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ESCUELA TÉCNICA SUPERIOR DE INGENIEROS DE CAMINOS, CANALES Y PUERTOS

DEPARTAMENTO DE INGENIERÍA CIVIL – TRANSPORTE Y TERRITORIO

Considering Cycling for Commuting: the Role of Mode Familiarity

An exploration on the (circular) relation between cycling behaviours and attitudes toward cycling in Vitoria-Gasteiz, Spain

PhD thesis

Gianni Rondinella

Urban and Regional Planner, Iuav University of Venice, Italy

Madrid, 2015

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Candidate

GIANNI RONDINELLA

Urban and Regional Planner, Iuav University of Venice, Italy

Supervisors

ANDRÉS MONZÓN

Dr. Ingeniero de Caminos, Canales y Puertos

ELENA LÓPEZ

Dra. Ingeniera de Caminos, Canales y Puertos

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TESIS DOCTORAL: Considering Cycling for Commuting: the Role of Mode Familiarity

AUTOR: Gianni Rondinella

DIRECTORES DE TESIS: Dr. Andrés Monzón y Dra. Elena López

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To Roberta and Olmo

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SUMMARY

Is the fact that people like cycling the reason for them to cycle? Or is the fact that they do cycle the reason for them to like cycling? Or is a combination of the two? This kind of questions reflect a problem that can be called 'the cycle of cycling consideration': in order to consider cycling in the set of possible options to be chosen, an individual needs to have positive beliefs about it, especially in the case of 'low-cycling contexts'. However, positive beliefs seem unlikely to be formed with low levels of *mode familiarity*, say, with a low acquaintance with mode features, functioning and images; at the same time, higher levels of familiarity are likely to be reached if cycling is practised over relative threshold levels of intensities and extensively across individual life courses.

The problem looks like a chicken-egg recursive cycle, since the latter condition is hardly met in places where cycling is little practised. In fact, inside the current conglomerate of technologies, infrastructures, regulations, user practices, cultural preferences that have grown around the automobile (the current "socio-technical system of urban mobility", Urry 2004; Geels 2005, 2012) cycling is commonly considered as *difficult*, *unsafe*, *and abnormal*. Consequently, the processes of familiarity forming remain disabled, and, as a result, beliefs cannot rely on mode familiarity as a source of information and influence. Without cycling familiarity, origins of positive beliefs are supposed to rely only on personal traits (affect, values, identities, willingness, etc.), which, in low-cycling contexts, confine the possibility of cycling consideration (and eventual adoption) mainly to 'cycling enthusiasts' who are willing to "go against the grain" (Horton & Parkin 2012), as it results from previous research.

New research conducted by author provides theoretical insights for a different approach of the cycling consideration problem in which the presence of the new construct of *cycling familiarity* is hypothesised in the relationship between mode choice behaviour and the set of psychosocial constructs that are supposed to precede it (beliefs and attitudes). Cycling familiarity is conceived as a measure of the real and the perceived relative intensity of use of a bicycle (building upon Diana & Mokhtarian 2009) which may be differently formed for utilitarian or non-utilitarian purposes. The construct is assumed to be related to the amount

of time, the intensity and the regularity an individual spends in using a bicycle for the two distinct categories of purposes, gaining in this way a certain level of acquaintance with the mode. Familiarity with a mode of transport is conceived as an enabling condition to properly define the decision-making context in which individual travel mode choices are taken, in line with rather disperse research efforts postulating inverse relationships between mode behaviours and mode choices (Tardiff 1977; Dobson et al. 1978; Golob et al. 1979; Golob 2001; Schwanen et al. 2012; Diana et al. 2009; Vij & Walker 2014).

The new construct is built theoretically and methodologically, and a cross-sectional design instrument is employed. Results from a telephone survey in a representative sample of 736 commuters in the Spanish city of Vitoria-Gasteiz, provide suggestive –although preliminary– evidence on the role of mode familiarity as a mediator in the relationship between cycling use and the formation of beliefs and attitudes toward cycling. Measures of both cycling consideration and cycling familiarity are defined making use of exploratory factor analysis. On the one hand, four distinct *cycling consideration* measures are created, based on attitude expressions on four underlying factors relating to the cycling commuting behaviour: on how cycling commuting is considered *green and smart* (G&S); on *its pleasant and suited* character (P&S); on its *efficiency* as a mode of transport for commuting (E); and on the main drawbacks of its use, namely the *difficulties* implied (sweating and being exposed to adverse weather conditions) *and* the sense of *unsafety* it generates (feeling at risk of accidents and getting stressed by traffic) (D&U). On the other hand, dimensions of *cycling familiarity* are measured on two distinct ordinal variables (whether based on the utilitarian or non-utilitarian use) comprising four stages to a complete mode familiarity: *not familiar*; *barely familiar*; *moderately familiar*; *fully familiar*.

For each of the four stages of cycling familiarity defined, statistical significant differences are found, especially for the measure related to the utilitarian use. Consistently, people at the lower levels of cycling familiarity have a lower consideration of the positive aspects of cycling and conversely they exhibit higher concerns towards the negative characteristics than those individuals that are more familiar in utilitarian cycling. Using a bicycle occasionally for practical purposes, as opposed to not using it at all, seems associated to significant higher scores in the three positive factors (G&S, E, P&S) while it appears to be associated to significant lower scores in the factor relating with the negative characteristics of cycling commuting (D&U). A same pattern also occurs with a moderate use, as opposed to an occasional one, especially for the consideration of the negative characteristics.

The results are in line with previous literature based on similar variables (e.g. de Geus et al. 2008; Stinson & Bhat 2003, 2004; Hunt & Abraham 2006; and van Bekkum et al. 2011a, among others), but in this study the differences are observed in a low-cycling context and derive from an analysis of the entire population of commuters, which rises the reliability of results.

