The styles of navigating (as reflected in the number of navigational elements counted for each road environment in Figure 5.12) for the UK participants in their home environment showed consistency in the types of elements selected, apart from *direction – ego* and *landmarks – reference*. There was also a slight increase in the number of occurrences for *landmarks – locators* in one of the foreign environment (Malaysia) for the UK group (Figure 5.12).
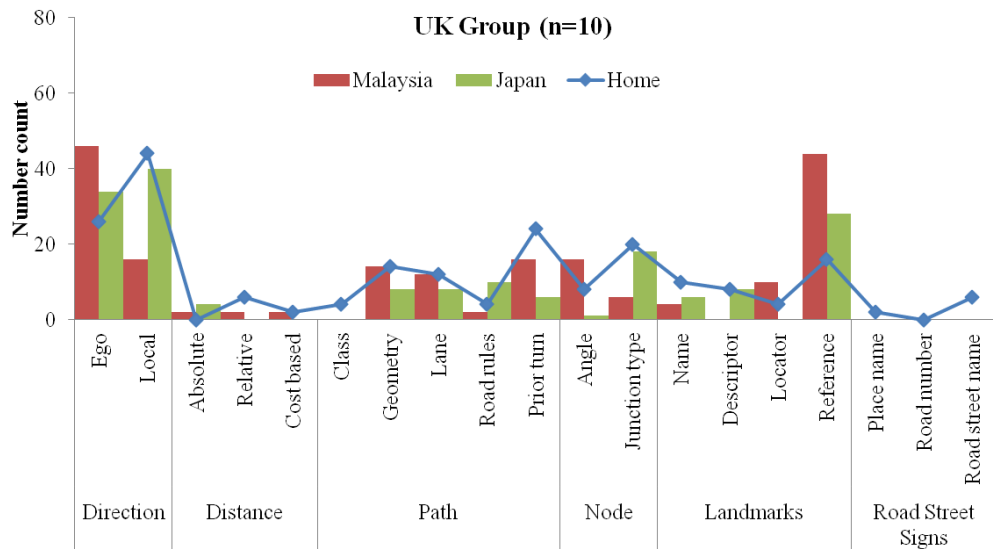
Figure 5.12: Navigational elements used in culturally different road environments for UK

5.5.2 Density of Navigational Information

In addition the styles of navigation, cultural differences were also noted in the total number of navigational elements found in their paper-based directions (density). The total number of en-route information extracted from the three environments showed a gradual decrease in density between home and foreign environments in the Malaysia group (Figure 5.13a).
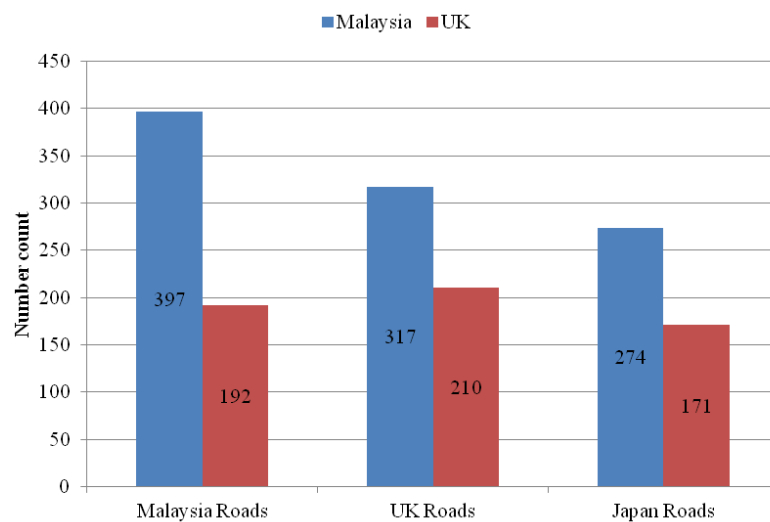
Figure 5.13a: Total number of information between Malaysia and UK across three environments

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This decreasing pattern was not visible in the UK group, instead the total number of information across UK, Malaysia and Japan road environments were almost similar. Comparatively, the Malaysians used more navigational elements to structure their paper-based directions, in both home and foreign environments. For example, when constructing paper-based direction for Japan roads, the Malaysia group used 274 navigational elements while the UK group used only 171 elements (as illustrated in Figure 5.13a).

A two-way repeated ANOVA was carried out to examine the interaction between national and environment on overall density of navigational information. There was a statistically significant interaction effect of environment on nationality, $F_{(2,18)} = 8.33$, $p=0.003$ (as illustrated in Figure 5.13b and Figure 5.13c). There is a significant linear trend in the interaction effect of environment on nationality. Foreign environment had a relatively lower density of information when compared to home environment.
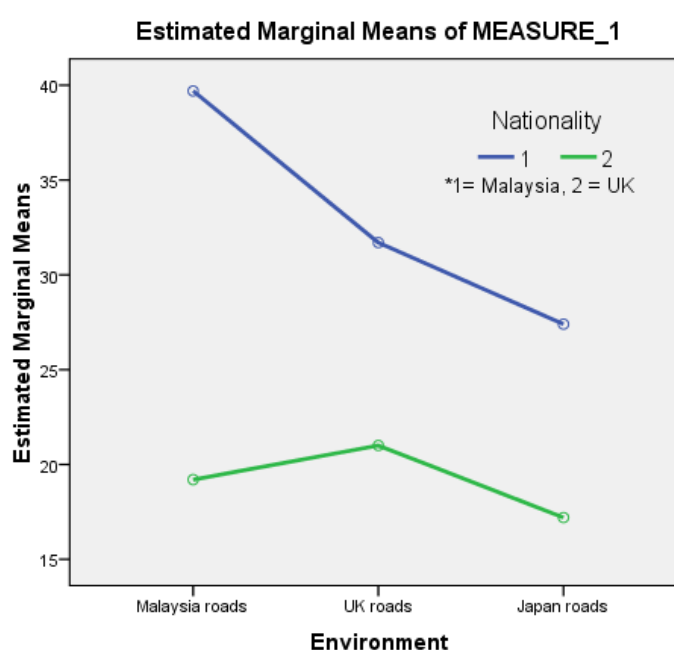
Figure 5.13b: Estimated marginal means between Malaysia and UK across three road environments
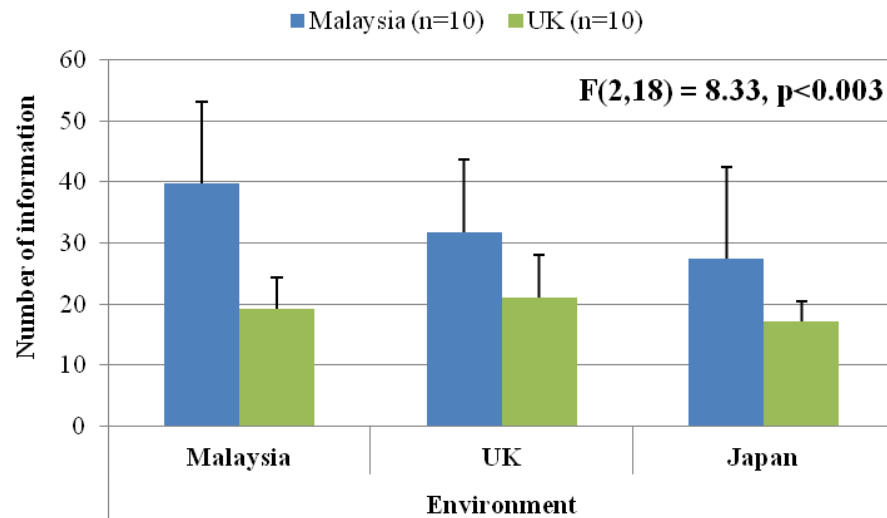
Figure 5.13c: Means and standard deviation for Malaysia and UK showing a significant difference for information density across three environments

5.5.3 Differences between Malaysia and UK

Table 5.4: Significant difference (p<0.05) between groups in culturally different environment analysis framework

Difference between Cultural Groups (n=10/group)	Malaysia Road Environment	UK Road Environment	Japan Road Environment
Malaysia and UK	*Distance – cost-based* t(18)=-2.4, p=0.03 *Landmarks – descriptors* t(9)=-3.2, p=0.01 and *locators* t(13)=-3.6, p=0.02 *Node – junction types* t(18)=-2.7, p=0.01	*Direction – ego* t(16)=-2.8, p=0.01, and *local* t(18)=3.1, p=0.01	*Direction – local* t(18)=2.6, p=0.02 *Distance – cost-based* t(9)=-3.0, p=0.01 *Landmarks – descriptors* t(12)=-2.5, p=0.03, and *locators* t(9)=-3.0, p=0.01

Unpaired T-Tests were used to understand the relationship between the two cultural groups in their choice of navigational elements for personal paper-based directions in home and foreign environments. Table 5.4 provides the navigational elements that were found to be significant. The results suggest that cultural background does have an effect on how the environment is being perceived.

In particular, the result suggests that when indicating turning directions, there was a preference over the use of *ego*, such as "turn left" and *local*, such as "over the mini roundabout" across the two cultural groups. Furthermore, when indicating distance, *cost-based*, such as "take immediate left" was commonly used by participants compared to *distance – absolute*, such as "100 metres". The Malaysian participants used more *cost-based* distances compared to the UK participants in Malaysia roads, $t(18)=2.4$, $p=0.03$ and Japan roads, $t(9)=3.0$, $p=0.01$. Significant difference was noted in the use of junction types as part of participants' paper-based direction for Malaysia road environments.

Importantly, cultural background showed an effect in describing landmarks between the two cultural groups. The Malaysian participants showed a higher mean than the UK group in two ways of referring to landmarks, *descriptor* and *locator* (Figure 5.14). Unpaired T-test showed that *descriptor* and *locator* were statistically different between the two cultural groups (Figure 5.14 and Table 5.4). Other than *descriptor* and *locator*, landmarks were also referred as *name* such as "traffic lights". Although the data provided in Table 5.5 have shown that the Malaysia group had a higher total than UK participants for *name*, the

mean difference was only near significant for Malaysia roads (p=0.07), UK roads (p=0.099), and Japan roads (p=0.07).

The UK group made more use of landmarks - *reference* in foreign environments (Malaysia and Japan roads) compared to home environment (UK roads) (Table 5.5). Conversely, the Malaysia group had used less of referenced landmarks in foreign environment, instead the Malaysians have utilised a mixture of all elements of landmarks for their paper-based direction. Interestingly, the Malaysians have differed in their style of navigation (refer to section 5.6.1 and Table 5.5) for landmarks where more *name* was used in Japan roads.
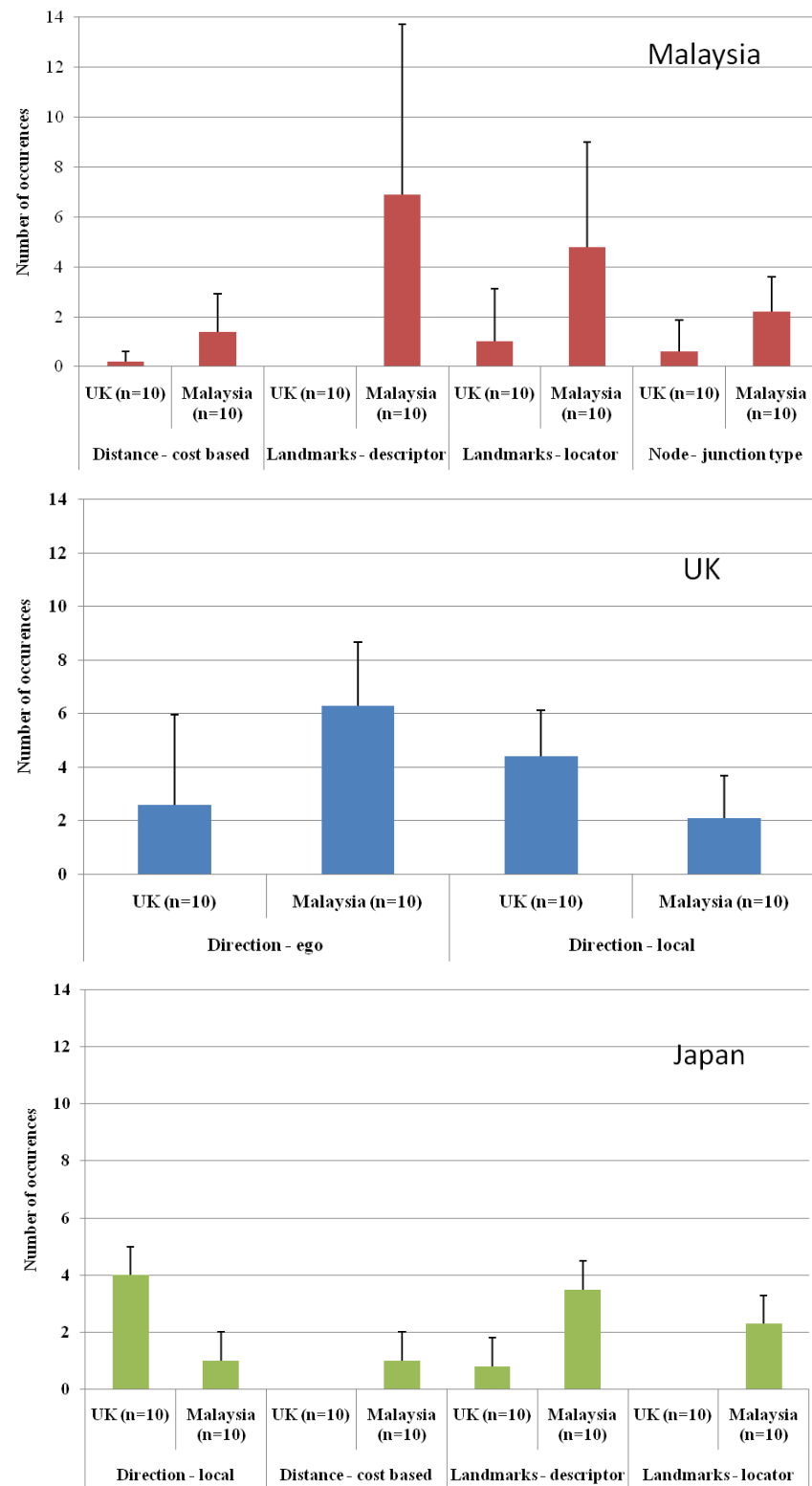
Figure 5.14: Mean (SD) for selected navigational elements in Malaysia, UK and Japan roads

Table 5.5: Showing total number of selected navigational elements in culturally different environment

Groups (n/10)	Malaysia Roads				UK Roads				Japan Roads			
	Name	Descriptor	Locator	Reference	Name	Descriptor	Locator	Reference	Name	Descriptor	Locator	Reference
UK	4	0	10	44	10	8	4	16	6	8	0	28
Malaysia	32	69	48	37	24	17	25	9	43	35	23	16

5.6   Discussion

Prior studies (chapter 3 and chapter 4) have noted the effects of culture on drivers' behaviour. In chapter 3, cultural background effects were measured using their paper-based directions for one road environment (the UK roads). In chapter 4, an online survey was distributed to local residents in Malaysia, UK and Japan which suggested the existence of differing driving styles from the perspective of driver's nationality (see Section 4.10.1 in chapter 4). Hence, there is an unambiguous relationship between culture and nationality, in part due to feeling of belonging to a nation (Edensor, 2004). More often, such differences are apparent in the spoken language, customs and traditions which result in national identities (Edensor, 2004). Nevertheless, current advancement of information technology and demands of the global market has resulted in technical products such as vehicle navigation systems being available to user with little consideration or understanding for drivers' cultural background.

The literature review revealed little research on the question of cultural importance in global products such as vehicle navigation systems (Daimon et al., 2000, Heimgärtner, 2007b). This study aimed to assess the importance of culturally different road environments in navigation across two independent cultural groups. The results indicate that there are differences between the two

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cultural groups in their density of information used for constructing the paper-based directions, and in the elements selected to describe each road environment.

5.6.1 Use of established cultural characteristics in choice of nations

Prior to discussing the above-mentioned potential cultural differences, it is important to argue the method applied in the selection of the two study groups in this present study. Earlier on (in section 5.4.3), it was stated that the cultural groups were chosen based on established cultural characteristics from the literature (Hall and Hall, 2001, Hofstede et al., 2010). The two nations were reported to have different characteristics in accordance to Hofstede's dimension (for *power distance* and *individualism*) and Hall's communication (for *high context* and *low context*). These differences have been reported in the literature to have an effect in the way user's communicate and perceived information (Marcus, 2005, Ahmed et al., 2009). Therefore, having had the choice in choosing cultural groups for this study, it seemed necessary to select nations based on established cultural dimensions, in the effort to learn and understand more about other aspect of cultural differences. In particular for this present study, the emphasis was to explore how culturally different road environments are affecting driver's behaviour in navigation. In other words, when given two different road environments, home and foreign, would drivers be affected in structuring their paper-based directions? However, this approach had to introduce the established cultural characteristics in the methodology section without discussing it further in the results section. It is believed that exploring other aspect of cultural differences does not necessarily need the established

cultural characteristics to explain the differences and similarities found in the result section. This is because exploration of the cultural effects of the road environment requires more detailed and specific explanation. Hence in this present study, reference was made to the *categorisation scheme* which was developed in the UK environment by UK participants in another direction-giving study (Burnett, 1998) to discover cultural differences and similarities in participant's paper-based direction.

5.6.2 Differences in styles and density of information representations

Despite the little information available in the literature on the existence of driving styles due to nation (Huang et al., 2006), secondary data such as travel blog[7] and car rental website have been suggesting the difference of national driving styles through advice given on how to expect driver's driving behaviour when travelling abroad (Nova blog 16 May 2008). Interestingly in this study, culture was found to cause differences in information representation between home and foreign road environments. The number of elements selected to represent information of the environment was almost similar between home and foreign environment in the Malaysia group. However, there was a decreased in the number of occurrences for each element in the foreign environments, with an exception for *node – junction types* and *path – prior turns*. It is believed that when placed in foreign environment setting through the video task, participants from Malaysia have limited cultural information such as the local public images of the environment (Lynch, 1960), social

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[7] Sourced from http://www.kyleandrach.com/2011/01/29/driving-in-malaysia/ [last accessed 2 June 2011]

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meanings of the infrastructure (Edensor, 2004) or the laws of the local traffic systems (Huang et al., 2006). Such limitations have reduced the numbers of count for each navigational element. Instead, it is believed that participants were compensating these limitations with describing more of the *node* via *junction types* and, describing the *path* with *prior turns*, such as "7th traffic lights, turn left". Importantly, the Malaysians participants were generally more inclined towards having landmarks as part of their paper-based directions with degree of differences in the type of elements used, for example more *descriptor* and *locator* counted compared to *name* and *reference*. An interesting deviation from this was observed in the Japan roads where more *name* was noted than other elements of landmark. This could probably be due to cultural restriction experienced by the Malaysian participants in the Japan environment which resulted into naming common landmark such as "traffic lights" and "trees" at every instance of the video. It may be possible that in comparison to the other foreign environment (UK roads), participants felt more restricted due to not being able to understand Japanese language which visible in the video (from the road signs and shop names) and map (in road names and point of interest names). Nevertheless, this finding is not conclusive in showing that the Malaysia group would prefer having *name* landmark over *descriptor, locator* and *reference* in foreign environment.