The possibility that higher levels of cycling use for utilitarian purposes may lead to more positive levels of cycling consideration opens up to theory and policy implications which are discussed. We argue that the conventional focus on changing attitudes may become less paramount in order to achieve travel mode changes in favour of a more decentred and distributed scheme of influences that allows for the existence of a positive conception of habits, as "pre-reflective embodied intelligence" (Schwanen et al. 2012). Such understandings lead to a more practical approach to cycling promotion, which may be based on cycling 'tasting' and cycling 'exposure'.

Keywords: perception of cycling; cycling attitudes; mode familiarity; travel behaviour

RESUMEN

¿La gente utiliza la bicicleta porque les gusta? ¿O es el propio hecho de usarla la razón por la que les gusta hacerlo? ¿O es una combinación de las dos? Este tipo de preguntas reflejan un problema que se puede llamar '*el círculo de la consideración de la bicicleta*': para poder considerar el uso de la bicicleta en el conjunto de posibles opciones a escoger, un individuo tiene que tener creencias positivas sobre ella, sobre todo en el caso de '*contextos de bajo uso*'. Pero parece poco probable que se formen creencias positivas cuando hay bajos niveles de *familiaridad al modo*, es decir, con un bajo conocimiento de sus características, su funcionamiento y del imaginario asociado; al mismo tiempo, la familiaridad irá alcanzando niveles más altos conforme aumente el tiempo y la intensidad con la que se utilice la bicicleta a lo largo de la vida de los individuos.

El problema parece un circulo recursivo huevo-gallina, ya que es difícil que alguien considere el usar la bicicleta en lugares donde su uso es una práctica poco extendida. En estos lugares, y dentro del conglomerado actual de tecnologías, infraestructuras, reglas, prácticas de los usuarios y preferencias culturales que se han desarrollado alrededor del automóvil (el actual "sistema socio-técnico de la movilidad urbana", Urry 2004; Geels 2005, 2012) usar la bicicleta es considerado por la mayoría como algo *difícil*, *inseguro*, y *anormal*. Como consecuencia, los procesos de aumento de familiaridad con la bicicleta permanecen inactivos. La tesis asume la familiaridad como una fuente de información e influencia sobre las creencias positivas sobre la bicicleta. En 'contextos de bajo uso', sin familiaridad al uso de la bicicleta, estas creencias sólo pueden surgir de ciertos rasgos personales (afecto, valores, identidades, voluntad, etc.). Tal como han evidenciado investigaciones recientes, en estos contextos la posibilidad de considerar el uso de la bicicleta (y su eventual adopción), se circunscribe principalmente a los 'entusiastas', a los que están dispuestos a "ir contra corriente" (Horton & Parkin 2012), limitando el alcance de las políticas de promoción.

La investigación llevada a cabo en esta tesis ofrece un nuevo enfoque al problema del 'círculo de la consideración de la bicicleta'. Para ello, plantea un modelo en el que se introduce a la *familiaridad* como un constructo que media entre el comportamiento final –qué modo de transporte elige el individuo– y el conjunto de constructos psicosociales que preceden la elección modal (creencias y actitudes). La familiaridad al uso de la bicicleta se concibe como

una medida de la intensidad relativa del uso de una bicicleta, real y percibida (basándose en Diana & Mokhtarian 2009) que puede formarse de manera distinta según sus fines (utilitarios o no utilitarios). El constructo *familiaridad con el modo bicicleta* está relacionado con la cantidad de tiempo, la intensidad y la regularidad con la que un individuo ha hecho uso de la bicicleta a lo largo de su vida. La familiaridad se concibe así como una condición que permite definir adecuadamente el contexto en el que se toman las decisiones modales de los individuos, en línea con investigaciones que postulan patrones de causalidad alternativos entre los procesos cognitivos de elección y los comportamientos modales (Tardif 1977; Dobson et al. 1978; Golob et al. 1979; Golob 2001; Schwanen et al. 2012; Diana et al. 2009; Vij & Walker 2014). De este modo se plantea que el esquema unidireccional actitudes-conductas podría no ser completamente valido en el caso de la consideración de la bicicleta, explorando la hipótesis que sean las propias conductas a influenciar la formación de las actitudes.

En esta tesis, el constructo de familiaridad se articula teórica y metodológicamente, y se emplea un instrumento de diseño transversal para contrastarlo. Los resultados de una encuesta telefónica a una muestra representativa de 736 personas en la ciudad española de Vitoria-Gasteiz proveen evidencias que sugieren –aunque de forma preliminar– que la familiaridad juega un papel de mediadora en la relación entre la utilización de la bicicleta y la formación de las creencias y actitudes hacia el su uso. La tesis emplea mediciones para cada individuo con respecto tanto a su consideración como a su familiaridad al uso de la bicicleta. Éstas mediciones se definen haciendo uso del análisis factorial exploratorio (AFE). Por un lado, el AFE arroja una estructura del constructo 'consideración' formada por cuatro factores, tres de ellos asociados con elementos positivos y uno con elementos negativos: (1) de cómo el uso de la bicicleta se considera *verde e inteligente* (G&S); (2) sobre su carácter *agradable y adecuado* (P&S); (3) sobre su eficacia como modo de transporte para ir al trabajo (E); y (4) sobre los principales inconvenientes de su uso, es decir, las *dificultades* implícitas (sudoración y estar expuestos a las inclemencias del tiempo) y la *sensación de inseguridad* que genera (sentirse en riesgo de accidentes y estresarse por el tráfico) (D&T). Por otro lado, la familiaridad al uso de la bicicleta se mide en dos distintas variables ordinales (según se base en el uso utilitario o no utilitario). Como resultado, se puede hablar de que cada individuo se encuentra en una de las siguientes cuatro etapas en orden creciente hacia una familiaridad completa al modo: *no familiarizados; apenas familiarizados; moderadamente familiarizados; totalmente familiarizados*.