Meanwhile, similar pattern was also noted in the UK group between home and foreign environments. However, in foreign environments, participants from the UK have opted to use more *ego* elements for *direction* and, *landmark – reference* to produce their paper-based directions. The use of *reference* was perceived as more useful than other types of navigational elements (*name*,

locators, and *descriptor*). The findings of the present study are consistent with those of Lovelace et al. (1999) who found that landmarks are highly correlated at turning points in unfamiliar environment as compared to familiar environment. Nevertheless, *landmark – reference* was not found significant between the two cultural groups. Participants from both groups were almost equal in placing selected landmarks as a reference point in their paper-based directions.

However, it important to note that UK participants have used mainly *reference* while the Malaysians have perceived landmarks found within the videos into three elements, *name, descriptor, locator and reference*. For this study generally, the Malaysians have indicated higher number of landmarks compared to the UK group.

5.6.3 Differences in types of navigational elements

Reflecting onto findings of the previous direction-giving study (section 3..4.1 of chapter 3), *ego* and *landmarks* were also common in the present study. These navigational elements were believed form an important part in navigation. According to Lovelace et al.(1999), part of general route direction characteristics are landmarks. In the present study, landmarks were further categorised into four elements of *name, descriptor, locator* and *reference*. When culture was taken into consideration, *descriptor* and *locator* were found significantly different between the Malaysia and the UK groups. Therefore, it would have been possible to consider these two elements as potential cultural needs in the construction of paper-based direction. More importantly, such

findings could also be considered in the designing process of route instruction within vehicle navigation systems.

Apart from *descriptor* and *locator*, cultural difference was also found in the use of elements for *direction*. The UK group have referred to more *local* than *ego* elements, with an exception to findings in the Malaysia roads where participants used as much *ego* as *local* to depict the direction in their paper-based directions. These findings were not as clear as findings for *landmark* in this study. It could have been that culture does not have similar impact on *direction* as shown for *landmark*. If we ignore the culturally different road environment, and the type of elements for *direction*, the Malaysia and the UK groups do not differed in their choice of using *direction*. In other words, *direction* is the basic requirement in constructing paper-based directions. Nevertheless, there is a potential that for UK participants in their local environment (UK roads), the use of *local* could increase driver's satisfaction in interacting with vehicle navigation systems, particularly at certain type of junction. For example, in the baseline (chapter 3) and current direction-giving study, the use of local element was apparent at roundabouts where the direction of turning is referred to the number of exits at a roundabout. Such information would be useful for UK road environment where roundabouts are more common than other national road environments.

Importantly, *distance* was not always noted in participant's paper based directions. Perhaps, in structuring paper-based direction, *distance* was perceived as less important compared to *direction, landmark* and *node*. In other words, successfully navigation does not require information that is related to

distance, particularly *absolute* element, such as "100 metres". Nevertheless, the Malaysia participants have used *cost-based* elements such as "turn immediately" in structuring their paper-based directions.

5.7 Summary

The overall aim of the thesis was to explore for potential cultural values when drivers are on the move, for use in the process of designing navigational products. Given the vast concept of culture, the focus of exploration has been based on driver's perceptions about direction-giving. Although providing direction does not provide direct information towards guidelines in designing products such as vehicle navigation systems, the contextual information are nevertheless useful. This is argued on the basis that the environment where driver's had to refer in the effort to produce a paper-based direction was essentially 'good' information from driver's perspective. Given that drivers were grouped according to their nationality (along with other restrictions such as national driving licence and limited length of staying abroad), the navigational elements used in context of paper-based direction may offer essential information needed for understanding culture. In other words, the empathy of cultural communication could potentially be available within paper-based directions, particularly when the studies were designed with control groups and road environment according to cultural values.

Understanding driver's needs is important in ensuring successful designs of technical products thus for culturally-aware products, incorporating empathy into the intercultural communication process is the key to successful international product design (Heimgärtner et al., 2011). Hence, it is believed

that direction-giving exercise had places drivers in route perspective (moving through an area) where driver's views were limited to turn by turn and encourages drivers to use the surrounding road environment to build step-by-step navigational instructions. While there was a discrepancy in the clarity of some environmental information due to limitation in the quality of videos used in the present study, participants have been supplied with corresponding maps that had the highlighted route. Therefore, participants have also been given the survey perspective (similar to navigating with a map) of the road environment which provided information in relation to the overall sense of direction.

The interest in this design of culturally-restricted direction-giving exercise was to determine differences (between cultural groups) in using the road environment for navigational purposes. It has been argued that road environment has a cultural effect onto drivers, particularly when driving abroad where their cultural expectations were not met (Huang et al., 2006). Furthermore, differences in driving situations also were reported as causing cultural discrepancy which effects driver's normal driving behaviour (Huang et al., 2006, Lindgren et al., 2008). The findings of the present study have shown potential differences in structuring direction (in the use of *ego* and *local* elements) which was also found in the baseline direction-giving study (see section 3.4.1 in chapter 3). In contrast to the current navigational products, the use of *local* elements such as "towards Church" or "over the mini roundabouts" in providing direction for navigational instructions, were not as common as *ego* such as, "turn right". Nevertheless, *ego* element was as popular as *local* in foreign environment as exemplified by the UK participants in foreign

environments. Hence, it may be possible that *local* elements would be more useful at specific condition, such as at roundabouts.

More importantly, the most referred information found was landmarks. This has been referred by in four different ways in accordance to the *categorisation scheme* (Burnett, 1998), *name, descriptor, locator* and reference. This present study has found significant differences only for *descriptor* and *locator*. This finding was parallel to those reported in various literatures about landmarks having an impact in successful navigation (Lovelace et al., 1999, Burnett et al., 2001, Davies and Pederson, 2001, Lawton, 2001, Goodman et al., 2005, Hund et al., 2008). Given that there has been restriction in cultural aspect of the design in this study, the differences found in this study have demonstrated cultural differences in driver's expectations of landmarks in navigational instructions. However, more exploration is needed prior to concluding towards potential culturally-sensitive landmark elements.

5.8   Implication for designs

The findings of this study have managed to generate a cultural understanding from drivers' navigation strategies in culturally different environment The influence of road environment (between home and foreign) was seen in the styles of representing information, the density of information and the types of elements used in culturally-restricted environment, between the Malaysia and the UK groups.

Samples of current designs navigational interface for Malaysia and UK market are shown in Figure 5.15. These products were manufactured by one global company. Comparatively these interfaces were almost identical in its styles of

representing information and density of information. Moreover, types of navigation elements used were almost identical, such as for *direction* (i.e. written navigation instructions) *"Exit 1804B (Sg Jelok)"* was used for Malaysian road environment and *"Exit 13:A30 (W/London)"* was displayed for the UK road environment.

Figure 5.15: Sample interfaces of a brand name nomadic IVNS for Malaysia market (top) and UK market (bottom)[8]

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[8] All images were last assessed on the 23 September 2011. Sources of images:

    A. http://www.aeco.com.my/BACKUP/Products/2565series.html
    B. http://www.garmin.com/uk/products/in-car-sat-navs/

Despite having the navigational element *path* (i.e. the junction view), the given navigational instructions were believed to be more suitable for UK road environment as opposed to Malaysia road environment. This is because the given instruction for the latter road environment contradicted with the display of road signage (*Seremban Semenyih)* at the junction (refer to Image A of Figure 5.15). This situation may create confusion to both British tourist travelling on Malaysia roads and local Malaysians who are not familiar with the area. The uniformity in providing written navigational instructions across a global such as those displayed in Figure 5.15 may have underestimated driver's cultural needs. Reflecting onto the finding of this study, the UK participants have showed a preference for using *reference* landmark in their navigational directions which correspond to the given written instruction in Image B of Figure 5.15, *"Exit 13:A30 (W/London)"*. Conversely, the Malaysia participants have showed a preference for using *locator* and *descriptor* in their navigational directions. Therefore, applying these navigational elements such as "*Exit Seremban Semenyih"* could potentially avoid confusion to drivers and improve their satisfactions with their in-vehicle navigation systems (IVNS).

5.9   Conclusion and key findings

The study has proven that established cultural dimensions such as Hofstede et al. (2010) and Hall and Hall (2001) are useful in preliminary understanding of culture, in the effort of exploring other aspects of culture such as driver's choice of navigational elements in culturally different road environment. This study has also shown that knowledge of established cultural dimension such as

power distance and *high context vs. low context* are insufficient in explaining cultural discrepancies across culture, particularly in relation to understanding relationship between drivers and the road environments while on the move. Instead, reference to the *categorisation scheme* (Burnett, 1998) was needed to understand driver's expectations of the information from the road environment. The influence of road environment (between home and foreign) was seen in the styles of representing information, the density of information and the types of elements used in culturally-restricted environment, between the Malaysia and the UK groups. Similar to earlier findings (chapter 3), *ego* directions and landmarks form the basic navigational elements required for navigation in all contexts given its high frequency of occurrences in paper-based directions for this present study and elsewhere (Burnett et al., 2001). Further research of the PhD has aimed to explore more of these cultural discrepancies through a scenario-based design study.

Chapter 6: A scenario based design study between UK and Malaysia

6.1 Introduction

This chapter describes a scenario-based study which aimed to understand driver's preferences in an effort to improve driver's satisfaction with their personal in-vehicle navigation system (IVNS). Following the discoveries of several potential cultural needs from the direction-giving studies (Chapter 3 and 5), this current study explored those potential cultural needs at an early stage of design for IVNS. Three culturally different road environments (UK roads, Malaysia roads and Japan roads) across two cultural groups (UK and Malaysia) were utilised, similar to variables reported in Chapter 5.

Participants in the study were given the freedom to sketch their preferred navigational interfaces on a blank interface. This task provided participants from different cultural background with the freedom to express their requirements for navigational interfaces according to their needs.

In part, the video scenes of road environments from three countries helped in understanding driver's needs whilst engaging with in-vehicle navigation systems in home and foreign environments. This is particularly important in considering cultural values related to interfaces of IVNS.

6.2 Transfer of cultural knowledge learned onto navigational interface

The previous two studies explored cultural values from established cultural dimensions (Hall and Hall, 2001, Hofstede et al., 2010) and applied a categorisation scheme (Burnett, 1998) to investigate potential cultural needs

through direction-giving exercises. This work was further supported with an online survey about drivers' perceptions, based on respondents from different cultural backgrounds. The differences and similarities found across participants of different national cultures raised a need to bridge the knowledge learned onto designs of vehicle navigation systems.

The assistance from navigation systems is particularly important in novel journeys. Some navigational products available in the global market are manufactured by a relatively small number of companies; inasmuch that the overall designs of such product has been stereotyped for road users of various geographic locations and nationalities. For example, Garmin® in-vehicle navigation systems (IVNS) products, nüvi 3790T and nüvi 3790V are available in UK and Malaysia respectively. These models are identical in specifications and product's dimensions; their difference is only in its pre-loaded map database whereby for UK market, nüvi 3790T is equipped with European map while nüvi 3790V contain map of Malaysia and Singapore. Issues pertaining to internalisation of products have been discussed in the literature review of the thesis (see Section 2.4.2 of Chapter 2). It may be possible that the designs of the product itself such as interface layouts, menu structure and the representation of navigational information has an impact factor towards driver's satisfactions and product usability (Daimon et al., 2000, Heimgärtner et al., 2007, Lindgren et al., 2008, Heimgärtner et al., 2011).

This study is interested in the navigational information found on interfaces and the navigational instructions (pictorial or verbal), following the discrepancies in drivers' opinions of the road environment from previous studies (chapters 3,

4 and 5) and the type of navigational information selected whilst creating personal directional instructions (Mohd Hasni and Burnett, 2011). Despite the difference in modes of travelling between providing directions and following navigational instructions, the information in both situations referred to the roads and its adjacent environment.

For example, there is a large volume of published studies describing the role of landmarks in navigation (Lovelace et al., 1999, Michon and Denis, 2001, Burnett and Porter, 2002, Goodman et al., 2005, Hund et al., 2008). Moreover, *landmark* was one of the elements found in the previous direction-giving studies (Chapter 3 and 5) offering potential as a cultural indicator. Hence, the thesis needed another study to investigate drivers' cultural characteristics within the perspective of designs for navigational interfaces.

Exploration of potential cultural needs related to the design process of navigational interfaces in the present study utilised various natural scenes from culturally-different road environments. It is believed that reliable navigational information may differ across cultural groups and between different road environments. Therefore, this present study attempted to explore cultural values at the early stage of design using natural road scenes as scenarios. This information could determine potential cultural needs within the restriction of space of navigational interface. Furthermore, such information could be used as preliminary guidelines in design-building prototypes that considered drivers' cultural values.

6.3 Aim, Objective and Activity

Table 6.1: Summary of Overall Aim, Objective and Activity for Chapter 6

Overall Aim To explore potential cultural needs within the design of in-vehicle navigation systems				
Code	**Objectives**	**Code**	**Activities**	**Chapter**
O1		A1		3
O2		A2		4
O3		A3		5
O4	To understand cultural needs in drivers' expectations of navigational interface	**A4**	A scenario-based design study across UK and Malaysia in three culturally different environments, UK, Malaysia and Japan roads	**6**

To achieve the overall aim given earlier in section 1.9 of Chapter 1, the fourth specific objective (O4) was addressed in this chapter (see Table 6.1 above). A further four sub-objectives were also listed:-

1. Participant's requirement using the density of navigational information;

2. The influence of culturally different road environments;

3. The reliability of direction and landmarks across different culture and road environments;

4. The potential for other cultural needs from the sketch-interface

Hence, the fourth activity (A4) as given in Table 6.1 is reported in this Chapter.

6.4 Methodology

6.4.1 Justification for a scenario based design study

In relation to cultural patterns learned from the previous three studies, another study was constructed to transfer the knowledge onto designs of navigational interfaces. It was not feasible to directly transfer the knowledge onto culturally sensitive interfaces without understanding the underlying issues concerning design concepts for navigational interfaces.

Taken into consideration, the potentials cultural needs were found to originate from road environment, particularly roads that were local to the drivers: consequently, a scenario based study on culturally different surroundings was arguably the most appropriate method needed to understand drivers' cultural needs whilst engaged with navigation systems. A scenario based design study offer greater flexibility in designing a system by adopting a storybook style approach (Stanton et al., 2005). For this study, given the limitation of transferring the learned cultural patterns (from findings of Chapter 3 to 5) onto navigational interfaces, a blank interface and a pen offer a flexible approach for drivers to express their cultural needs. Hence, this study was designed to capture a participant's expectation of a navigational interface, while navigating in culturally different road environments. Although the approach is to utilise low-end tools of pen and paper, this methodology provides a flexible design approach and offers useful outputs. Moreover, designers are able to visualise how navigation information is represented on the interface itself. Additionally, this study has received an ethical approval from the Faculty Research Ethics Committee, University of Nottingham.

6.4.2 Study Procedures

The potential participants were briefed on tasks requiring completion for this study. Then, participants were seated at a desk that have a desktop computer, a 17 inch monitor, a mouse, five laminated A4-size blank navigational interface (see Figure 6.2 in p.167), three paper-maps with highlighted route of road environment used in the videos, a written scenario of study and three coloured non-permanent marker pens, a whiteboard eraser and a consent form. Next, participants were given a time to familiarise themselves with the control buttons of the software player used in the video task by viewing a short video of a road environment. During the familiarisation stage, participants were briefed again on how to create their preferred navigational interfaces using the marker pens and an eraser. They were also told that a complete sketch of navigational interface should be given to the Researcher immediately.

This was followed by a procedure where participants were asked to view a series of three videos and create their preferred navigational interface for the journey shown in each environment. Participants were told that to facilitate the process of creating their interfaces, they were given the allowance to pause and rewind the videos at any time during the task. The videos were shown to participants in a balance sequence and no association with name of a country or town names. Then, participants were interviewed for their opinions of the task and their cultural profile. At the end of the task, participants were informed to leave a contact detail if they wished to learn the outcomes of the study.

6.4.3 Participants background and choice of road environments

6.4.3.1 Participants cultural background

The choice of nationalities for this study was similar to the structured direction-giving study (Chapter 5), whereby selected participants were either Malaysians or British residents. Six participants were recruited through paper advertisements placed within the University of Nottingham. This study was designed to explore descriptively in depth underlying issues of drivers' behaviour in culturally different environments. Such exploration is needed to understand drivers' choice of navigational elements that is influenced by culture. Participants for both the UK group and the Malaysia group were students and staff of the University of Nottingham with more than 10,000 miles annual mileage and mean age of 31 years old (n=6). There were three participants (two females and one male) in each cultural group. Four of the participants had used vehicle navigation systems in their national roads (UK or Malaysia roads), whilst the remaining two participants (from the Malaysia group) had only used vehicle navigation systems on UK roads only, while holidaying to novel places in the UK.

The three participants from the UK group were frequent drivers who had little experience driving in other countries. One of the UK participants reported himself as a local resident who rarely drives outside of the Nottingham area. This participant mainly used his in-vehicle navigation systems (IVNS) to navigate to novel places in Nottingham and occasionally used it for leisure within the UK only. Meanwhile, the other two participants had some

experience in travelling outside UK road environments. However, none of the participants in the UK group had driven and used IVNS whilst abroad. They were generally passengers in vehicles (such as taxis or rented cars) while visiting other countries. In general, participants in the UK group had never lived outside the UK, particularly Malaysia and Japan.

On the other hand, the three participants from the Malaysia group had experienced travelling in the UK road environments due to their recent move to Nottingham to pursue their graduate studies at the University of Nottingham. However, the participants reported more experience driving in Malaysia road environment than in the UK. Furthermore, the participants in the Malaysia group had not been living in the UK for more than three years. During their stay in Nottingham, every participant had travelled back to Malaysia at least once for a holiday. In the unstructured interviews, the Malaysian participants indicated that their holiday in Malaysia were long term holidays during the summer break or a minimum of thirty days. Whilst holidaying in their hometowns, they reported that they were frequent drivers with an average of seven days a week.