El análisis de los datos de los cuatro grupos de sujetos de la muestra, –definidos de acuerdo con cada una de las cuatro etapas de familiaridad definidas– ha evidenciado la existencia de diferencias intergrupo estadísticamente significativas, especialmente para la medida relacionada con el uso utilitario. Asimismo, las personas en los niveles inferiores de familiaridad tienen una consideración menor de los aspectos positivos de la bicicleta y por el contrario presentan preocupaciones mayores hacia las características negativas respecto a

aquellas personas que están más familiarizados en el uso utilitario. El uso, aunque esporádico, de una bicicleta para fines utilitarios (ir de compras, hacer recados, etc.), a diferencia de no usarla en absoluto, aparece asociado a unas puntuaciones significativamente más altas en los tres factores positivos (G&S, E, P&S), mientras que parece estar asociado a puntuaciones significativamente más bajas en el factor relacionado con las características negativas (D&U). Aparecen resultados similares cuando se compara un uso moderado, con uno esporádico, sobre todo con respecto a la consideración de las características negativas.

Los resultados de esta tesis están en línea con la literatura anterior que se ha basado en variables similares (por ejemplo, de Geus et al. 2008; Stinson & Bhat 2003, 2004; Hunt & Abraham 2006; y van Bekkum et al. 2011a, entre otros), pero en este estudio las diferencias se observan en un contexto de bajo uso y se derivan de un análisis de toda la población de personas que se desplazan a su lugar de trabajo o estudio, lo cual eleva la fiabilidad de los resultados.

La posibilidad de que unos niveles más altos de uso de la bicicleta para fines utilitarios puedan llevar a niveles más positivos de su consideración abre el camino a implicaciones teóricas y de políticas que se discuten en la tesis. Con estos resultados se argumenta que el enfoque convencional basado en el cambio de actitudes puede no ser el único y prioritario para lograr cambios a la hora de fomentar el uso de la bicicleta. Los resultados apuntan al potencial de otros esquemas de causalidad, basados en patrones de influencia más descentrados y distribuidos, y que adopten una mirada más positiva hacia los hábitos de transporte, conceptualizándolos como “inteligencia encarnada y pre-reflexiva” (Schwanen et al. 2012). Tales esquemas conducen a un enfoque más práctico para la promoción del uso de la bicicleta, con estrategias que podrían basarse en acciones de ‘degustación’ de su uso o de mayor ‘exposición’ a su uso.

Palabras clave: percepción de la bicicleta; actitudes hacia el uso de la bicicleta; familiaridad modal; comportamiento de elección modal

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1 Introduction: posing the problem

Promoting urban cycling is currently a policy objective that involves many constituencies around the world. Municipal, regional and national governments, international agencies, institutional and grass-roots bodies, as well as research entities are increasingly engaged in finding effective strategies to raise cycling use in urban settings (Heinen & Handy 2012; Handy et al. 2014). A switch to active transportation modes –such as cycling– is increasingly being seen as a way of improving urban sustainability, particularly in view of its benefits in terms of reducing urban congestion and climate change effects, and as means of promoting health (Larsen et al. 2013). However, policy measures designed to increase bicycle use should carefully consider the specific bicycle context in which these are to be implemented, as there is evidence that these measures are not directly transferable from one city or country to another (Heinen & Handy 2012; O'Dolan 2013; Marsden & Stead 2011).

Research shows that the 'cycling context' –including the characteristics of the built environment, and social, cultural and institutional aspects– demands greater attention if a cycling promotion strategy is to succeed (Cervero et al. 2009; Heinen et al. 2011; Heinen & Handy 2012). In cities with a 'low cycling culture' –as opposed to 'bicycle friendly' or 'cycling oriented cities'–, using the bicycle as a mode of transport to perform everyday activities is a difficult 'choice', since the option requires people to "go against the grain" (Horton & Parkin 2012). There are few cyclists, little infrastructure and no cycling culture, leading to a widespread perception that cycling is in some ways an *abnormal* thing to do (Handy & Xing 2011; Pooley et al. 2011). Issues about safety, trip distance, hilliness, lack of physical fitness, bad weather, risk of theft, lack of specific facilities or discomfort are commonly seen as barriers that prevent most people from considering and ultimately choosing the bicycle for urban journeys. In other words, the socio-cultural context plays an important role in considering the choice of cycling (Horton & Parkin 2012; Titze et al. 2007). Aspects that in a low-cycling context can be valued as barriers to cycling, such as the physical effort required to overcome distance or slopes, can be considered a motivator –because it allows a more active lifestyle or an opportunity for physical exercise– in locations with more established cycling culture (Akar & Clifton 2009).

Several factors that affect cycling –and especially cycle commuting– have been identified, and the heterogeneous corpus of literature have been reviewed and synthesized under different theoretical and methodological perspectives (Heinen et al. 2010; Parkin, Ryley, et al. 2007; Fernández-Heredia, Monzón, et al. 2014; Handy et al. 2014; Willis et al. 2014). Within the range of studies into the influence of different variables on cycling, it is particularly worth noting the analysis of how users' riding experience influences the perception of said factors.

Previous experience with the practice of cycling appears as a key factor for an individual considering the possibility of cycle commuting (de Geus et al. 2008; Akar & Clifton 2009; Shannon et al. 2006; van Bekkum 2011). Mode experience can be conceptualized as the real and the perceived relative intensity of use of a specific mode of transport, then by the level of *acquaintance* with its features, its functioning and the images associated to it (building upon Diana & Mokhtarian 2009). This experience is what it is conceived in this thesis as the **mode familiarity**, a concept which share many similarities with what in the transport literature has been conceptualised as *habit* but, distinctly from it, allows for a more positive view on its role for behaviour change.

While habit is typically understood as more or less automatic behaviour acquired through repetition and positive reinforcement, and the challenge is to break or defrost unsustainable, carbon-intensive habits (cf. Gärling & Axhausen 2003; Aarts et al. 1998; Verplanken et al. 2008), mode familiarity is here conceived as tendency, predisposition, ability and intelligence formed though past experience, building on Deweyan ideas, recently recovered for the travel behaviour debate by Schwanen et al. (2012). Rather than as the automatically cued, repetitive behaviour of individuals, mode familiarity – and specifically cycling familiarity– is understood here as a generative and propulsive *capacity* brought about through repetition and belonging to body–mind–world assemblages that exceed the human individual as conventionally understood.

The problem: considering an unfamiliar mode in a low-cycling context

The theoretical premise of this study is that familiarity with a mode of transport is an enabling condition to properly define the decision-making context in which individual travel mode choices are taken, in line with rather disperse research efforts postulating inverse relationships between mode behaviours and mode choices antecedents, like attitude and beliefs (Tardiff 1977; Dobson et al. 1978; Golob et al. 1979; Golob 2001; Schwanen et al. 2012; Diana et al. 2009; Vij & Walker 2014). That theoretical link cannot be supported by the methodological tools employed in this thesis since evidence for causation relationships is not compliant with the explorative nature of this research.

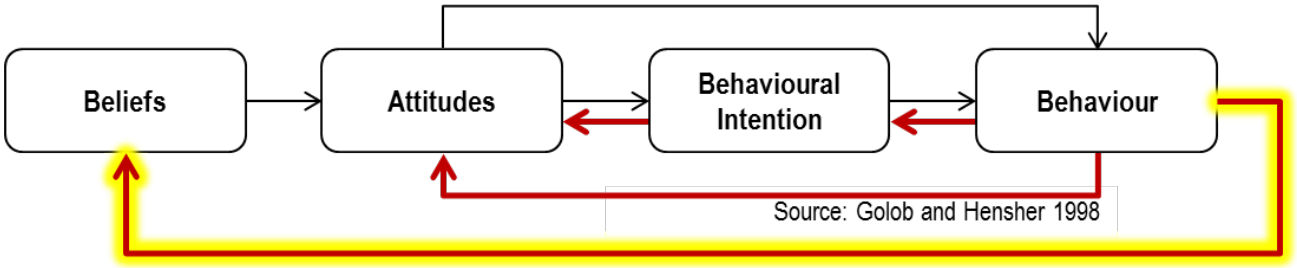


Figure 1. Diagram of the inverse relationships between mode behaviours and mode choices

Nonetheless, assuming such theoretical premise as true, **the problem** this thesis aims to disentangle **is the recursive cycle of cycling consideration**. The problem is schematically represented in Figure 2 and may be formulated as follows.

In order to consider cycling in the set of possible options to be chosen for urban trips feasible to be made by bicycle[1], an individual needs to have positive beliefs about it. This is especially the case of 'low-cycling contexts'. However, positive beliefs seem unlikely to be formed with low levels of mode familiarity; at the same time, higher levels of familiarity are likely to be reached if cycling is practised over relative threshold levels of intensities and extensively across individual life courses. However, the latter condition is hardly met in places where cycling is little practised. In fact, inside the current conglomerate of technologies, infrastructures, regulations, user practices, cultural preferences that have grown around the automobile (the current "socio-technical system of urban mobility", see Urry 2004; Geels 2005; 2012), cycling is commonly considered as *difficult* / *unsafe* / *abnormal* (Pooley et al. 2011). Consequently, the processes of familiarity forming remain disabled, and as result, beliefs cannot rely on mode familiarity as a source of information and influence. Without cycling familiarity, origins of positive beliefs are supposed to rely only on personal traits (affect, values, identities, willingness, etc.), which, in low-cycling contexts, confine the possibility of cycling consideration (and eventual adoption) mainly to 'cycling enthusiasts' who are willing to 'go against the grain', as it results from previous research.

[1] The problem refers to those urban trips without severe constraints at the physical level (i.e. long distances, steep or prolonged slopes, etc.) which would make cycling unfeasible even before entering in the mode choice processes (Kingham et al. 2001; Rietveld & Daniel 2004; Heinen et al. 2010).