Two of the Malaysian participants (both females) had never experienced using satellite in-vehicle navigation systems (IVNS) as an assisted driving tool in Malaysia. Instead, their experiences with IVNS were gained from navigating to novel places within Nottinghamshire. Meanwhile, the other participant (male) from Malaysia had experienced assisted driving in Malaysia and UK road environments. Based on the unstructured interview, the said participant had used global position satellite (GPS) software from the mobile phone to

navigate in Malaysia whilst in the UK road environment he had used the portable vehicle navigation system.

Despite the variation shown in both cultural groups, between assisted navigation and non-assisted navigation; and between experience in national and non-national road environments, every participant was familiar with IVNS and generally understood its basic functions. Participants in this study were not frequent users of vehicle navigation systems, particularly when travelling to a workplace, university and other common places such as shops near their living area.

6.4.3.2 Choice of road environment

The road environments used in this study were chosen to follow participants' nationalities in an effort to re-create the familiar surroundings of driving in their country. Therefore, each group had a 'local' road environment whereby the road environment, particularly signage and language were in their national language, and a 'foreign' road environment. In addition to these two road environments, another foreign road environment was introduced due to the fact that Malaysians in this study were residing in Nottingham, UK. The 'total' foreign road environment in this study was Japan roads. It was chosen given that the road environment had similar rule of the road which was left-hand traffic. Furthermore, Japan road environment was also part of the road environments used in the study design of structured direction-giving (Chapter 5). Moreover, some useful background information relating to Japanese car drivers were made known through the baseline studies, direction-giving (Chapter 3) and online survey (Chapter 4).

6.4.4 Study design

The scenarios for this study were created using video footages from the three road environments, UK, Malaysia and Japan roads. The video was recorded separately in each country, using a camcorder during clear daylight. The total length of the videos was approximately 5½ minutes. Each video showed natural driving conditions where road markings, road signage, road furniture, landmarks and other road users were present (as shown in Figure 6.1). Furthermore, the video in each environment were recorded according to a driver's normal front view whilst on the move.

The video captured the view of the road environment of a designated route. The route selected for each video was clearly highlighted within an accompanying paper map with a pointed arrow to reflect the direction of the car. The paper map was taken from the online Google map which was enlarged to ensure that the name of the Road Street signs were legible. However, none of the maps were provided with a length conversion scale.

The videos were created with natural road scenes in part of an effort to encourage participants to create their preferred interface for use in their personal vehicle navigation systems. Moreover, participants were also encouraged to design the navigational interface according to their requirements as to what, how and when information should be presented for the visual/voice display on the interface. Participants were given the freedom to sketch their requirements onto a blank navigational interface using coloured non-permanent pen markers (as shown in Figure 6.2).

Importantly, with the administration of a pen and paper as a tool in creating designs, participants had no limitation in the number of information and the representation of information. Upon completing the sketching task, participants were interviewed in a semi-structured way, for their views of the task and their cultural profile (age, gender, years of driving experience, annual mileage and experience using in vehicle navigation systems [IVNS]). Participants were also asked to answer, *"What are the information you constantly look for in the three road environments?"* and *"Name at least one thing that you would change in current IVNS designs"*. Participants' answers for the interview were recorded manually in a record booklet by the researcher.

Figure 6.1: Snapshots from the videos of UK, Malaysia and Japan roads

The quality of the video for Japan is relatively clearer than the videos for UK and Malaysia roads. Recordings in Japan used a high definition video camera whereas for the other two roads, the recordings used a standard video camera.

Despite this difference, road signs and markings in all videos were legible in the sketching task.

Figure 6.2: Showing blank navigational interface used in the present study

6.4.5 Implementation of the video task

Participants were required to view three videos of culturally different road environments. For each of the videos, participants were asked to create navigational interfaces according to their requirements. Participants were encouraged to identify their expectations of a navigational interface through inclusion of information they believed would be needed at the beginning of a manoeuvre, along the route and towards the late stage prior to the intended manoeuvre. Participants were provided with corresponding paper maps which had a highlighted route (marked with clear blue arrows from point A to point B) in each environment (as shown in Figure 6.3, Figure 6.4 and Figure 6.5). Furthermore, a written scenario was included in part to assist the participants in completing the video task successfully. The following written scenario was given to participants to read and understand prior to the start of the video task:

Figure 6.3: The highlighted route on the paper map for Malaysia roads
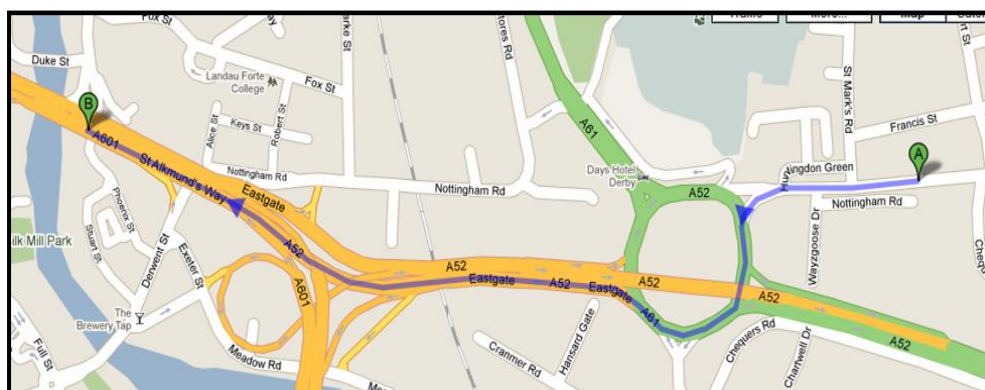
Figure 6.4: The highlighted route on the paper map for UK roads

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Figure 6.5: The highlighted route on the paper map for Japan roads

Every sketch was captured in a photo format using a digital camera and labelled according to the order sequence of when it was produced. The resultant sketches were grouped according to road environments for each participant.

At the end of the video task, participants were interviewed about their personal driving experience and views about the road environments shown in the video. Also, participants were asked about the information that they would have preferred to be included in a current navigational interface (as stated in section 6.4.2 of this chapter).

6.4.6 Analysis of data

Most of the data collected from this present study were subjective and descriptive. Furthermore, the number of participants per cultural group was insufficient for quantitative analysis. Therefore, none of the data were analysed using statistical software. Instead, the data were grouped according to the categorising scheme developed in another study by Burnett (1998) (see Appendix 3-2 for more details about the categorising scheme). Participants' opinions about their sketched interfaces from the post sketching interview were

also included. No specific analysis was applied for this interview due to small number of participants; however participants' age and annual mileage were averaged according to cultural groups (n=3/group).

6.5   Results

Reference was made to the categorisation scheme (Burnett, 1998) to identify the type of navigational elements between the two national groups. Each cultural group had a corresponding road environment as home environment and two foreign environments as tabulated in Table 6.2 which was similar to the variables in the structured direction-giving study (Chapter 5). Participants from both cultural groups (n=6) took between 30 minutes to 1½ hours to complete the sketching task and answer questions for the post-task interview.

Table 6.2: Cultural groups and their corresponding home and foreign environments

Group (n=3/group)	Home Environment	Foreign Environment	Foreign Environment
Malaysia	Malaysia Roads	UK Roads	Japan Roads
UK	UK Roads	Malaysia Roads	Japan Roads

6.5.1 Density of navigational information

The number of interfaces sketched by participants varied within and between cultural groups. In total, the Malaysia group had two times more of sketch-interfaces compared to the UK group (as illustrated in Figure 6.6 below). Meanwhile, between the culturally different road environments, the Malaysia group have shown a gradual decrease in the numbers of sketch-interface. The Malaysia group produced more navigational interfaces for their home environment when compared to the other two foreign environments (apart from

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P3 [Malaysia]). On the other hand, the UK group was more consistent in their numbers of sketch-interface between one to four interfaces across culturally different road environments.
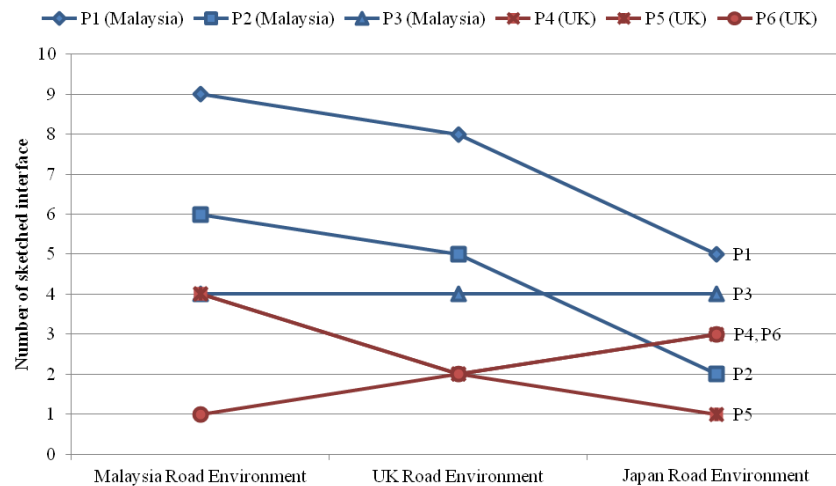
Figure 6.6: Showing the total number of sketched interface per participant

More importantly, the density of navigational information was generally higher in the Malaysia group than in the UK group (as shown in Table 6.3). The number of navigational elements noted from the Malaysia group was similar to the UK group, with eleven elements respectively out of 22 possible navigational elements from the categorisation scheme (Burnett, 1998). However, the types of navigational elements selected by each group members were not identical. *Local* and *prior turns* were not found in the Malaysians' sketched interfaces, while *class* and *Road Street name* were not noted in the UK group. The most frequently used element was *ego direction*, where participants either sketched arrows or wrote directions in relation to the driver's view.

Table 6.3: Showing the density of navigational information between Malaysia and UK across different road environment

Navigational elements	Malaysia Road Environment		UK Road Environment		Japan Road Environment	
	Malaysia (n=3)	UK (n=3)	Malaysia (n=3)	UK (n=3)	Malaysia (n=3)	UK (n=3)
Direction						
Ego	17	11	12	4	9	7
Local	-	-	-	3	-	-
Distance						
Absolute distance	9	3	7	-	3	1
Path (Road) [Environment]						
Class	1	-	-	-	-	-
Geometry	5	3	6	-	8	2
Lanes	4	-	5	4	1	-
Road-rules	1	-	1	-	2	1
Prior turns	-	1	-	1	-	-
Node (Junction) [Environment]						
Junction type	12	1	6	3	4	2
Landmarks [Environment]						
Name	5	-	2	-	4	1
Locators	7	-	3	-	5	1
References	-	-	1	1	-	-
Road/street signs [Environment]						
Road/street name	2	-	1	-	-	-
Overall Total	63	19	44	16	36	15

The participants in the Malaysia group also used more navigational elements in their home environment when compared with the other two foreign road environments (as illustrated in Figure 6.7). This gradual decreasing pattern was not visible in the UK group which showed a nearly consistent number of navigational elements used across culturally different road environments. However, the UK group utilised several different types of navigational elements in their sketch-interface for foreign road environments. For example, *absolute distance* and *geometry* were observed in the UK group only for sketch-interfaces in foreign roads (see Table 6.2).
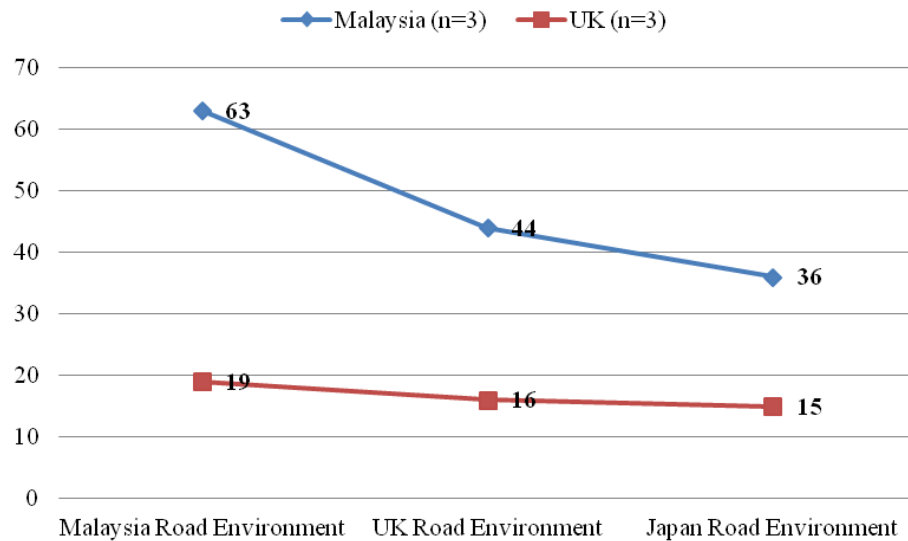
Figure 6.7: Showing the number of navigational elements

6.5.2 Structure of written navigational instructions

Participants were encouraged to include written navigational instructions in their sketch-interfaces which they would like to hear as voice prompts. Interestingly, not all participants believed such instructions crucial at every manoeuvre. The Malaysians in this study included more navigational instructions than the UK group. In total the Malaysia group used 36 prompts while the UK group used 20 prompts (as shown in Table 6.4). Repetitious instructions were observed in both groups, particularly close to approaching the next manoeuvre (for example, near junction types or when a change in the geometry of the road occurred). There was no clear definitive pattern observed in each cultural group with regards to the structure of these navigational instructions. However, there were few prompts which might have a 'localised' effect, such as in representing similar information at the junction type – roundabout and, in the system of measurement to indicate distances. More

detailed results on this point are given in the following two sub-sections, 6.5.3.3 and 6.5.3.4.

Importantly, the prompts showed discrepancies in the choice of words adapted for describing geometries of the road. In this group sample, the UK group used the phrase, *"Follow the road along"* or opted for pictorial representations of the path, while the Malaysia group used the phrase, *"Go straight on..."* Examples of these sketch-interfaces are shown in Figure 6.8.
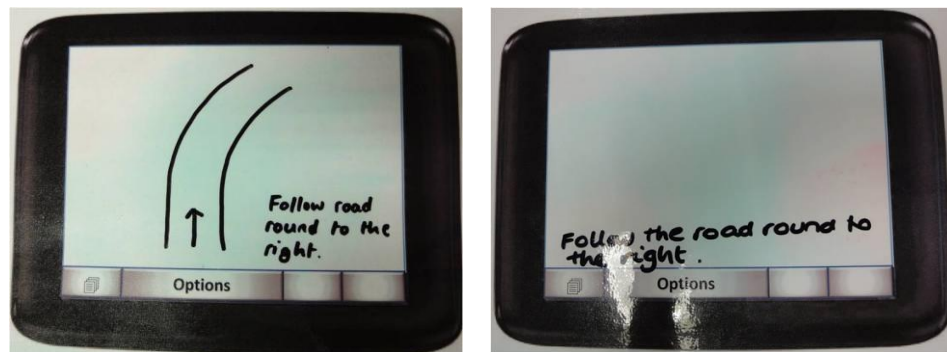
Samples of sketched interfaces from UK

Samples of sketched interfaces from Malaysia

Figure 6.8: Comparison of phrases used in navigational instruction between UK (top) and Malaysia (bottom)

Table 6.4: Showing the voice/written navigational instructions used between Malaysia and UK across different road environment

Associated navigational instructions	Malaysia Group (n=3)	Associated navigational instructions	UK Group (n=3)
Malaysia Road Environment			
Malaysian 1	Go straight on	British 1	Take the first left
	Keep left		Turn left
	Go straight on & keep left		500 yards take first right
	Go straight on & keep left. In 500m turn left	British 2	Follow the road round to the right
	Keep left. In 200m, turn left		Turn left in 100 yards / 50 yards. Turn left
	Turn left		Turn left in 100 yards / 50 yards. Turn left
	Go straight on		Turn right at the next junction
	In 500m, turn right	British 3	**No associated navigational instructions*
	Turn right		
Malaysian 2	Caution! Three lanes to one lane		
	Caution! Approaching school, low velocity		
Malaysian 3	Go straight 500m		
	Turn left in X m		
	At junction, take a left X m		
	X m till you arrive at destination		
UK Road Environment			
Malaysian 1	Go straight on	British 1	At island take the 3rd exit
	After traffic light, keep left		Keep right
	In 200m, there's a roundabout	British 2	"On a roundabout with several lanes, the Sat Nav should tell you which lane(s) you can take"
	Go left at the roundabout		
	Keep left, in 500m turn left		"When the road divides in two, the Sat Nav should tell you to keep right or left as appropriate"
	Turn left		
	Keep right		
	Go straight on		
Malaysian 2	Keep right	British 3	Continue through pedestrian crossing lights to roundabout
Malaysian 3	Go straight X m till roundabout, take the 9 o'clock		
	Take the turning into Eastgate St. and keep right for X m for the right turn		Upon exiting the roundabout, take the road to the right - get in the right lane
	Continue for X m till destination		Road passes under 2 road bridges
Japan Road Environment			
Malaysian 1	Go straight on	British 1	Follow road along
	Go straight on		Carry on along
	Go straight on		Continue straight ahead
	Go straight on	British 2	Turn left in 100 yards / 50 yards. Turn left
	Go straight on		Warning: be aware of road on left
Malaysian 2	Keep left	British 3	Follow road to right in front of 'landmark'
Malaysian 3	Continue till bend		
	Continue X m ahead		
	X m from destination take the right bend		