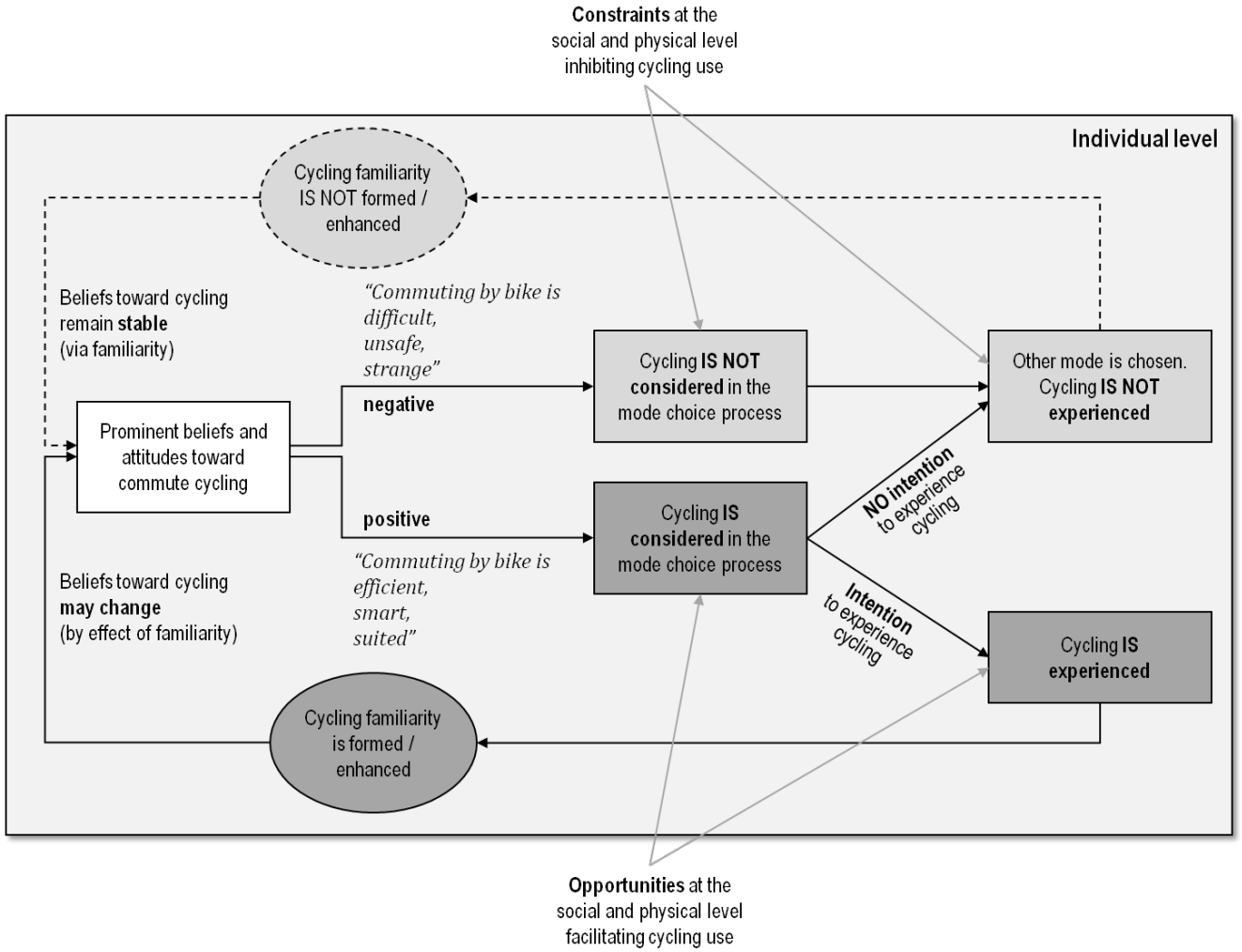


Figure 2. Conceptualisation of the recursive cycle of cycling consideration

Taking into account familiarity in the understanding of cycling consideration permits to reframe the misleading question of "how many people would use a bicycle to commute?" The question is believed as misleading because it assumes the given attributes of the socio-technical system of mobility (Urry 2004; Geels 2012; Marletto 2014) to remain substantially unmodified, unless for specific 'cycling infrastructures´ which do not alter the functioning of the entire system (Watson 2012).

Contribution to the knowledge

This thesis builds upon previous pieces of evidence that *cycling familiarity* does influences the individual's perception of cycling attributes and performances. It has been observed that not only the perception of *barriers* (reasons not to cycle), but also of *motivators* (reasons to cycle) (van Bekkum et al. 2011a; Gatersleben & Uzzell 2007; Muñoz et al. 2013; Akar & Clifton 2009) are influenced by what we can call as *individual cycling familiarity*. Barriers, either individually or collectively formed, are a common inhibitor of cycling uptake which often leave behind perceived motivators (van Bekkum 2011). Especially in low cycling contexts where the socio-technical

systems of transport are designed around automobile access to activities and places (Urry 2004; Geels 2005; Geels 2012), cycling is mostly hardly contemplated as a possible mode of transport (Gatersleben & Appleton 2007). In addition, cycling familiarity influences the extent each person is willing to accept certain policy strategies to increase cycling use. Indeed, –mostly in low cycling countries– some individuals seem reluctant to accept these initiatives –e.g. the provision of cycling lanes or the reduction in maximum speed– as they do not consider to use the bicycle and they foresee these strategies will increase their travel time and/or create inconveniences.

This thesis moves one step forward in the research addressing cycling promotion in 'low cycling contexts', focusing on the role of such *cycling familiarity*. The new construct is built both theoretically and methodologically, and required empirical evidence is collected through an extensive set of research methods (including a telephone survey) in the city of Vitoria-Gasteiz, Spain.

The research is conducted from a twofold perspective. First, it investigates the importance of *cycling familiarity* in influencing the *consideration of cycling* as a mode of urban transport, specifically for commuting purposes. Second, it builds a new theoretical model for the cycling consideration process, in line with rather disperse research efforts postulating inverse relationships between mode use behaviour and the supposed antecedents influencing mode choices.

Structure of the dissertation

The structure of the dissertation is as follows. Next chapter includes a review of the current state-of-the-art literature, on how cycling consideration has been understood so far and which are the knowledge gaps that limit an alternative understanding capable of entangling the problem posed above. Chapter 3 describes the research approach taken by this thesis and the methodological design followed, outlying the elements for a different theoretical framework on cycling consideration in the mode choice process in the light of the defined construct of cycling familiarity. Chapter 4 is dedicated to provide a deep understanding of the 'cycling context' in which the research takes place (Vitoria-Gasteiz), analysing the several ecological layers of its cycling environment and how this affects the ways cycling there is practised and how it is viewed by people. Empirical research undertaken in Vitoria-Gasteiz is subsequently described in Chapter 5, with the research tools employed and the measures taken to build new evidence and insights. Results are subsequently analysed in Chapter 6. Finally, conclusions, discussion and indications for further research are included in Chapter 7.

2 Background and motivation

In order to understand the choice of cycling as a mode of transport, particularly the consideration of it for commuting purposes, the researcher has to cope with the corpus of literature developed by travel behaviour research on mode choice processes and, more broadly, by a wider area of research focusing on human decision-making. During decades, travel behaviour research has been applying several theoretical frameworks to guide investigation around mobility choices and people's transportation behaviour and practices, building upon concepts and evidence taken from behavioural and social sciences, mainly from economics and psychology (Darnton 2008).

Adopting the central assumption that human behaviour is largely driven by rational choices and conscious thought (i.e. maximising benefits and minimising costs), theories coming from mainstream *economics* have traditionally been used for understanding human behaviour, mainly for their ability to formally model it and thus to realize predictions about future actions. Nevertheless, criticism to that excessively simplified assumption has arisen even inside the same discipline, with the increasing recognition of the importance of systematically irrational behaviour, opening up to the branch of behavioural economics to develop and to examine the consequences of the bounds of rationality of human choices.

Also inside *psychology* many theories have been developed, ranging from those that argue that behaviour is driven primarily by conscious and deliberative thoughts, mainly internal to the individual, to those that draw particular attention to the importance of the external influences (environment, situations, social norms…) or to the importance of non-conscious influences, such as habit and emotions.

The vast majority of theories have the common aim of helping explain an outcome (in this case *behaviour* regarding the way people travel) as a function of some inputs (*variables* or *factors*), postulating some relationship between them. Thus, they define a *model* that aims to account for key factors or elements that determine behaviour, considering some sort of cause-effect relationships in a deterministic fashion.

However, models often fail to predict outcomes in real world contexts since human behaviour is complex, and models are deliberately simple. They in fact tend to perform best at explaining and predicting a particular type of behaviour since they have usually been developed with a particular type of behaviour in mind. The models which have tried to account for *all* the factors influencing behaviour (the so called 'comprehensive models'), have as a matter of fact proved inoperable (Jackson 2005). Subsequently, evidence shows that no model matches the reality perfectly and the best understandings are often achieved when more than one model is applied to a particular behaviour (Darnton 2008; Chatterton & Wilson 2013).

Furthermore, while many models of behaviour focus on explaining behaviour at a single point in time (predict an outcome on the basis of current and stable conditions), they generally show poorer performances when the aim is elucidating on how behaviours change over time or could change by effect of policy interventions (Darnton 2008). Not to mention the fact that travel behaviours are a specific set of behaviours that have conventionally been conceptualised as 'derived' demand, i.e. a by-product of the final activity that the person wish to perform and not the primary goal of intentions. Although such conventional wisdom has been widely contested (Mokhtarian & Salomon 2001), behavioural theories often do not properly consider the peculiarities of transport related behaviours.

In this dissertation, attention is placed on one particular type of travel behaviour: the use of a bicycle for travel purposes in current mobility systems, specifically in urban contexts where cycling is not a common option. As highlighted in the previous chapter, focus is then on trying to understand and analyse the antecedents of that behaviour or, better saying, the antecedents of NOT performing that specific behaviour. Attention is placed on **antecedents of cycling consideration**, that is, on the inclusion (or not) of the bicycle in the set of potential ways to perform a particular kind of urban trip –the commuting trips to work and study centres–. Thus, central are the beliefs different people hold about bicycling and why they may or may not see bicycling as a commuting option, trying to understand how those beliefs are different among population and how they may change over time.

In order to provide a theoretical framework to understand this particular kind of behaviour – particularly the processes of its consideration and eventual adoption– and to define the boundaries of the current research, this chapter draw on the following structure. Firstly, a synthetic review of the theories and models used (or eligible to be used) in travel behaviour research on mode choice processes is drawn, with a focus on cycling consideration (Section 2.1). Secondly, the knowledge and the linkages posed by this thesis between cycling consideration and mode familiarity are reviewed in the available literature (Section 2.2). Lastly, research gaps in current knowledge are identified (Section 2.3). As a result, the sequence proposed will provide a base for the building of a conceptual framework for the cycling consideration problem and for the methodological structure of this thesis, discussed in Chapter 3.

2.1 Theories on cycling consideration

Theories and models developed in many different disciplines and applied in travel behaviour research have mainly attempted to understand the relationship that exist between the factors that influence the choice of a particular mode of travel and to the final mode adopted as behaviour by individuals, which is revealed by mobility surveys. To the author's knowledge, no theoretical models have been developed on what is relevant for the disentangling of the problem posed in Chapter 1, i.e. the inclusion of a particular mode in the set of possible options to be chosen, namely its *consideration* as a feasible form of transport. In spite of that, this section first depicts the conventional approaches to travel choice behaviour, describing the main theories which are the ground for the traditional approaches to the travel mode choice problem (the mode adoption) and their utility for the cycling consideration problem (Section 2.1.1). Then, Section 2.1.2 describes the application of theories reviewed to the decision of cycling for commuting and particularly to the consideration problem, identifying the reasons why those approaches are failing to address the problem. Finally, Section 2.1.3 will introduce some theoretical shifts which, questioning traditional assumptions, have been considered to better guide the conceptual and methodological development of this thesis.

2.1.1 Conventional approaches: models to predict (transport related) behaviours

The choice of the mode of transport – as well as other mobility related choices (regarding the route of journey, the destinations, the time to travel, but also the frequency and amount of travel, the location of residence, the vehicle purchasing and ownership, the acquisition of a driving license, the parking choices, the pooling or sharing travel arrangements, etc.) – is commonly understood in the travel research literature and practice as the physical outcome exhibited by a traveller and captured by his/her revealed (or stated) preferences and actions. Most of the research on travel behaviour refers to this term as representing observed physical actions in the travel sector, thus without a deep understanding of psychological or sociological variables and processes that result in these actions.

In this section, most common theories and models developed to predict transport related behaviours will be reviewed, with a focus on the models that have been developed and applied to the process of choosing which mode of travel is used for commuting purposes, i.e. going to the workplace or to school.

The rational behaviour assumed by economic theories

Foundation of travel behaviour research can be found on the central postulates of economics, especially microeconomics (Timms 2008), which studies how individuals and organisations make decisions to allocate limited resources. Individuals (whether people or organisations) are considered as the unit of analysis and their choices assumed to be 'rational', that is they make decisions by

ordering preferences on the basis of the individual costs and benefits of different courses of action; then, they choose the option that maximises their expected net benefits (Jackson 2005). Some broad assumptions underpin the theories that come from microeconomics, also called Rational Choice theories:

- Individuals have *preferences* which are determined by the value associated with different outcomes
- Decisions are made in a stable state: individuals' preferences are *fixed*
- Individuals *maximise* utility
- They act *independently* (their choices are not affected by choices made by others)
- They have *comprehensive* knowledge of the various alternatives available to them.