6.5.3 Driver's requirement in culturally different environment

6.5.3.1 Similarities in representation of ego direction

Visual comparisons were made between the Malaysia and the UK cultural groups. There were similarities across the cultural groups in the way *ego* directions were presented to indicate the direction of the manoeuvres. Two common representations were pointed arrows and written instructions. Examples of these sketches are shown in Figure 6.9.
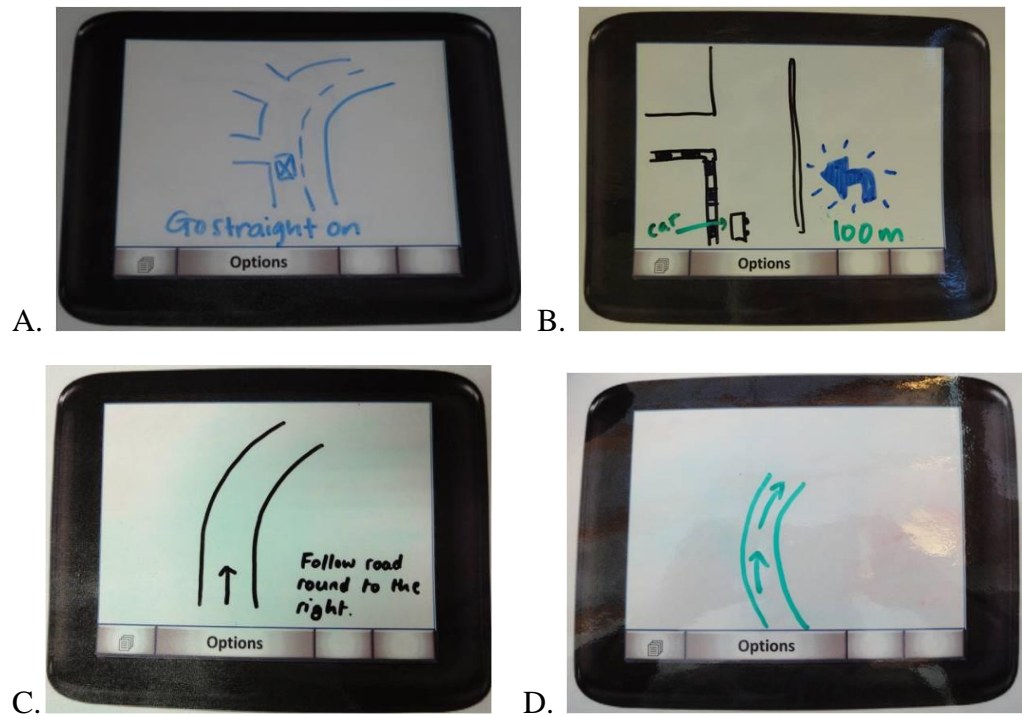
A: a Malaysian in Japan Roads,
B: a Malaysian in Malaysia Roads,
C and D: British participants in Malaysia Roads

Figure 6.9: Examples of *ego* direction representations

6.5.3.2 Differences in representation of landmarks

Landmarks that were visible in the videos were more often described as *locator* by the participants in this study compared to *name* and *reference*. Visual inspection of all sketched interfaces between the two cultural groups showed that these selected *locators* were mainly presented in pictorial format, while a few of the *locators* were a combination of written and pictorial formats. The illustration of each *locator* varied in its simplification from the real landmark. For example, rows of shops were drawn as small icons of squares and large buildings were pictured as house icons. Importantly, one of the participants from the Malaysia group reported a greater conformity and satisfaction if

recognisable landmarks were included in personal in-vehicle navigation systems (IVNS). When interviewed further concerning the type of landmarks preferred, the said participant informed that 'global' landmarks such as the Ford logo sign that was available alongside a Japan road from the video. Examples of the above sketched interfaces are shown in Figure 6.10.
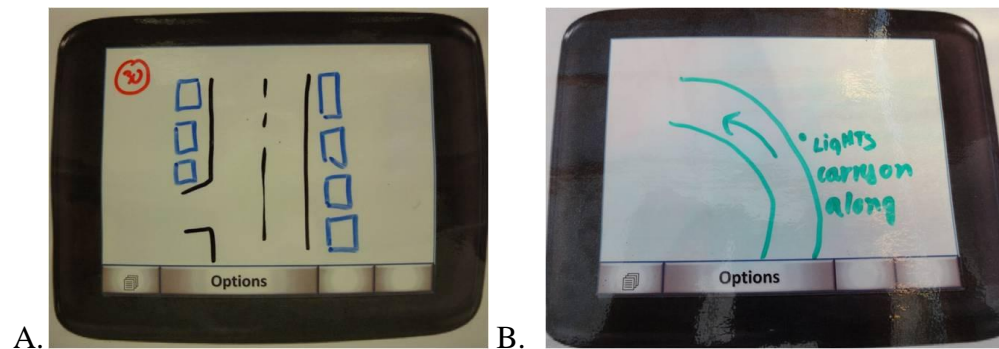
A. B.

Samples of sketched interfaces from Malaysia

C. D.
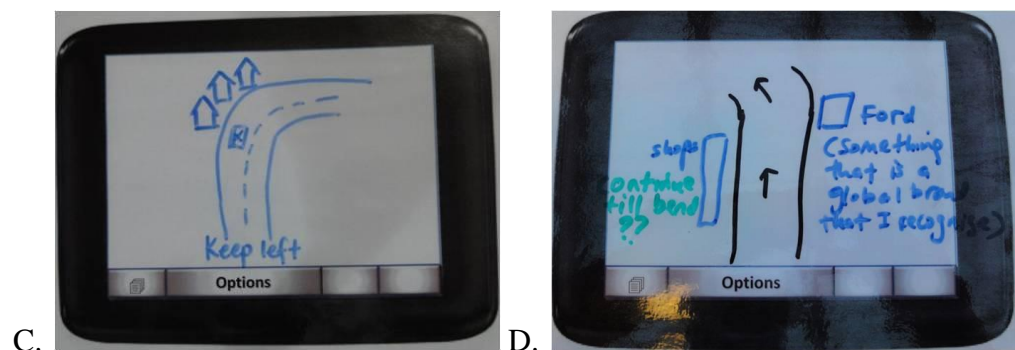
Samples of sketched interfaces from Malaysia

Figure 6.10: Examples of *locators* found in the study across culturally different environment

The visual analysis also scanned for the presence of landmarks that were local to the cultural groups. One local landmark, a mosque (masjid) was present in the video of the Malaysia roads. This landmark was also marked and labelled as 'masjid' on the paper map. The UK group did not use the mosque as a landmark in their navigational instructions. On the contrary, two participants

from the Malaysia group selected this local landmark as a *locator* (as shown in Figure 6.11). However, the mosque was not part of any written instructions, instead it was represented in pictorial format.
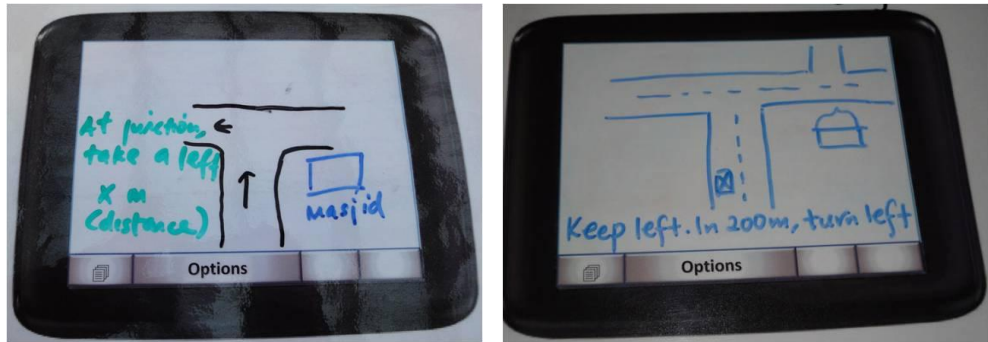
Figure 6.11: Examples of local landmarks from the Malaysia group

6.5.3.3 Differences in representation of junction type – roundabout

Apart from direction and landmarks, differences were also observed in the representation of roundabout junctions which appeared in the UK roads video. Visual inspections of the sketched interfaces showed that a British participant used a common local term which was 'island', in referring to the roundabout. Furthermore, this participant also used *prior turns*, whereby the number of exits at the roundabout were counted and used as a reference number in the navigational instruction to turn out at the junction. This British participant indicated the following instructions, *"Take the 3rd exit"* (Figure 6.12).

Moreover, two out of three British participants used *local* directions (for example, *"upon exiting..."* and *"...the 3rd exit"*) to indicate manoeuvring out of a roundabout junction (Figure 6.14). None of the UK participants used ego directions as part of their navigation instructions for roundabout junction. Meanwhile, the use of *lane* element was also noted in both the UK and the Malaysia groups.

Interestingly, a Malaysian participant perceived the roundabout as a clock face whereby exiting the junction followed the position of the exit road on the clock face. This Malaysian participant used the phrase *"9 o'clock"* as indication for which road to take at the roundabout junction (Figure 6.12). Meanwhile, other Malaysian participants used *ego directions* such as 'turn left at the roundabout' and *lanes* where information about the correct lane was given in order to exit the roundabout (Figure 6.13). The *ego direction* elements utilised for this roundabout were represented on the blank interface either with a pictorial arrow on the roundabout's icon or written in the navigational instruction. Examples of the above sketched interfaces are shown in Figure 6.12, Figure 6.13 and Figure 6.14.

Figure 6.12: The use of island as instruction in UK samples (left) and the use of clock face as instruction in Malaysian sample (right)

Figure 6.13: Pictorial icon and *ego* direction representation of a roundabout (left) and written *ego* direction in instruction (right) from the Malaysia group

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Figure 6.14: Written local direction representation of a roundabout from the UK group

6.5.3.4 Differences in system of measurement for absolute distance

The Malaysian group used a metric system of measurement to indicate distance in metres (m), while the UK group opted for imperial systems (yards) (as shown in Figure 6.15). Examples of phrases observed in this study were, *"...in 500m, turn left"* and *"turn left in 100 yards..."* One Malaysian participant used the letter 'x' to replace numbers and associated it with 'm' (metres). These *absolute distance*s were how the participants' perceived the distance in the environments, from the video task, given that the actual scale conversion was not included in the respective paper maps.
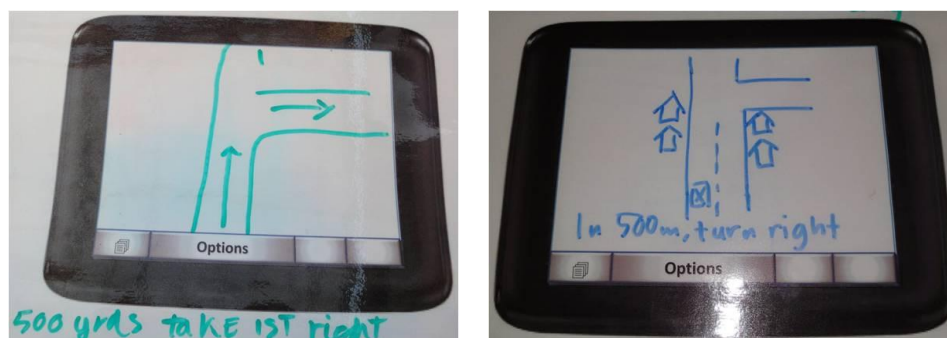
Figure 6.15: Comparison of *absolute distance* between UK (left) and Malaysia (right)

6.6   Discussion

The effects of culture on drivers were investigated in the two baselines studies (non structured paper-based direction-giving study and online survey) described in Chapters 3 and 4. Meanwhile, the importance of culturally different road environments was addressed in the structured paper-based direction-giving study (as described in Chapter 5). The argument of national identities by Edensor (2004), and the perceived existence of national driving styles (as described in Chapter 4) in part, explained the importance of exploring cultural needs from drivers' behaviours. The literature review revealed little research on the question of cultural importance in global products such as in-vehicle navigation systems (Daimon et al., 2000, Heimgärtner, 2007b). The current study aimed to assess the reliability of these cultural needs as related to the design process for navigational interfaces. Given that these cultural needs were discovered through a series of iterative direction-giving studies (Chapter 3 and 5), further exploration was needed to understand their characteristics within the perspective of designs for navigational interface. Furthermore, the study also aimed to discover other potential cultural needs. The results indicate that there are differences between the two cultural groups, consistent with the findings from previous studies.

6.6.1 Differences in density of navigational information

The density of navigational information observed in the Malaysia group in this present study was generally more than the UK group. The Malaysia group in this present study used the same type of navigational elements for their sketch-interface (see Table 6.3) with a general decrease in the number of occurrences

for each element in the foreign environments. The Malaysia group mainly used a combination of *ego direction*, *absolute distance*, *geometry*, *name* and *locator* to construct their navigational instructions and sketch-interfaces. This combination was sufficient to support navigation in foreign environments due to the trueness of the said elements. As an example, *locator* is probably the next best option in culturally restricted situations, particularly when landmarks have no known attachment to social meanings (Edensor, 2004) to the drivers.

On the contrary, there was a slight difference in the type of information the UK group used between home and foreign environments. For example, *absolute distance* and *geometry* were observed in the UK group only for sketch-interfaces in foreign roads, while the *local* direction and *reference* landmark were particularly present in the home environment (see Table 6.3). This resulted in the UK group showing little changes in the information density for home and foreign environments. Similarly, this horizontal pattern was also observed in the UK group from previous study (compare Figure 5.13a of Chapter 5 with Table 6.3 of this Chapter). A generalisation to emerge from such a finding might be that UK drivers use nearly similar number of information in navigation, and perceive a need for different types of navigational elements between home and foreign environments.

It is believed that when placed in a foreign environment, participants (both UK and Malaysia groups) have limited cultural information such as the local public images (Lynch, 1960), social meanings of landmarks (Edensor, 2004) or laws of the local traffic systems (Huang et al., 2006). This was exemplified in this study when the Malaysia group used similar types of navigational elements,

such as *ego* directions and *locator* landmarks, for both home and foreign environments. However, the total number of elements included for foreign environments were generally small when compared to home environment, despite the fact that both home and foreign have similar number of turning points. On the contrary, the UK group used different types of elements between home and foreign environments. For example, *reference* landmarks and *local* directions were used for home environment while *ego* directions and *locator* landmarks were used for foreign environment. When the total numbers of elements were added up in both situations, the numbers were within a close range (as shown in Table 6.3).

The findings of this present study and other previous studies (Figure 5.13a of Chapter 5) are consistent with those of Heimgärtner (2007a) who found differences in the density of information through the number of Points-of-Interest (POI) (between low and high) noted across three cultural groups, China, England and German. According to Heimgärtner (2007b), culturally-different participants showed different preferences in the amount of POI needed in the map display test task. Following this, the density of information was listed as a potential cultural interaction indicator for interaction between participants and computer (Heimgärtner, 2007a, Heimgärtner, 2007b).

These findings are confirmed by the results of this study (see Table 6.3) and have important implication to the designs of culturally-aware navigational interfaces for in-vehicle navigation systems. The future designs need to consider drivers' cultural limitation in the overall density of information accordingly. Such a design approach could enhance a driver's safety and

drivers' satisfactions. Nevertheless, given that this cultural exploration was aimed at the early stage of the overall designing process, further work is needed to test the validity of preferences in density of information across different cultural groups.

The numbers of sketched interfaces across the two cultural groups showed similar patterns (general decrease in the Malaysia group between home and foreign environments and a consistent number of sketch-interface in the UK group). The visual observations of these sketch-interfaces across the cultural groups showed that the Malaysia group required more interfaces to confirm a turning on the final approach of a manoeuvre. Such a finding was similar to those reported by Heimgärtner (2007b) who found the China participants in his study required 30% more advice messages prior to a turning than the Germans and British participants. Heimgärtner argued that differences in requesting advice messages described another prevalent cultural characteristic of information density (between low and high).

6.6.2 The influence of culturally different road environments

A factor explored in this study was the influence of culturally different road environments on drivers' behaviour. The natural scenes of culturally different road environments used in this study explored driver's needs whilst engaged with in-vehicle navigation systems. This is shown in the similarities and differences in the way information along the designated route was represented in participants' sketch-interfaces. It was evident in this study that perceived 'good' navigational elements are generally different across cultural groups.

Nevertheless, the influence of culturally different road environments was observed in the Japan roads. Five out of six participants in this study did not sketch many interfaces for this foreign environment (between one to five interfaces) which were comparatively less than the number sketched for other environments (between one to nine interfaces) (as illustrated in Figure 6.6 of this chapter). One possible explanation was the cultural restrictions, given that the Japan roads and Japan paper map were mainly visible to the participants in the Japanese language. Interestingly, participants mentioned to the researcher how the abundance of repetitive information (visible in the video and paper map) helped in assisting the road journey. For example, there were six instances of road signs (one from road map and five from the video) indicating the right bend would take drivers to Route no. 31 (marked with the red squares in Figure 6.16 below).
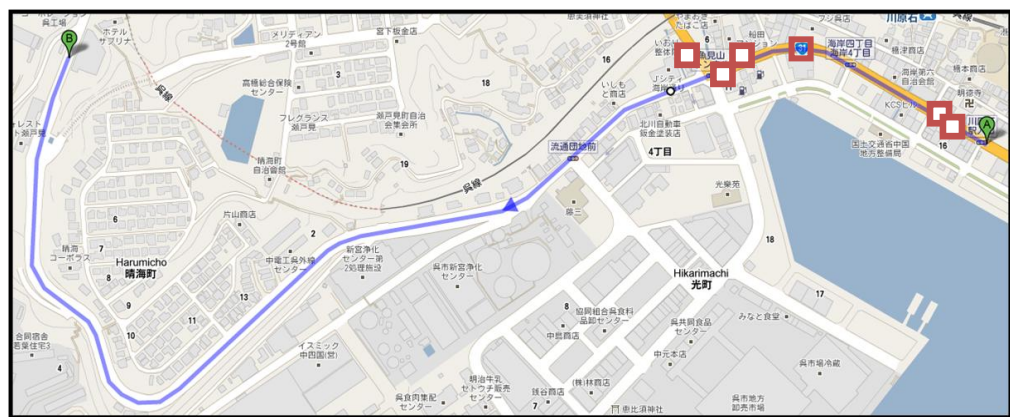
Figure 6.16: Red squares showing places of repeated road signs "Route no. 31" in the Japan roads

This repetitive navigational information could be linked to the cultural dimension, *uncertainty avoidance* (Hofstede et al., 2010) which is considered to be high in Japan. According to Hofstede et al. (2010) high uncertainty avoidance refers to cultural groups that tend to avoid uncertainty in life by

defining items in great detail. With regards to implications in designs, it is possible that drivers navigating in a foreign environment that is particularly high in uncertainty avoidance could comfortably navigate without much assistance from the in-vehicle navigation systems as the road environment itself provides ample information to assist the journey.

Conversely, when engaged with in-vehicle navigation systems manufactured from a high uncertainty avoidance nation, such as Japan, drivers could possibly be faced with complex interfaces which could be unsatisfying to drivers that do not require high density of information. Nevertheless, such statements are not conclusive given that the number of participants in this study was relatively small. Further clarification is required in a quantitative study to determine the extent of drivers' satisfaction.

6.6.3 Exploring potential cultural needs

The published cultural dimensions such as *power distance* (Hofstede et al., 2010) and *high context* (Hall and Hall, 2001) were able to predict user interaction behaviour with web pages (Marcus, 2005, Ahmed et al., 2009). Also, these cultural values were successful when applied in part as a tool to create driver information systems (Heimgärtner, 2007a) yet they were not able to investigate the potential of culturally different road environments. Furthermore, such cultural dimensions were not sufficient in explaining cultural characteristics in drivers whilst engaged with in-vehicle navigation systems on actual roads. For example, high power distance values embedded in Malaysians were not transparent in justifying the choice of navigational elements from culturally different road environments as noted in the studies

from this thesis. The proposed guidelines for high power distance developed elsewhere (Ahmed et al., 2009) were insufficient for navigational interface. Nevertheless, these cultural dimensions could be used, in part to explain the high density of information required by the Malaysia group.