Consequent to these assumptions, individuals are driven by the desire to obtain the highest possible wellbeing for their self and this process of *maximization of utility* among the set of available alternatives is the result of conscious thought, with individual agents consciously evaluating the costs and benefits of options –hence, ranking them– before consciously choosing how to behave.

Some of these assumptions have been criticised during the decades, mainly for their unrealistic character, so that changes have been made to the classical rational choice theories in efforts to address some of its limitations (Simon 1955; Kahneman 2003). The principle of 'bounded rationality' for example has been introduced by Herbert Simon (1955) in an attempt to address the limitations of some assumptions like the comprehensive knowledge of all available alternatives or the cognitive capacities of the human brain in computing the various utilities and dis-utilities. As the human brain does not have the capacity to either formulate or solve the complex problems required for even a reasonable approximation of objective rational behaviour, an individual is assumed to behave rationally only with respect to a simplified model of the real world by making *trade-offs*. Hence, instead of 'maximising', the individual seeks an alternative that is 'satisficing'. This means the collection of less information and less computation efforts compared to classical rational choice theory (Kahneman 2003).

Developing on the increasingly evidence on how human behaviour was sometimes systematically irrational, with individuals and organisations sometimes taking actions which appeared to undermine their own wellbeing, an entire new branch inside the economics discipline emerged at the end of the last century. Aiming to understand and explain such 'irrational' behaviour, behavioural economics integrated insights from psychology with neoclassical economic theory in order to explain why the economic decisions of individuals and organisations can deviate from purely 'rational' decision-making. Despite the great interest that behavioural economics' key insights have arisen in guiding behavioural change and sustainable consumption policies (Dolan et al. 2010), so far little research has been transferred to the transport domain in order to analyse transport behaviours and travel choices (Metcalfe & Dolan 2012; Avineri 2012).

The utility-maximizing framework posed by mainstream economic perspectives has long dominated the conventional transport theory as well as planning and modelling practices from the 1960s

onwards. A model of mode choice behaviour based on such framework could look as a linear flow where the mode chosen is determined by the expected utility associated to that specific mode, which results from both the attributes of the mode as observed by user and the characteristics of user, such as his socio-economic status, the alternatives available to him, the value he attaches to the journey, etc. (see Figure 3).

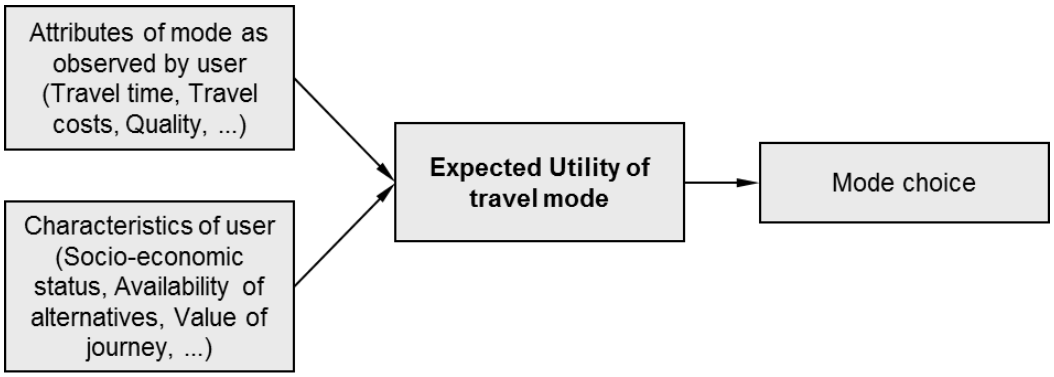


Figure 3. Example of a rational choice model of mode choice behaviour

In the transport field, a particular exemplar of such kind of models have been extremely influential, the so called *discrete choice modelling* based on Random Utility Theory (RUT), a version of Rational Choice Theory developed by the Nobel Prize McFadden and his associates (Domencich & McFadden 1975)[2]. In this framework, each possible choice in the 'choice set' confers a certain 'utility' or benefit to the traveller, reflecting (above other elements) what is referred to as the *generalised cost of travel* (mainly monetary and time costs). The (expected) utility of each choice depends on both positive and negative characteristics of the alternative, the characteristics of the decision maker, and the relative importance of all those characteristics.

The model estimates the probability of a particular choice based on the utility of that choice relative to the utility of all other choices available (Ben-Akiva et al. 1999). The approach recognizes the limitations of such utility to represent the reality of the user and, for this reason, a distinction between *theoretical utility* (defined by the researcher) and user's *real utility* is made. The real utility is the result of the theoretical one plus an *error term* which, in addition to measurement errors, includes the variables unknown to the modeller. By doing so, the difference between the choice really taken and the one supposed according to the theoretical utility is resolved because the problem becomes a statistical problem, with the integration of the error distribution assumed among the

[2] What differentiated travel behaviour theory from Rational Choice Theory (or consumer choice theory) is that transportation choices are discrete (e.g., where to go, when to go, which mode to use) rather than continuous (e.g., how much of a good to buy). For continuous choices, in which small marginal adjustments are possible, researchers could assume common tastes across all individuals; for discrete choices, in which a small change in price either leads to no change or a significant change, unobserved variations in tastes were an important consideration (Domencich & McFadden 1975). To accommodate taste variations, McFadden and others formulated a function for utility that included *mean* utility, reflecting representative tastes, plus a *stochastic* or *random* component, reflecting unobservable variations in taste and unobserved attributes of the choices (Handy 2005).

population. This approach allowed to overcome the barrier of pretending that the researcher could capture the complexity of reality by explicitly recognising the part of user behaviour that could not be measured. However, it also presented many limitations recognised by the same authors. Its mathematical resolution was based on the assumption that the mean error is zero or that it takes a particular type of statistical distribution, whilst experience has confirmed that is not always true. When the role of elements relegated to the 'black box' of the stochastic term is big and the user's choice is not sufficiently explained by the variables present in theoretical utility, this approach proves to be ineffective (as reported by authors like Ben-Akiva, Raveau, Correia, Alvarez-Daziano, Bolduc, etc. cited in Fernández-Heredia 2012). An example of such limitations is just its application to the choice of cycling, as discussed later in Section 2.1.2.