It is believed that an exploration of cultural needs for in-vehicle navigation systems requires the categorisation scheme (Burnett, 1998) alongside published cultural values (Hofstede et al., 2010, Hall and Hall, 2001). The categorising scheme is needed to determine the types of navigational element extracted from road environments. In part, this study aimed to explore the consistency of two potential cultural needs, direction and landmarks (*name*, *descriptor*, *locator* and *reference*) discovered from previous research (see Chapters 3 and 5).

6.6.3.1 Exploring the reliability of directions and landmarks

Direction (ego and local)

Depending on its context of use, directions can be transformed into three navigational elements, *ego*, *local* and *global* (Burnett, 1998). The two cultural groups opted for *ego* directions for most of their sketch-interfaces. The present findings seem to be consistent with previous direction-giving studies of this thesis (Chapter 3 and 5) between UK and Malaysia. The consistency shown in the use of *ego* directions increases its suitability for structuring potential cultural needs across cultural groups.

Furthermore, previous studies in this thesis have suggested that UK participants were more likely to include local directions for UK roads,

particularly at specific junction types such as roundabouts (see section 5.6.3 of Chapter 5). In this present study, such characteristics of local directions were observed at the roundabout junctions in the UK roads. The UK group were more likely to use the word 'exit' for roundabouts rather than 'right' or 'left'. It may be possible that the UK participants were unable to use local directions, as much as ego directions due to the lack of perceived 'good' navigational elements in the video for local directions. Further exploration is needed to clarify the suitability of local directions as demonstrated in this present study and two earlier studies (Chapters 3 and 5).

A strong relationship between the effectiveness of navigation and landmarks has been reported in the literature (Lovelace et al., 1999, Burnett, 2000, Michon and Denis, 2001, Burnett et al., 2001, Goodman et al., 2005, Hund et al., 2008). However, the argument about cultural values of landmarks has not been discussed in great detail in previous work. In this present study, the use of landmarks was assessed to determine their cultural characteristics to understand the suitability of landmarks from a cultural perspective.

Landmarks (name, locator, descriptor and reference)

Landmarks information was categorised into four elements, *name*, *locator*, *descriptor* and *reference* based on their contextual use (Burnett, 1998). Previous direction-giving studies (chapters 3 and 5) suggested common usage of these four elements across the cultural groups. The present findings did not show common use of all four elements as *descriptor* was not observed in any sketch-interface. A possible explanation for this discrepancy is the lack of adequate landmarks in the video. Nevertheless, the present study observed

pictorial used of landmarks (*name, locator* and *reference*) across the cultural groups.

It is encouraging to compare the use of pictorial landmarks with those found in earlier studies (Chapter 3 and 5). *Locator* was first found significant in the baseline direction-giving study (Malaysia, UK, Japan and China groups in UK roads) (see Table 3.3 of Chapter 3). Then, in the subsequent structured direction-giving study (Malaysia and UK groups in Malaysia, UK and Japan roads), *descriptor* and *locator* were found significant only in Malaysia and Japan roads (see Table 5.5 in Chapter 5).

Finally, in the sketch-interface exercise of this study, *name*, *locator* and *reference* were not always included within the written navigational instructions. Instead these landmarks were represented in pictorial format. These findings taken as a whole (that of the present study and those of described in Chapters 3 and 5), although preliminary, suggest that participants valued landmarks differently across cultural groups. It seems possible that these findings are showing culturally-influenced characteristics of landmarks amongst cultural groups and across culturally different roads.

Importantly, culturally different roads showed an effect of 'local' landmarks in the Malaysia sketch-interfaces. Two out of three participants selected mosque (masjid) from the road environment and represented the mosque (masjid) as a pictorial *locator* on the sketch-interface. Mosque (masjid) is a typical feature in geographical areas that is dominated by Muslims. Since the majority population in Malaysia is Muslim, the generic icon or building features of a mosque is known to Malaysians. On the contrary, none of the UK participants

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included this salient landmark, despite its availability on the paper map and visibility in the video.

This nation-specific landmark was one of many issues raised by Burnett (2000) in predicting good landmarks. Justification of good landmarks requires knowledge of its specific attributes (Burnett, 2000) which would increase a landmark's legibility. As an example, the mosque was selected because of its salient character and social meanings in Malaysia. However, such attributes are not always transferable to another cultural group such as UK when Muslim population in UK are relatively small compared to Malaysia. However, a driver's choice of information from the environment is perceived as 'good' for navigating the said environment. It is believed that for nation-specific landmark such as the mosque could be considered as a potentially 'good' cultural-specific landmark.

The data collected throughout this thesis does show consistency in the potential of landmarks as cultural needs. The cultural groups in the present study and other studies within this thesis did show promising variation in patterns in perceiving landmarks (such as preference to use *reference* over *locator* across different cultural group). These results however need to be interpreted with caution. Issues pertaining to 'good' landmarks need further exploration to understand the attributes of cultural-specific landmarks.

6.6.3.2 Exploring other potential cultural needs

Roundabouts

Apart from *ego* directions and landmarks, this study also aimed to explore other potential cultural needs. One interesting finding was in the representation of roundabouts between the two cultural groups in this study. The UK group were observed to associate roundabouts with local direction and prior turns. The word 'exit' was used to indicate turning off the roundabouts, while adjacent junctions around the roundabout was referred to in numbers. Hence, an indication to take a right at the roundabout is analogous to 3rd exit for a four-legged intersection roundabout. This finding is consistent with those found in a previous study of this thesis (see section 5.6.3 of Chapter 5). It seems possible that these results are due to cultural values embedded in drivers given that this specific junction type is a common feature in the UK road environments.

Meanwhile, the Malaysia group used a variety of navigational elements to describe how to negotiate roundabouts. The most common element was *ego* direction and *lane*. Other interesting phrase found in this study was the use of clock face to indicate a turning at roundabouts. There was no literature (to the author's knowledge) to support this finding. Therefore, use of clock's arm to indicate point of exit that was discovered in the Malaysia group could be an influence of national culture in navigation. In summary, it seems possible that socio-cultural context had affected driver's perception in manoeuvring at roundabouts.

Metric vs. Imperial absolute distance

There was a clear difference between the two cultural groups in the system of measurement used for *absolute distance*. This finding is in agreement with Srinivasan's (1999) findings which discussed human factors issues including driver's preferences in unit of measurement.

Structure of written navigational prompt

The results in this study indicate discrepancies in the choice of words adapted for describing road geometries. This was exemplified in one section of a long road in Malaysia where the geometry of the road curved to the right. The geometry representations of this section were almost identical across the two cultural groups (five out of six participants). Interestingly, the structure of words clearly shows two sets of potential navigational instructions *"Follow the road along"* and *"Go straight on..."* Issues in the use of phrase which led to incorrect goal formation for similar geometry of road were noted by Curzon et al. (2002) as described earlier in section 2.2.4 of Chapter 2.

6.7 Limitations in study

The study is limited in two apparent ways. First, the numbers of participants for each cultural group were relatively small which restricted the analysis to descriptive analysis. Secondly, participants in this study exploration were considered as representatives for Malaysia and UK which overlooked the needs of specific groups within a nation such as elderly and young drivers.

6.8 Implication for designs

This descriptive scenario-based study has enabled greater understanding of driver's cultural needs for a navigational interface. Every participant was able to demonstrate cultural pattern for information density and types of navigational elements (i.e. landmarks, node and path). Importantly, participants were also able to demonstrate a cultural pattern for structure of written navigational prompt. The findings of this study increases the needs to consider having a one-design concept for a global product (such as sample interfaces described in section 5.8 of Chapter 5).

Another important implication for designs of navigational interfaces is density of information within an interface. Sample interfaces of current nomadic in-vehicle navigation systems (IVNS) for Japan market and UK market is shown in Figure 6.17. Comparatively, the navigational information in Image A is higher in density than the information displayed in Image B. A Japanese tourist travelling with a hired car with a nomadic IVNS may have experience a lower satisfaction in driving experience due to insufficient navigational information (from both the navigational interface and UK road environment). Reflecting onto one of the findings in section 4.9.3 of Chapter 4, the local Japanese from that survey have perceived non-navigational item such as dictionary as more useful when travelling abroad. On the other hand, a British tourist may not be comfortable with the density of navigational information displayed in nomadic IVNS for Japan roads. The description analysis of this current study has shown participants placing a limited number of navigational information onto their sketched interfaces. It is believed that Japan road environment has redundant

information their roads which may be sufficient for foreign travellers (see Figure 6.16 in section 6.6.2 of this Chapter)

Figure 6.17: Samples of current nomadic IVNS interfaces for Japan market (left) and UK market (right)[9]

6.9 Conclusion

- The result of this study suggests needs to consider the cultural effects of information density on navigational interfaces. The Malaysia group showed changes in total number of navigational elements between home and foreign environments. Meanwhile, the UK group used nearly similar total number of navigational elements but applied different types of elements between home and foreign environments.

- Participants' sketched interfaces suggest that navigation in a foreign environment particularly high in uncertainty avoidance value (for example Japan) could enable drivers to comfortably navigate with reduced assistance from in-vehicle navigation systems (IVNS). This is

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[9] All images were last assessed on the 23 September 2011. Sources of images:

    A. http://www.houseofjapan.com/electronics/mitsubishi-bdnav-system
    B. http://pda-gpsnav.bestproductsreview.net/2010/07/12/garmin-nuvi-265w-gps-navigator-review/

predicted because the road environment itself has in itself ample information to assist the journey.

- Based on participants' needs (from their personal sketched interfaces) in Japan road environment, it could be hypothesised that drivers using IVNS manufactured from a high uncertainty avoidance nation, such as Japan, could be exposed to complex interfaces which could be unsatisfying to drivers that do not require high density of information.

- *Ego* directions were consistently used by all participants. Taken together with previous studies of this thesis (Chapter 3 and 5), these findings suggest the role of ego direction as the basic navigational element required for navigation in all contexts, particularly in exploring characteristics of cultural needs.

- *Local* directions were consistently associated with roundabouts junctions by the UK participants. This finding was also observed in Chapters 3 and 5

- Landmarks were also consistently used by all participants. Taken together with previous studies in this thesis (Chapter 3 and 5) and elsewhere (Burnett et al., 2001), these findings suggest the role of landmarks as the basic navigational elements required for navigation in all context, particularly in exploring characteristics of cultural needs.

- The cultural groups in this study indicated preferences in the unit of measurement for absolute distance. This finding suggests the need to consider systems of measurement in each nation as part of cultural indicator for distance.

- Findings in this study and those of previous studies (chapter 3 and 5) show that participants value landmarks differently across cultural groups. It seems possible that these findings are showing characteristics of culturally-influenced landmarks. Nevertheless, careful considerations are needed to address nation-specific landmarks in identifying 'good' landmarks. Hence, issues pertaining to 'good' landmarks need further exploration to understand the attributes of cultural-specific landmarks.

Chapter 7: Thesis conclusion and future work

7.1   Introduction

The previous chapters of this thesis have discussed and described a literature review, together with a series of four studies that have employed quantitative and descriptive methods. The overall aim of the thesis was to explore characteristics of potentials cultural needs for in-vehicle navigation systems (IVNS) (Figure 7.1). To achieve this, a set of objectives and corresponding activities were structured (Table 7.1).

In general, the thesis has demonstrated an exploration of drivers' behaviour by employing a bottom-up approach with a combination of mixed methods. A potential cultural framework was proposed for consideration as a tool in defining cultural needs. Such knowledge is essential for designing prototypes of culturally-sensitive navigational interface. Cultural groups were also generalised, according to the density of information displayed on the navigational interface. Apart from that, other prevalent cultural issues were also highlighted for further exploration.

Aim

To explore potential cultural needs within the design of in-vehicle navigation systems

Objective

To generate an understanding of cultural needs using elements deriving from drivers navigating in a road environment across national cultures

To understand cultural needs via perceptions of local drivers from different national cultures about differences in driving behaviour

To generate a cultural understanding from drivers' navigation strategies in culturally different environment

Tounderstand cultural needs in drivers' expectations of navigational interface

Activity

A direction giving study across UK, Malaysia, Japan and China

Online questionnaire across UK, Malaysia and Japan

A structured direction giving study across UK and Malaysia in culturally different environments, UK, Malaysia and Japan roads

A scenario-based design study across UK and Malaysia in three culturally different environments, UK, Malaysia and Japan roads

Figure 7.1: Illustration of aim, objectives and activities of the thesis

Table 7.1: Overall Aim, Objectives and Activities

Overall Aim To explore potential cultural needs within the design of in-vehicle navigation systems				
Code	**Objectives**	**Code**	**Activities**	**Chapter**
O1	To generate an understanding of cultural needs using elements deriving from drivers navigating in a road environment across national cultures	A1	A direction giving study across UK, Malaysia, Japan and China	3
O2	To understand cultural needs via perceptions of local drivers from different national cultures about differences in driving behaviour	A2	Online questionnaire across UK, Malaysia and Japan	4
O3	To generate a cultural understanding from drivers' navigation strategies in culturally different environment	A3	A structured direction giving study across UK and Malaysia in culturally different environments, UK, Malaysia and Japan roads	5
O4	To understand cultural needs in drivers' expectations of navigational interface	A4	A scenario-based design study across UK and Malaysia in three culturally different environments, UK, Malaysia and Japan roads	6

Table 7.1 provided a coding system for every objective and activity in this thesis. In the effort to map on how the structured objectives were complimented with its associated activities. As an example, O1 was achieved via A1 and the findings were reported extensively in Chapter 3. A summary of every finding for A1 to A4 is provided in section 7.3 to section7.7 of this Chapter.

This chapter aims to discuss the findings of all studies in this thesis collectively in an effort to show the overall exploration outcome of driver's cultural needs for an in-vehicle navigation system (IVNS). The outcomes that have emerged from the thesis are:

- Potential cultural characteristics, derived from original categorising scheme by Burnett (1998);

- Potential cultural characteristics for density of navigational information displayed on IVNS interfaces;

- Cultural issues for roundabout junctions; and

- Cultural issues in navigating curved roads.

The chapter begins with a brief summary of the literature review, followed by issues relating to methodology encountered while conducting the initial study plan for this thesis. To demonstrate this, the discussion was focussed on how a combination of mixed methods formed an iterative process for exploring driver's cultural needs. To demonstrate further the issues, the basis of utilising Hofstede's cultural dimensions in exploring driver's cultural needs for navigation was also included in this section. Then, a proposal of cultural framework was discussed in greater detail in the subsequent section as one of two emerged items for driver's cultural needs for IVNS.

Another synthesised finding relating to potential cultural characteristics of information density was discussed in the following section. Several other cultural issues such as roundabout junctions and navigating bend roads were

discussed in the next section, and highlighted as future exploration for use in in-vehicle navigation systems. To assist designers in utilising the proposed cultural framework, a handful of possible prototypes were designed and discussed in a subsequent section about suggestions for future work.

7.2 Overview of literature review for driver's cultural needs
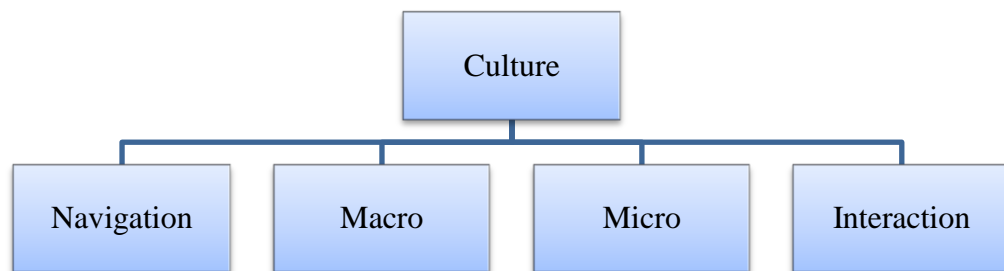
Figure 7.2: Thematic areas affected by culture

The focus of the review was to understand how issues relating to culture in human factors knowledge for in-vehicle navigation systems (IVNS) were addressed in understanding drivers' behaviours. The review has shown extensive amount of research that focuses on differences in drivers' behaviours. Culture was found to have been affecting drivers' behaviours, which could be grouped into four overlapping entities, navigation, macro entry level, micro entry level and interaction behaviour (as illustrated in Figure 7.2).

Comparative studies conducted across nations under the 'navigation' entity have demonstrated how drivers were affected by various issues including environmental layouts (Davies and Pederson, 2001), mental models (Knapp, 2007) and verbal directions (Lovelace et al., 1999). These differences were noted at national entry level which overlapped with the 'macro' entity whereby

drivers' behaviours were studied comparatively across nations. Moreover, road environments were found as having an influence on drivers' styles in navigation across nations. Examples of differences reported in the literature were in relation to behavioural characteristics (differences between Japanese and Swedish in the work of Daimon et al., 2000) and road traffics (differences in driver's perceptions due to different traffic situations in the work of Lindgren et al., 2008).

The literature review has found promising evidence on potential cultural needs across national cultures within 'navigation' and 'macro' entities. However, there was a substantial amount of research claiming differences in navigation at individual level (such as age and gender in the work of Carpenter et al., 2004). Studies reporting such differences were grouped as 'micro' entity whereby research was focussed at a particular group of people or driver's ability at individual levels. Examples of 'micro' research were different designs of in-vehicle navigation systems (IVNS) for the elderly (Zhao et al., 2006) and gender differences in navigation (Lawton, 2001, Lawton and Kallai, 2002).

The final entity, 'interaction' was referring to drivers' interaction behaviour when engaged with user interfaces. The literature showed drivers' interaction behaviour with navigational interfaces differed at national level in numbers of Points-of-Interest (POI) along the route and numbers of advice required prior to change-of-directions (Heimgärtner, 2007, Heimgärtner et al., 2007).

Due to culture's wide ranging definitions (Kroeber et al., 1952), issues as reported in the literature existed in driver's behaviour at various entities. As an example, an elderly driver from UK may be examined according to age (aging

culture in drivers) or by national culture (British drivers). These differences in drivers' behaviours have raised concerns over the use of global products such as nomadic IVNS which often have similar features and styles of displaying navigational information (refer to Figure 5.15 in section 5.8 of Chapter 5). Therefore it is believed that a gap existed within the literature in explaining driver's cultural needs for in-vehicle navigation systems (IVNS). In the effort to improve driver's satisfaction when engaged with IVNS, a combination of mixed methods was constructed iteratively to explore for driver's cultural needs.

7.3   Summary of participants' key characteristics

The four studies in this thesis have managed to recruit participants from four national cultures, the UK, Malaysia, China and Japan. Every study has applied a different method in exploring for driver's cultural needs for in-vehicle navigation systems. A summary of participants is provided in Table 7.2a and Table 7.2b.

Table 7.2a: Summary of differences in participants in different studies

Participants' Profile	Study 1 (S1) in Chapter 3				Study 2 (S2) in Chapter 4		
Nationality	UK (n=9)	MAL (n=9)	JPN (n=8)	CHI (n=9)	UK (n=76)	MAL (n=96)	JPN (n=76)
Origin of driver's licence	UK	MAL	JPN	CHI	UK	MAL	JPN
Length of stay in the UK	Since birth	On average 3 years	On average 1.5 years	On average 2.5 years	Since birth	0 years	0 years

Note: UK – United Kingdom, MAL – Malaysia, JPN – Japan, CHI – China

Table 7.2b: Summary of differences in participants in different studies

Participants' Profile	Study 3 (S3) in Chapter 5		Study 4 (S4) in Chapter 6	
Nationality	UK (n=10)	MAL (n=10)	UK (n=3)	MAL (n=3)
Origin of driver's licence	UK	MAL	UK	MAL
Length of stay in the UK	Since birth	On average 3 years	Since birth	On average 2 years

Note: UK – United Kingdom, MAL – Malaysia, JPN – Japan, CHI – China

7.4 Needs to consider culture in designs of in-vehicle navigation systems (IVNS)

The literature review showed that studies reporting differences in drivers' behaviours were carried out comparatively across nation-states, yet there was paucity in outlining the effects as due to culture. This has inspired the researcher to use Hofstede's cultural dimensions as a reference in a pre-selection process of nations for a comparative direction-giving study. Following the entities demonstrated for culture in the literature review, a non-structured direction-giving was designed and conducted across culturally-different nations.

Hofstede's five cultural dimensions provided every nation a cultural characteristics profile using an index integer number across a bi-polar scale (between high-end and low-end)(Hofstede et al., 2010). The selected nations (Malaysia, United Kingdom (UK), Japan and China) were rated as high-end for at least one of five Hofstede's cultural dimensions, *power distance*, *individualism*, *masculine*, *uncertainty avoidance* and *long term orientation*.

A direction-giving exercise was used as a method to explore culture following the promising differences noted in drivers' behaviour in other studies (Burnett,

1998, Lovelace et al., 1999, Daimon et al., 2000, Davies and Pederson, 2001, Michon and Denis, 2001, Lawton, 2001) as shown in the literature review.

However, the outcome of the non-structured direction-giving study did not follow Hofstede's cultural dimensions accordingly whereby a distinct pattern for direction-giving was expected in each cultural dimension. Instead, the four selected nations showed similarities and differences in selecting navigational information from the environment. These patterns were visible after participants' paper-based directions were quantified with a categorising scheme developed in another study by Burnett (1998), suggesting the needs to use the scheme together with Hofstede's cultural dimensions.

The similarities were apparent in the use of *ego* direction and landmarks in every cultural group. Meanwhile, total density of navigational information (total number per cultural group) suggested a close relationship between Malaysia and UK (high density), and between Japan and China (low density). These relationships were in contrast to Hofstede's definitions for power distance index (reported as high for Malaysians) and, individualism index (reportedly high in the UK). Furthermore, differences were also noted in participants' styles of paper-based directions whereby the Japan group was more schematic (more sketched directions) than the other three nations (more written directions).

In parallel to the non-structured direction-giving study, an online study was conducted to explore for local (nation-state) drivers' opinions of navigational behaviours and road traffic issues. The online methodological approach was chosen due to its capability of collecting responses from drivers residing in

Malaysia, UK and Japan. The online survey revealed interesting findings on 'national' driving styles which were based upon acceptable norms and beliefs amongst drivers at national level. These driving styles were not elaborated in the literature as having the influence of culture; instead such nation-state driving styles were described in travel blogs (Giovine, 2010, Tarek, 2010, Fadi, 2011). The driving styles found in the literature were focussed on enhancement of road safety, therefore, the studies reported nation-state differences were partly due to driving habits (such as risky or aberrant behaviour) (Reason et al., 1990, French et al., 1993, Taubman-Ben-Ari et al., 2004) .

The online survey also revealed interesting facts concerning Japanese participants' low confidence to navigate in a foreign environment, and their preference for non-navigational items as important tools to navigate in foreign environment (as described in section 4.9.3 of chapter 4). These findings and those deduced from the direction-giving study (chapter 3) have expanded Marcus and Gould (2001) argument concerning the needs for a cultural-sensitive web design to a culturally-aware navigational interface. Nevertheless, other findings from the studies in this thesis also suggest limitation in defining culturally-sensitive navigational interfaces according to published cultural dimensions/concept (see chapter 3).

The non-structured direction-giving study and the online survey were structured as a baseline studies in the thesis framework (see Table 1.3 of chapter 1). These studies have demonstrated the needs to consider culture in navigation. Drivers' behaviour in navigation across different cultural background has shown similarities and differences in preferences of elements

from the road environment. These preferences could have a positive impact on navigational interfaces such as in-vehicle navigation systems (IVNS) in improving product's usability and driver's satisfactions.

7.5 Potential cultural framework, derived from original categorising scheme (Burnett, 1998)

The original categorising scheme (Burnett, 1998) was developed using UK participants in UK road environments for practical use in designing navigation systems. This scheme has structured good navigational elements from the environments into meaningful categories. Having used this categorising scheme across three studies (two direction-giving studies and one scenario-based design study), a potential cultural framework has emerged following the findings of the thesis.

Specifically, the 22 navigational elements that were grouped into six categories, from the original categorising scheme have been structured into three attributes, basic, trueness and personal, as illustrated in Figure 7.3. The 'new' term given for each attribute was based on the number of occurrences in participants' paper-based directions (chapters 3 and 5). For example, a highly populated navigational element such as *ego* direction should be described as a basic attribute.

This potential cultural framework has elaborated the original six categories, direction, distance, path (road), node (junction), landmarks and Road Street sign into an additional three attributes, basic, trueness and personal. These three attributes are required as observed in the studies of this thesis to explain changes in drivers' behaviour from home to foreign road environments. This

effort was deduced according to findings described earlier in Chapter 3, 5 and 6 (Table 7.3).

Table 7.3: Summary of methods and variables used in the thesis

Methods	(Chapter 3) Baseline direction-giving study	(Chapter 4) Online survey	(Chapter 5) Structured direction-giving study	(Chapter 6) Scenario-based design study
Participants national cultures	UK, Malaysia, China, Japan	UK, Malaysia, Japan	UK, Malaysia	UK, Malaysia
Road environments	UK roads	'Experience in local roads of UK, Malaysia and Japan	UK, Malaysia, Japan roads	UK, Malaysia, Japan roads
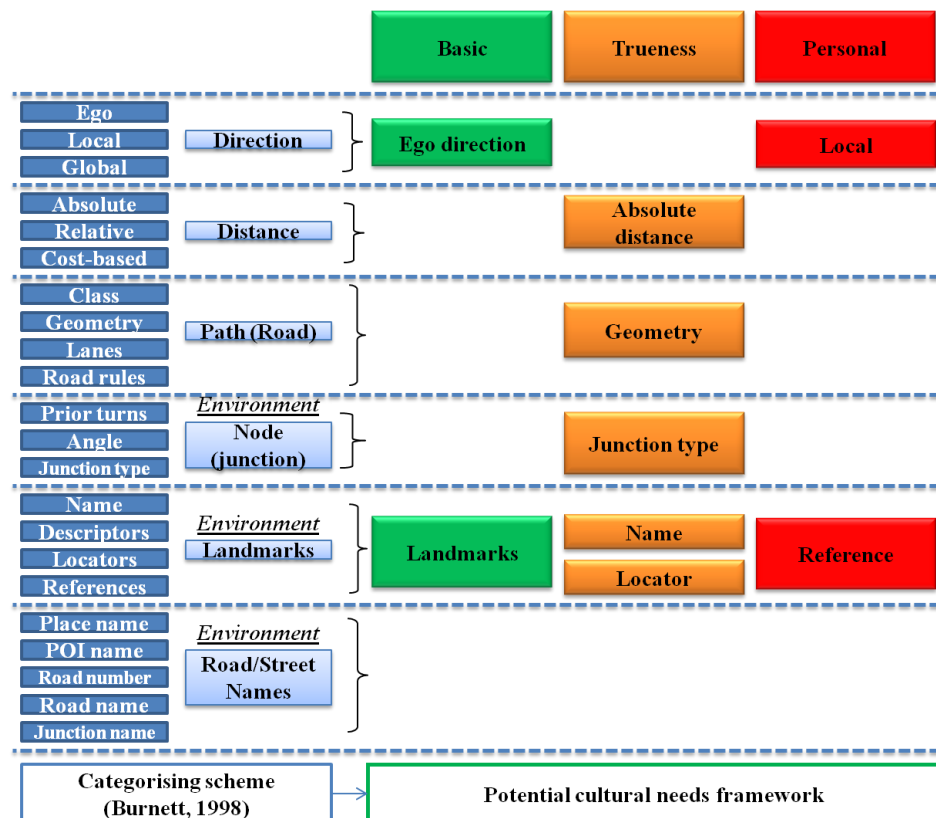
Figure 7.3: Transformation of categorisation scheme (Burnett, 1998) into potential cultural framework

A designer could first apply the framework on current navigational designs by ensuring basic attribute is represented on an interface. Then, designers could use the navigational elements listed in the trueness attribute to continue the process of designing a navigational interface. The personal attribute is an option which follows user's market needs. For example, a navigational interface that is showing a roundabout junction could be presented with a *local* direction for UK group, and an *ego* direction for the Malaysia group. An illustration showing application of the potential cultural framework is given in Figure 7.4 and Figure 7.5.

7.5.1 Guidelines in applying potential cultural framework

The three prototypes (number 1 to 3) from Figure 7.4 were sketched by adapting a storyboard concept using three colours green, amber and red. These colours were representing the three attributes of potential cultural framework, basic, trueness and personal. Prototype number 1 of Figure 7.4 is showing two elements of basic attribute, ego direction (green arrow) and landmark (photo of a building taken from the real environment). Prototype number 2 of Figure 7.4 is showing the element of geometry (a bend road) and locator. It is important to note that the landmark from Prototypes number 1 has changed its attribute to being a locator. This is a display of how elements placed onto a navigational interface may represent two attributes. Similar situation is also displayed in Prototype number 3 of Figure 7.4 where the said landmark is sketched in red colour whereby the building landmark was used as part of reference element (from personal attribute). This is considered as a personal attribute when the

Figure 7.4: Suggested prototype no. 1 to 3 after application of potential cultural needs framework for Malaysia roads
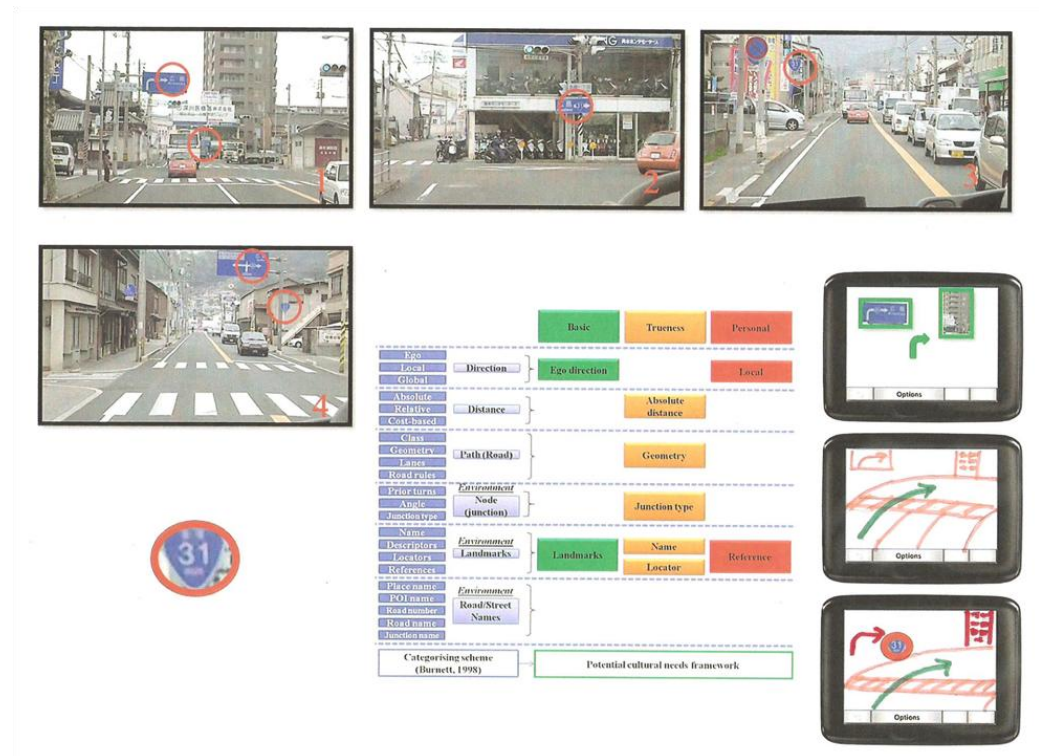
Figure 7.5: Suggested prototype no. 1 to 3 after application of potential cultural needs framework for Japan roads

building landmark is associated in the written navigational instruction such as 'follow the road along at the building'.

The consistency of *ego* direction and landmarks in every study has made it clear the requirement of having these navigational elements as a fundamental basis for constructing navigational interfaces. Exploration for further cultural needs has shown that navigational elements that inherit characteristics of 'trueness' from the environment were considered appropriate by participants of various national cultures. 'Trueness' is defined as the quality of being exact to the real environment. Navigational elements deduced in this attribute supported the basic elements in building the navigational interface. Most of these elements are present in current in-vehicle navigation systems (IVNS) interfaces, such as absolute distances, geometry of the path and junction types.

It is important to note that absolute distances were only apparent in the final study when participants had to sketch interfaces. Information referring to distance was not consistent in the types of element selected; rather the attributes for distance seem to reflect a process of transformation. There are three types of elements for distance in the original categorisation scheme. In the baseline study, relative distance was apparent in the UK participants, while in the structured direction-giving study, cost-based distance was apparent in the Malaysia group only. Finally, in the design study, both UK and Malaysia have used absolute distance as part of their navigational instructions. It is believed that the presence of absolute distance in the trueness category could probably show drivers adaptations to current INVS systems. Absolute distance given in

metres or miles, provide drivers with a sense of trueness in positioning of the vehicle. Moreover, the numbers associated with distance in the final study were not 'true' to the actual map; instead the numbers were 'unreal' numbers. The author believed that participants used an absolute phrase to provide a sense of proximity to next manoeuvre.

The findings in Chapter 3 and 5 showed that landmarks were consistently used as part of navigational instructions, while in Chapter 6, landmarks were apparent in the sketch-interface and occasionally mentioned in the navigational instructions. There were four types of navigational elements for landmarks in the original categorising scheme. However, *locator* (defined as 'information that would help in locating a particular landmark (noted by Burnett, 1998, p.103) and, landmarks such as traffic lights and pedestrian crossings were significantly used for navigation. Importantly, the landmarks selected by participants across cultures for all studies were visible along the designated routes.

Junction types were also perceived as useful across cultures. However, there were differences in the way this information was represented. In both direction-giving studies, the junctions were either given in written format or abstracted as iconic symbols, while in the sketch-interfaces, these junctions (such as roundabouts and t-junctions) were sketched and were not always included in the navigational instructions.

In the baseline study when only UK roads were used, seven elements were found to be significantly different across cultures. However, when other nation-state roads were introduced (Chapter 5 and 6), only navigational elements that

have characteristics of 'trueness' were persistent (for example *locator*). This condition suggests that navigational interfaces could potentially be generalised across cultures by including one true navigational element for each category of the original categorising scheme. As an example, the 'general' navigational interface could require ego direction, absolute distance, geometry of the path, locator or name landmarks, junction types and Road Street names. These elements represent the six categories of the original categorising scheme.

Such generalisation represents the navigational elements chosen by participants for their home (nation-state) environment. However, in foreign (other nation-state) environment, participants across nations begins to apply different navigation strategies. This is the point where navigational elements are entering the personal attribute. The author believes that any chosen element at this stage reflects the personal identity of the participants. In the case of this research, the personal attribute reflects participants' identity according to their national culture. For example, the UK group were found to use reference landmarks in foreign environment and local directions to navigate through specific junctions.

7.6 Cultural characteristics of information density on navigational interface

In one of the baseline studies (see Chapter 3), the Malaysia and the UK groups were almost similar when compared against the Japan and the China groups in their density of navigational information. Both Malaysians and British participants (n=9/group) from the direction-giving study used more

information to construct their navigational instructions (as illustrated in Table 3.6 of Chapter 3).

However, a difference was first observed in the structured direction-giving study (see Figure 5.13a of Chapter 5) whereby the Malaysia group (n=10) have higher total number of navigational information than the UK group (n=10) for every road environment. Then, when compared again with the UK group (n=3) from the exercise of designing personal navigational interface (present study), the Malaysia group (n=3) have shown similar pattern in density of information (compare Figure 5.13 of Chapter 5 with Table 6.3 of this Chapter).

Importantly, a general decreasing pattern was observed in both studies (Chapter 5 and 6). In both situations, the Malaysia roads (home environment) have the highest number of information, followed by the UK roads and the Japan road respectively. This could probably be due to cultural restrictions experienced by the Malaysian participants in identifying local attribute in the foreign environments. It is important to note that none of the three studies described here and elsewhere in the thesis have employed the same participant.

Therefore, there is a possibility in generalising that the Malaysians use more information in navigation. Two patterns of interaction behaviours emerged from the research included in this thesis, cultural groups exist which either:

1. require similar types of navigational information between home and foreign environments, or this former group used navigational information which has more characteristics of

'trueness' such as *ego direction*, *absolute distance*, *geometry*, *name* and *locator*; and

2. require different types of navigational information between home and foreign environments. This second group seem to deviate from their normal navigation strategies observed in home environment. Specifically, *reference* landmark and *local* direction were perceived as not suitable for use in foreign environments. Instead, information that has more characteristics of 'trueness', such as *absolute* distance and *geometry* were adapted for navigation in foreign environments.

Moreover, participants' sketch-interfaces suggest that navigation in a foreign environment particularly high in uncertainty avoidance value could enable drivers to comfortably navigate without much assistance from the in-vehicle navigation systems (IVNS). This is probably because the road environment itself has provided ample information to assist the journey. This could have explained the lower density of information found in the Japan group from the baseline direction-giving study when compared with participants from UK and Malaysia (chapter 5). The UK roads may not have 'enough' elements that support the same information. The Japanese in this study were reportedly using similar types of information more than once in their navigational instructions. For example, indicating a turning to the right was represented with an arrow, a symbolic icon and written instruction 'turn right'. Furthermore, this also could have explained why the Japanese named published maps and non-navigational items such as guide book and dictionary, as their first choice of useful items when travelling abroad. Meanwhile, the UK and Malaysia cultures were able to

navigate the Japan roads with sufficient navigational elements as shown in the structured direction-giving study, due to having an abundant of similar information.

Based on participants' needs (from their personal sketch-interfaces) for Japan roads, it could be hypothesised that drivers interacting with an in-vehicle navigation system (IVNS) manufactured from high uncertainty avoidance nations, such as Japan could face complex interfaces which would be unsatisfying to drivers that do not require high density of information.

7.7   Cultural issues for roundabouts junction

A roundabout is a specific junction which is not necessarily common in every road environment across nations. Given that IVNS is available in the global market, cultural considerations are needed in constructing navigational instructions for roundabouts. Roundabout junctions were presented in the videos of UK roads used throughout the research. Every UK participants was able to construct navigational instructions for roundabouts using local directions and prior turns while other cultures have used mainly ego directions. It appears that this type of navigational instruction is common place in UK. One sketch-interface from the Malaysia group in the scenario-based design study described roundabouts as a 'clock face' and indicated turnings as "take the 9 o'clock". The findings in this thesis were limited in measuring drivers' ease of use in using local directions and prior turns for roundabouts, however cultural disparities were noted at roundabouts across nations. Hence, it seems desirable to investigate further cultural behaviours at roundabouts.

7.8 Cultural issues in navigating curved roads

Curved roads are another road feature that requires attention in designs of in-vehicle navigation systems (IVNS). As noted from the findings in Chapter 6, the choice of words adapted for describing road geometries was different across cultures, despite similar representation of the curve road. The structure of words clearly shows two sets of navigational instructions *"Follow the road along"* and *"Go straight on..."* between the UK and the Malaysia groups respectively. The importance of this issue was highlighted in Curzon et al. (2002) described earlier in Chapter 2, as an action failure where drivers may not comprehend the systems' given instruction which could lead to undesirable incident. It is believed that the formation of instructions was based on drivers' natural language formation. As an example, in the Malaysia sample for the scenario-based study (Chapter 6), the Malaysians used a common Malay sentence structure which when translated to English would be "Go straight on". However, the findings are limited, as was made to measure drivers' ease of use in using different phrase of navigational instructions. It may be possible to consider these differences as one of the early cultural needs that require exploration using interface prototypes.

7.9 Overall limitations in study

There was limitation in recruitment strategy applied in this thesis. The author was only able to recruit participants for three out of four studies from the UK University. The first, non-structured direction-giving study was conducted in the University of Nottingham (UoN), UK. Participants from other three national cultures were new students of UoN or students who have registered

with UoN for less than three years. The third and fourth studies, structured direction-giving and scenario based design also experienced similar situations in the recruitment strategy. The only study that had local participations was the online survey with total recruitment of 246 local residents from Malaysia, the UK and Japan.

7.10 Thesis contributions

In general, the thesis has demonstrated an exploration of drivers' cultural needs by employing a bottom-up approach with a combination of mixed methods. A potential cultural framework was proposed for consideration as a tool for defining driver's cultural needs. Several prototypes were sketched by adapting a storyboard concept to illustrate the use a potential cultural framework (see Figure 7.4 and Figure 7.5). An important generic guideline for the potential cultural framework is the basic attribute has to be present in every culturally-sensitive navigational interface. Then after, following the findings on the importance of considering road environment, it is vital to include the trueness attribute of the proposed cultural framework onto the design process. The personal attribute is desirable in the effort to increase driver's satisfaction when engaged with in-vehicle navigation systems (IVNS).

Such knowledge is essential in considering for driver's cultural needs when designing prototypes of culturally-sensitive navigational interface. The cultural framework proposed follows the findings of a series of studies within this thesis which could help designers of in-vehicle navigation system (IVNS) identify the elements needed to address drivers' needs. This would then help the construction of several prototypes that have considered driver's cultural

needs. Samples of current interfaces for UK and Japan markets were used to illustrate how basic, trueness and personal attributes from the proposed cultural framework were represented in the current designs of IVNS (Figure 7.6, Figure 7.7 and Figure 7.8). It was evident from the samples that landmarks (one of the two navigational elements under basic attributes) were limited in the UK samples, yet were in abundance in the Japan samples.

It may be possible from addressing driver's cultural needs onto navigational interface could increase drivers' ease of use when engaging with multi-function IVNS. Should the navigational interface feature the basic and trueness elements accordingly, drivers may be able to engage with the systems in a safe way. Furthermore, drivers could be actively engaged with the surrounding environment when confirming the landmarks used on the 'future' culturally-sensitive display.

Moreover, knowledge about drivers' cultural requirement of information density would increase drivers' experience and satisfaction when engaged with the systems. Importantly, the designers would have a generic guideline to ensure essential cultural elements have been considered in the design process for navigational interfaces

Importantly, the findings in this thesis have demonstrated a potential approach to generalise cultural groups (at national level) for density of information displayed on navigational interface (described earlier in section 7.6 of this chapter). Apart from that, the findings have also discovered other prevalent cultural issues which were highlighted for further exploration.

Figure 7.6: Images A and B show examples of nomadic IVNS for UK markets

C.

Figure 7.7: Images C shows an example of a nomadic IVNS for Japan markets
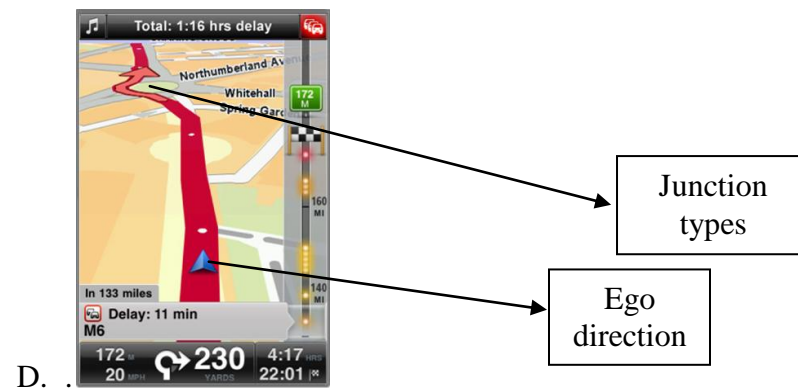
D. .

Figure 7.8: Images D shows examples of a mobile application IVNS for UK markets

7.11 Future work suggestions

The outcomes of the thesis highlight the exploration process from basic navigation (between drivers and environment) to an early design process where reliable cultural needs have emerged. Nevertheless, designing in-vehicle navigation systems (IVNS) requires an iterative process which includes testing for drivers' acceptance and satisfaction. A number of future work issues which require attention are:

- Given that the literature and findings from this thesis have indicated the essential role of road environments in influencing drivers' behaviour, a greater understanding of current road environments is crucial. Information about distinct road features (such as road patterns and junctions) is required, particularly in their distributions around the world and drivers' perception about these features. Such information would be useful in building attributes of the environments and would provide an insight to designers of in-vehicle navigation systems (IVNS) in considering cultural issues.

- The findings of the research have demonstrated certain drivers' perceptions about national driving styles. Little information existed on this topic. Therefore, it is desirable to distribute online surveys to drivers living locally in other parts of the world to build an understanding of national driving styles. Furthermore the Japan in this online survey (chapter 4) and the non-structure direction-giving study (chapter 3) have demonstrated characteristics of *Uncertainty Avoidance* (UAI) which suggests for a need to consider a navigational interface for

- UAI group. Such information would then be useful for designers of IVNS to estimate the cost-efficiency of building culturally-sensitive interfaces for a specific culture.

- The cultural framework extended form the original categorising scheme provides designers with the essential elements needed to explore drivers' cultural needs. Following from this cultural framework, two patterns of interaction behaviour were found across cultural groups (as described earlier in section 7.6 of this chapter). These needs further exploration in the design process. Furthermore, a factorial design study about information density (2x2) between displays and environment could also be considered in further investigation. It is therefore recommended to continue the design process by building several prototypes based on the persistent cultural needs and testing for driver's ease of use. The results of these evaluations would then contribute towards a better understanding of cultural characteristics.

7.12 Future navigational interface

Advances in technology have enabled additional to be added to current IVNS. Despite the convenient functionality offered in current systems, there has been a growing concern over drivers' safety and ease of use for systems. An extensive amount of research has tackled human factors issues raised; yet very limited information was available on culture. Nevertheless, comparison studies across national cultures in the thesis have indicated the potential to address driver's cultural needs in navigation, environments and interaction.

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I

Appendix 3-1: Paper Questionnaire

Pilot Study Questionnaire
Navigation Task: Evaluating Cultural Differences
November 2006

Section 1:	Personal details

1 *How old are you?*

Please tick one box only

Under 20 years old ☐ 1

21-30 years old ☐ 2

31-40 years old ☐ 3

41-50 years old ☐ 4

Above 50 years old ☐ 5

2 *Are you…?*

Female ☐ 1

Male ☐ 2

3 *What is your nationality?*

_____
_____
_____

4 *From which country did you obtain your driving license?*

_____
_____
_____

5 *How long have you had your driving license?*

Less than one year ☐ 1

1 to 5 years ☐ 2

6 to 10 years ☐ 3

11 to 15 years ☐ 4

Above 15 years ☐ 5

Section 1:	Personal details (continued)

6   *On average, how many days in a week do you drive?*   [ ] days

7   *Approximately how many miles or kilometres have you driven in the last 12 months?*   [ ] Miles or Km

8   *Approximately what percentage of your total annual driving experience is made up of the following types of journey?*

Please put a percentage in each box—they should total 100%

Journeys made on your own for which you needs maps or other route advice before and/or during the journey to reach your destination?   [ ] %

Journeys made with a passenger for which you need maps or other route advice before and/or during the journey to reach your destination?   [ ] %

Journeys for which you do not need any help to reach your destination?   [ ] %

                              Total   100%

9   *Approximately what percentage of your life have you spent in your home country?*

    [ ] %

10   *Approximately how long have you been working/studying in United Kingdom? Not applicable to UK respondents*

    [ ][ ] Years/   Months

11   *Apart form your country of origin, have you drove in any other country for more than six months?*

Please tick one box only

No   [ ]

Yes (please specify)   [ ]

_____

_____

_____

K

Section 2:	Unfamiliar Journeys

This section refers to **Unfamiliar Journeys** — these journeys in which you need some advice/ information before setting off on the journey and/or during the journey

Questions 12 to 14 refer to the reasons why you make unfamiliar journeys.

Please tick one box only

12 *How frequently do you make an unfamiliar journey as part of your work or business?*

2 or more times a week		1
About once a week		2
2-3 times a month		3
About once a month		4
About once every 2-6 months		5
About once a year		6
Never or very seldom		7

13 *How frequently do you make an unfamiliar journey for routine non-work purposes (for example shopping, personal business, school runs?*

2 or more times a week		1
About once a week		2
2-3 times a month		3
About once a month		4
About once every 2-6 months		5
About once a year		6
Never or very seldom		7

14 *How frequently do you make an unfamiliar journey for leisure purposes (for example holidays, day trips?*

2 or more times a week		1
About once a week		2
2-3 times a month		3
About once a month		4
About once every 2-6 months		5
About once a year		6
Never or very seldom		7

L

Section 3:	Your abilities at finding your way

Please circle the appropriate number for Questions 11 to 21

15 *When driving on your own in an unknown area, how good are you at finding your way?*

Very Good / Very Poor

1 2 3 4 5 6 7 8 9

16 *How good is your sense of direction?*

Very Good / Very Poor

1 2 3 4 5 6 7 8 9

17 *How good are you at navigating for someone else when acting as a passenger?*

Very Good / Very Poor

1 2 3 4 5 6 7 8 9

18 *How good are you at navigating for someone else when providing them with direstions (either written or over the phone)?*

Very Good / Very Poor

1 2 3 4 5 6 7 8 9

19 *When travelling in an unknown area, how often do you get lost?*

Always / Never

1 2 3 4 5 6 7 8 9

20 *How often do you get your lefts and rights mixed up?*

Always / Never

1 2 3 4 5 6 7 8 9

21 *How good are you at remembering an unfamiliar route after you have driven it for the first time?*

Very Good / Very Poor

1 2 3 4 5 6 7 8 9

M

Section 3: Your abilities at finding your way (continued)

Question 22 to 26 below concern your opinions as regards to published maps.

Please circle the appropriate number for Questions 11 to 21

22 *How easy do you find it to locate a particular street name (for example Park Drive, Gregory Boulevard) on a published map?*

Very Easy								Very Difficult
1	2	3	4	5	6	7	8	9

23 *How easy do you find it to plan a route using a published map?*

Very Easy								Very Difficult
1	2	3	4	5	6	7	8	9

24 *How easy do you find it to establish your current location using a published map?*

Very Easy								Very Difficult
1	2	3	4	5	6	7	8	9

25 *How much do you like reading published maps to find your way?*

Like a lot								Do not like at all
1	2	3	4	5	6	7	8	9

Please tick one box only
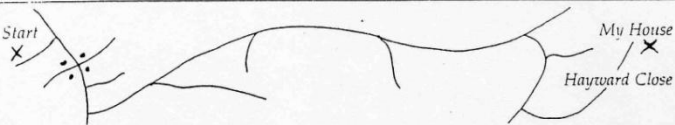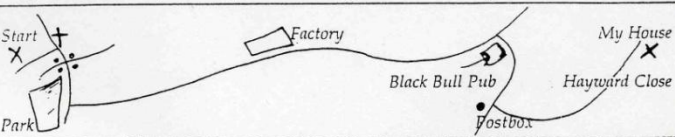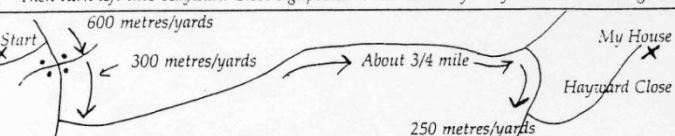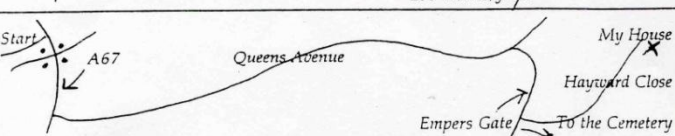
26 *Would you look at a published map out of general interest?*

Yes ☐ 1

No ☐ 2

Section 4:	Your choice of paper direction

27 *The following are different ways in which you could be given paper directions by someone on how to reach a destination?*

Please rank them in order of preference. Please do not use equal ranks

Most prefered   Least prefered

1   2   3   4   5   6   7   8

a)
- Turn right at the end of the road by the church
- Then drive past the crossroads (with traffic lights) and then turn left at a park
- Follow the road for a while past a factory and then turn right at the Black Bull pub
- Then turn left into Hayward Close by a postbox. My house is on the right

b)

c)
- Turn right at the end of the road
- Then drive for about 600 metres/yards until you go past the crossroads (with traffic lights) and 300 metres/yards after this turn left
- Follow the road for a while (about 3/4 miles) and then turn right
- Then after 250 metres/yards turn left into Hayward Close. My house is on the right

d)
- Take next turning right at the end of the road
- Then drive past the crossroads (with traffic lights) and then take second turning left
- Follow the road for a while and take the fourth turning on the right after the left-hand bend
- Then take second left into Hayward Close. My house is on the right

e)

f)
- Turn right at the end of the road onto the main A67
- Then drive past the crossroads (with traffic lights) and then turn left onto Queens Avenue
- Follow this road for a while and then turn right onto Empers Gate
- Then turn left into Hayward Close signposted to the Cemetery. My house is on the right

g)

h)

0

Section 3:	Your choice of paper direction (continued)

Please explain your choices of paper direction

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Thank you for taking the time to complete this questionnaire.

P

Appendix 3-2: Categorisation Scheme (Burnett, 1998)

The development of 'categorisation scheme' for navigational information elements

Burnett (1998) established a profile of good information for navigating in an unknown area using UK participants in UK road environment. The profile was named 'categorisation scheme'. This scheme was proposed based on other basic information types extracted from literature, namely *direction information*, *distance information*, and *environment information* (Burnett, 1998, pg. 101). The 'categorising scheme' has twenty two (22) elements spread across six (6) categories (Table 3.2a). Each element has a definition and examples in a context of paper-based directions. The definitions and given examples were used as a guide to locate various types of navigational information in direction giving study (Chapter 3).

In the work of Burnett (1998), two applications of task were structured to compare differences in selection of navigational information for paper-based directions. The applications were a video task and a map task where participants were asked to produce a paper-based direction. Each task had fifteen (15) participants. The coding process of the thirty (30) paper-based directions were based on information types from the literature and a card sorting exercise between eight (8) human factors specialists.

Q

Category	Elements	Description	Examples
Direction	**Ego**	Direction is defined in relation to the imagined/ viewed position of the car driver	turn <u>left</u>, go <u>straight on</u>
	Local	Direction is defined in relation to an external reference point	turn <u>towards</u> the post-box, 2nd <u>exit</u> at roundabout
	Global	Direction is defined in relation to a system that can be applied all over the world	head <u>northwards</u>
Distance	**Absolute**	Precisely given distance values	<u>300m</u>, <u>half a mile</u>
	Relative	Distance given relative to some other marker	<u>half way</u> there
	Cost-based	Distance given in cost terms (time, effort etc.)	turn <u>immediately</u>, a <u>long way</u>
Environment - Path (road)	**Class**	Information about the class or type of road between junctions	<u>A47</u>, <u>dual carriageway</u>
	Geometry	Information about the geometrical layout of the road	<u>bend</u> in the road, <u>dip</u> in the road
	Lanes	Information regarding which lane to take	keep in <u>right-hand lane</u>
	Road-rules	Information about the rules of the road along the path	follow <u>one-way</u> system. <u>no-entry</u>
	Prior turns	Information regarding turns along the path prior to an oncoming manoeuvre	<u>2nd</u> left, <u>3rd</u> exit
Environment - Node (junction)	**Angle**	Indications of angle of junction	<u>sharp</u> turn, <u>bear</u> left
	Junction type	Information which indicates the form of the oncoming junction	<u>T-junction</u>, roundabout
Environment - Landmarks	**Name**	Name of a particular class or type of landmark	<u>traffic lights</u>, <u>petrol station</u>, <u>pub</u>, <u>shop</u>
	Descriptors	Additional descriptive information that would help in identifying a landmark	the <u>white</u> house, <u>big</u> tree, <u>low</u> bridge, <u>Shell</u> petrol
	Locators	Information that would help in locating a particular landmark	post-box <u>on the corner</u>, church <u>on</u>
	References	A preposition that references a landmark to a manoeuvre	turn right just <u>before</u> church, left <u>at</u> lights
Environment - Road/street signs	**Place name**	References to a place name (on, or likely to be on a road sign)	<u>Loughborough</u>, <u>Derby</u>
	Point of interest name	References to a point of interest (on, or likely to be on a rd sign)	<u>Warwick castle</u>, <u>City museum</u>
	Road number	References to a road number (on, or likely to be on a rd sign)	<u>A417</u>, <u>M1</u>
	Road/street name	References to a road/st name (on, or likely to be on a rd sign)	<u>Park Drive</u>, <u>Elms Grove</u>
	Junction name	References to a junction name (on, or likely to be on a rd sign)	<u>Northwood roundabout</u>

Table 3.2a: Categorisation scheme for navigational information elements

R

Appendix 3-3: Drivers' Cultural Profile

Normal types of journey from total driven mileage

In the subsequent part of the questionnaire, the participants were asked to identify their recent annual mileage into three types of journey. For each journey, participants had to place value in percentage which represented their frequencies travelling in the said type. The three types of journeys were:

1. Journeys made alone for which require maps or other route advice before and/or during the journey to reach destination;

2. Journeys with passenger for which require maps or other route advice before and/or during the journey to reach destination; and

3. Journeys for which no help was acquired to reach destination

Reportedly, the UK and the Malaysia groups were always driving without any assistance from passengers, maps or route advice, given the percentage of 76% and 60% respectively out of their total annual mileage (Figure 3.5a). Despite the low annual mileage in the Japan and China groups, 113 km/year and 1272 km/year respectively; 40% of the annual mileage was claimed for journeys without any type of assistance to reach the destination (Figure 3.5a).

Types of journeys from annual mileage (%)
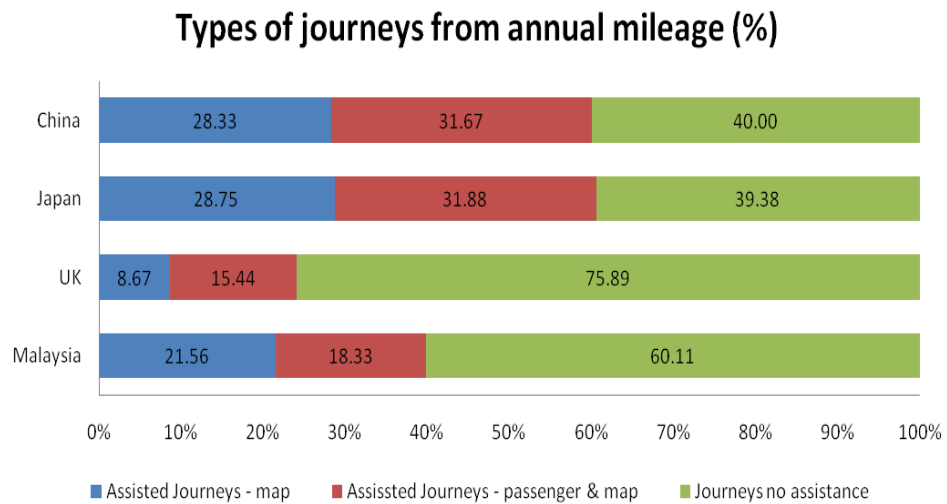
Figure 3.5a: Types of journeys from annual mileage in percentage

Driving experience
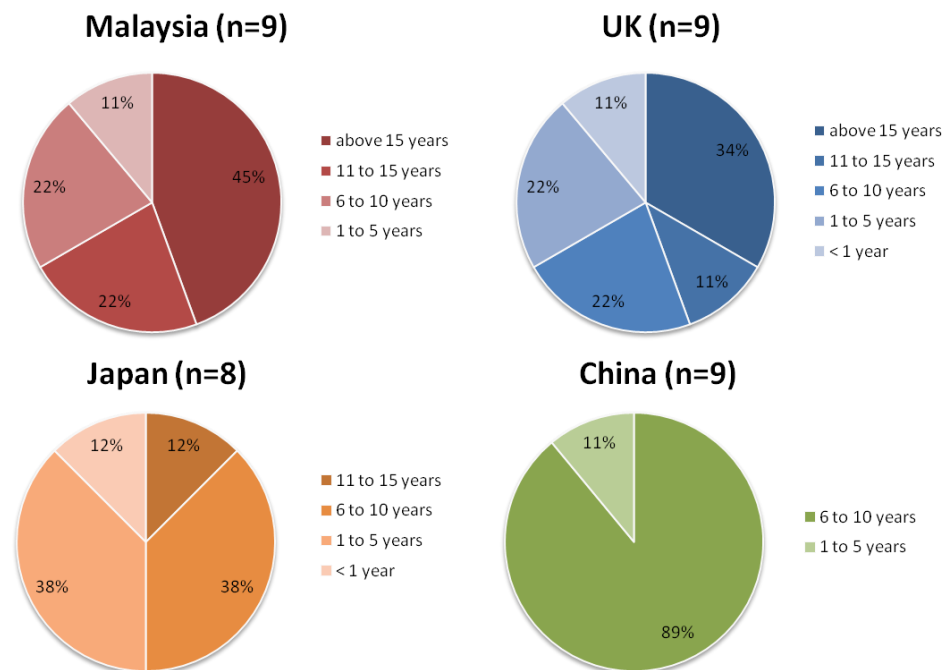
Figure 3.5b: Percentages of driving experience per cultural group

The driving experiences were largely within the range of six to ten years for most participants, with recorded percentage between 22% and 89% (Figure 3.5b). Participants with driving experiences of less than a year were limited to one driver per cultural group. Meanwhile, drivers with over fifteen years of experiences were from the UK and Malaysia groups (Figure 3.5b).

Appendix 4-1: Online Questionnaire (English version)

```
======================================
======================================
Drivers & navigating for different cultures
======================================
======================================


===========================================
 Your driving behaviour
===========================================
```

Hi,

Please complete the following questionnaire, which will help us to understand driver's behaviour from different cultures. The questionnaire will be analysed independently by me, and treated in total confidence.

Thank you for your input into this study.

Yasmin Mohd Hasni, PhD Student, University of Nottingham

Instructions for Completing the Questionnaire

This is an online questionnaire and should only take you 5 minutes to complete. A red asterisk at the end of a question indicates it is a compulsory question that must be answered so you can then proceed to next page. There are two basic types of question:

Radio button

Radio button have been used for some questions. To respond positively, simply click on the button next to your answer.

Text box

Free-form text boxes have been used to allow you to give a more detailed answer. Alternatively, if you have no information to put into the box, please enter the number "0"

U

1. Imagine that you are on holiday and the road system is different frm your home country, for example, you have to drive on the opposite side of the road and, in the car, the controls are on the opposite side of the car (e.g. left hand drive instead of right hand drive). Please rate how confident would you be driving in that environment?

    ( ) 1 (Not confident at all)

    ( ) 2

    ( ) 3

    ( ) 4

    ( ) 5

    ( ) 6

    ( ) 7

    ( ) 8

    ( ) 9 (Very confident)

2. Imagine you are about to start a journey to an unfamiliar place in your home country. Name up to three important items that you would bring with you for that journey.

    1 _____

    2 _____

    3 _____

3. Now imagine you are about to start a journey to an unfamiliar place in another country. Name up to three important items that you would bring with you for that journey.

    1 _____

    2 _____

    3 _____

===

 Drivers behaviour in different cultures

===

4. Drivers from my home country drive differently from drivers in other countries

    ( ) Strongly disagree

    ( ) Disagree

v

( ) Neutral

( ) Agree

( ) Strongly agree

5. Generally, it is common for drivers originating from the same country to drive in a SIMILAR manner or styles

( ) Strongly disagree

( ) Disagree

( ) Neutral

( ) Agree

( ) Strongly agree

6. Road traffic DOES have an impact on driving behaviour in general

( ) Strongly disagree

( ) Disagree

( ) Neutral

( ) Agree

( ) Strongly agree

7. Drivers' behaviour on the road is generally influenced by the local road traffic/environment

( ) Strongly disagree

( ) Disagree

( ) Neutral

( ) Agree

( ) Strongly agree

8. Drivers would normally change their natural driving behaviours in different road environments

( ) Strongly disagree

( ) Disagree

( ) Neutral

( ) Agree

( ) Strongly agree

W

```
============================================
 Finding your way in unfamiliar environment
============================================
```

9. Paper direction written in full sentences
    ( ) 1 (Useless)
    ( ) 2
    ( ) 3
    ( ) 4
    ( ) 5
    ( ) 6
    ( ) 7
    ( ) 8
    ( ) 9 (Very Useful)

10. Written paper direction together with navigational arrows
    ( ) 1 (Useless)
    ( ) 2
    ( ) 3
    ( ) 4
    ( ) 5
    ( ) 6
    ( ) 7
    ( ) 8
    ( ) 9 (Very Useful)

11. Just navigational arrows
    ( ) 1 (Useless)
    ( ) 2
    ( ) 3
    ( ) 4
    ( ) 5
    ( ) 6
    ( ) 7
    ( ) 8
    ( ) 9 (Very Useful)

X

12. A sketch map of the journey

    ( ) 1 (Useless)

    ( ) 2

    ( ) 3

    ( ) 4

    ( ) 5

    ( ) 6

    ( ) 7

    ( ) 8

    ( ) 9 (Very Useful)

13. A Road Atlas and A-Z Map Book

    ( ) 1 (Useless)

    ( ) 2

    ( ) 3

    ( ) 4

    ( ) 5

    ( ) 6

    ( ) 7

    ( ) 8

    ( ) 9 (Very Useful)

14. A passenger in your car that has local knowledge of the area

    ( ) 1 (Useless)

    ( ) 2

    ( ) 3

    ( ) 4

    ( ) 5

    ( ) 6

    ( ) 7

    ( ) 8

    ( ) 9 (Very Useful)

Y

15. A passenger in your car reading written instructions to you

      ( ) 1 (Useless)

      ( ) 2

      ( ) 3

      ( ) 4

      ( ) 5

      ( ) 6

      ( ) 7

      ( ) 8

      ( ) 9 (Very Useful)

16. A vehicle navigation systems (Sat Nav) using both audible and graphics-based directions

      ( ) 1 (Useless)

      ( ) 2

      ( ) 3

      ( ) 4

      ( ) 5

      ( ) 6

      ( ) 7

      ( ) 8

      ( ) 9 (Very Useful)

===
 About You and your driving experience...
===

17. What is your nationality?

_____

18. How old are you?

_____

Z

19. What is your gender?

( ) Male

( ) Female

20. How many years have you been driving/held a full driving license?

years _____

months _____

21. Approximately; what is your annual mileage (miles or kilometres)?

miles _____

kilometres (km) _____

22. Name the country/countries where you have passed your driving license.

_____

_____

_____

_____

_____

23. Have you ever driven in other countries?

( ) Yes

( ) No

24. Please state the estimated percentage of mileage of up to 3 countries you have driven; For example, if you are British and often travel to other countries and have driving experiences there, your total driving experience would be:-

Country   Mileage (%)

1. UK   90%

2. France   5%

3. USA   5%

```
          Country     Mileage (%)

Country 1  _____        _____

Country 2  _____        _____

Country 3  _____        _____
```

25. Have you had experience using a satellite navigation systems before?

    ( ) Yes

    ( ) No

26. If yes, how often do you currently use a navigation system?

    ( ) 1 (Not at the moment)

    ( ) 2

    ( ) 3

    ( ) 4

    ( ) 5

    ( ) 6

    ( ) 7

    ( ) 8

    ( ) 9 (Everyday)

```
===============================================
```

 Sincere gesture

```
===============================================
```

Thank you for taking part in our survey. Your response is very important to us. If you would like to know the outcome of the questionnaire, kindly email me at itxym2@nottingham.ac.uk

Appendix 4-2: Online Questionnaire (Japanese version)

====================================

====================================

その他の国における日本語ドライバとその運転方法

====================================

====================================

==

　あなたの運転行動

==

こんにちは。

私たちは「異文化によるドライバ行動の違い」を研究しています。そこで、下記のアンケートにご協力下さい。回答期限は2010年12月31日（金）です。なお、私がアンケートの分析を独りで行いますので個人情報は完全に保護されます。ご安心下さい。

　アンケートにご協力頂き、大変感謝致します。

ヤスミン（ノッティンガム大学：博士課程）

＜アンケートの回答方法の説明＞

アンケートの回答に要する時間は約5分です。

質問の最後に赤色の＊がある質問には必ず回答して下さい。回答が記入されない場合には、次のページに進めません。

回答方法は2種類あります。

1．ラジオボタン

質問には用意されている回答の選択肢から回答して下さい。ラジオボタンをクリックすることで回答となります。

2．テキストボックス

質問の回答を自由記入して下さい。なお、回答がない場合には、記入欄に数字の"0"を記入して下さい。

１．次の運転状況を想像して下さい。

休日、あなたは海外へ行き、例えば走行車線が日本とは逆（右側）、また運転席も逆（左側）の車を運転します。

このような環境で運転することに対するあなたの自信の程度を下記から選択して下さい。

　　　　（ ）１（全く自信がない）
　　　　（ ）２
　　　　（ ）３
　　　　（ ）４
　　　　（ ）５
　　　　（ ）６
　　　　（ ）７
　　　　（ ）８
　　　　（ ）９ （非常に自信がある）

2．次の運転状況を想像して下さい。

あなたは日本国内の知らない場所へ旅に出かけようとしています。このときに、あなたが旅に持って行く重要なアイテムを3つ挙げて下さい。

　　　　1 _____
　　　　2 _____
　　　　3 _____

3．次の運転状況を想像して下さい。

あなたは日本国外（外国）の知らない場所へ旅に出かけようとしています。このときに、あなたが旅に持って行く重要なアイテムを3つ挙げて下さい。

    1 ＿＿＿＿＿＿＿＿＿

    2 ＿＿＿＿＿＿＿＿＿

    3 ＿＿＿＿＿＿＿＿＿

===

 異文化による運転行動の違い

===

4．日本人ドライバーは海外のドライバーと異なる運転行動をする。

    ( )　1　全くそう思わない

    ( )　2

    ( )　3

    ( )　4

    ( )　5　強くそう思う

5．一般的に、母国が同じドライバーは同じ運転マナーや運転スタイルである。

    ( )　1　全くそう思わない

    ( )　2

    ( )　3

    ( )　4

    ( )　5　強くそう思う

6．一般的に、ドライバーの運転行動は交通環境や道路環境に影響される。

    ( )　1　全くそう思わない

    ( )　2

    ( )　3

    ( )　4

    ( )　5　強くそう思う

7.
ドライバーの運転行動はドライバの暮らしている場所の交通環境や道路環境に影響される。

( ) 1 全くそうは思わない

( ) 2

( ) 3

( ) 4

( ) 5 強くそう思う

8.
一般的に、ドライバーは異なる交通環境や道路環境において自然に運転行動を変化させる。

( ) 1 全くそう思わない

( ) 2

( ) 3

( ) 4

( ) 5 強くそう思う

===

不慣れな環境での運転行動

===

9．紙に方向を文章で示したもの

( ) 1 （全く役に立たない）

( ) 2

( ) 3

( ) 4

( ) 5

( ) 6

( ) 7

( ) 8

( ) 9 （非常に役に立つ）

10．紙に方向を矢印で示したもの

( ) 1 （全く役に立たない）

( ) 2

FF

（　）　3
（　）　4
（　）　5
（　）　6
（　）　7
（　）　8
（　）　9　（非常に役に立つ）

11．紙に方向を矢印と文章で示したもの
　　　（　）　1　（全く役に立たない）
　　　（　）　2
　　　（　）　3
　　　（　）　4
　　　（　）　5
　　　（　）　6
　　　（　）　7
　　　（　）　8
　　　（　）　9　（非常に役に立つ）

12．紙に旅の地図をスケッチしたもの
　　　（　）　1　（全く役に立たない）
　　　（　）　2
　　　（　）　3
　　　（　）　4
　　　（　）　5
　　　（　）　6
　　　（　）　7
　　　（　）　8
　　　（　）　9　（非常に役に立つ）

13．市販の地図
　　　（　）　1　（全く役に立たない）
　　　（　）　2
　　　（　）　3
　　　（　）　4

（　）　5

（　）　6

（　）　7

（　）　8

（　）　9　（非常に役に立つ）

14．土地勘（行くまでの道筋をよく知っている）のある同乗者

（　）　1　（全く役に立たない）

（　）　2

（　）　3

（　）　4

（　）　5

（　）　6

（　）　7

（　）　8

（　）　9　（非常に役に立つ）

15．方向の説明が書かれた紙を読んでくれる同乗者

（　）　1　（全く役に立たない）

（　）　2

（　）　3

（　）　4

（　）　5

（　）　6

（　）　7

（　）　8

（　）　9　（非常に役に立つ）

16．ナビゲーションシステム（音声と画像で方向を指示)

（　）　1　（全く役に立たない）

（　）　2

（　）　3

（　）　4

（　）　5

( ) 6

( ) 7

( ) 8

( ) 9 （非常に役に立つ）

==

あなたについて

==

17．あなたは日本人ですか？

( ) はい

( ) いいえ

18．年齢は？

_____

19．性別は？

( ) 男

( ) 女性

20．運転免許の取得年数は（免許を取得して何年）？

年 _____

21．普段のおおよその年間走行距離（キロ）は？

キロメートル (km) _____

22．日本の運転免許を持っていますか？

( ) はい

( ) いいえ

23．日本以外での運転経験はありますか？

      ( )　はい

      ( )　いいえ

24．ナビゲーションシステムの使用経験がありますか？

      ( )　はい

      ( )　いいえ

25．
「はい」と回答した場合、最近はナビゲーションシステムをどのくらいの頻度で使用しますか？

      ( )　1　（ほとんど使用しない）

      ( )　2

      ( )　3

      ( )　4

      ( )　5

      ( )　6

      ( )　7

      ( )　8

      ( )　9　（毎日）

===

 ありがとうございました

===

私たちのアンケートにご協力頂き、ありがとうございます。これらの回答は私たちにとって非常に重要なものとなります。このアンケート調査の結果をお知りになりたい場合は、お手数をおかけしますが、itxym2@nottingham.ac.ukまで電子メールでご連絡をお願いします。ありがとうございました。

JJ