The main applications of discrete choice modelling, in particular Multinomial Logit Models (MLN; McFadden 1978), have traditionally focused on the choice between driving a car and using public transport and allowed for the knowledge and the planning of current systems of urban mobility. They rely on the fundamental assumption of independently and identically distributed random component of utilities (Ben-Akiva & Lerman 1985). In recent years many attempts have been made to include also walking and cycling options, especially for transportation planning purposes in major metropolitan areas (Handy et al. 2002). However, the variables used to represent these modes are usually limited to the observable aspects of the examined alternative (mainly instrumental as travel time, comfort measurements and few others) so they show major limitations to account for other aspects that influence the utility of these choices (people's attitudes, beliefs and values, emotional states or situational circumstances) as it is described in the following sections. Nevertheless, the main scope of these approaches has been the assessment of the whole set of individual choices, mainly for planning purposes, and for such objectives still they do not have viable alternatives.

Recent developments in discrete choice modelling in transport studies have tried to enhance the utility-based framework by accounting for latent factors such as perceptions, attitudes, norms, and decision protocols (Ben-Akiva et al. 2002; Abou-Zeid et al. 2012), i.e. to account for what is left outside by the purely utilitarian focus of Random Utility models. These studies tend to adopt one of the following approaches to overcome the limitations:

- Include some kind of measures of those aspects considered by social psychology directly into the utility function instead of the conventional procedure of placing all matters related to personal preferences, motivations, and values in the error term (Mokhtarian & Salomon 2001; Jara-Díaz et al. 2008).
- Use a hybrid approach that incorporates latent variables whereby people are endogenously classified into groups with similar preferences/attitudes as part of the choice model (Ben-Akiva et al. 2002). For example, the Hybrid Choice Model, developed by Ben-Akiva and colleagues (Ben-Akiva et al. 2002), takes into account perceptions and attitudes and uses more flexible error structures to better model the realism of choice models. Hybrid models were used in a variety of contexts (Di Ciommo et al. 2013), including the choice of cycling (Fernández-Heredia

et al. 2013). Recent developments were also undertaken incorporating modality styles as latent modal references (Vij et al. 2013).

These approaches do make a significant advance in the explanatory power of models regarding the choice of travel modes (including cycling) and in making visible the effect of several kinds of interventions on mode demand, like changes in the built environment, in the availability of infrastructure or by the introduction of pricing measures (Handy et al. 2014). At the same time though, these models are partial. As Schwanen et al. articulate in their analysis, "*changes in socially shared norms and values that shape how people travel, in institutions and in the role of stakeholders other than consumers and policymakers cannot be represented so easily with those models*" (Schwanen et al. 2011, p.997). Furthermore, data availability issues and the difficulty of constructing reliable quantitative measurements of those "more-than-instrumental" factors, lead to neglect crucial elements that mediate people's decision-making, particularly important for soft modes, especially for cycling (as it is described in Chapter 3).

The consideration of internal factors by psychological theories

Insights from economics have soon been accompanied with theoretical constructs from psychology, the other discipline who considers individuals as unit of analysis, since it focuses particularly on how and why individuals, groups and organisations, behave as they do. Many psychological theories of behaviour have traditionally been based around the idea that internal mental states (rather than external conditions) are the main determinants of behaviour. One of such mental states is the attitudinal component, a common factor to many social-psychological models of behaviour.

Attitudes are conceived as the result of a calculation in which the individual balances her/his beliefs about an object (or behaviour) with the value s/he attaches to that object. By this fashion, the approach of psychology is essentially a rational choice one, in which attitudes are still the product of a conscious deliberation (such as in expected utility models from economics). The difference is that psychological theories explore the antecedent factors contributing to attitudes, while in economics the origins of the individual's preferences were left outside of the models (Jackson 2005).

Although other theories exist, the main social-psychological theories applied to travel behaviour are Ajzen's *Theory of Planned Behaviour*, Triandis' *Theory of Interpersonal Behaviour* and Schwartz's *Norm Activation Model* (Panter & Jones 2010; Bamberg et al. 2011). These frameworks have become increasingly popular in transport-related research over the past decade (e.g. Bamberg & Schmidt 2003; Anable 2005; Gardner 2009; Klöckner & Blöbaum 2010; Bamberg et al. 2011) and they are shortly described in the following.

The Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour (TPB; Ajzen 1991) is the most commonly used and supported psychological theory employed in the studies of travel behaviour. It postulates that human behaviour

is the result of an individual's *intention* to perform a particular behaviour. Intention is determined by the combination of three components with each one weighted for its importance in relation to the behaviour:

- the *attitude* toward the behaviour, which reflects an individual's desire to perform a behaviour, namely an individual's degree of like or dislike for some specific behaviour;
- the *subjective norm*, which represents what relevant others think of the behaviour, that is whether or not a behaviour is seen as acceptable or 'normal';
- the *perceived behavioural control*, which describes the individual's perception of how hard or easy it will be to perform the behaviour.

The model has been successively adjusted and in its final version (see Figure 4) postulates that intentions in the strict sense can only predict a person's *attempt* to perform behaviour and not necessarily the actual performance of the behaviour. The ability of intention to predict attempted behaviour, but not actual behaviour, implies that there may be factors beyond the persons' control preventing it. As a latest addition to what seems to be a continuous improvement of the TPB to predict actual behaviour, '*actual behavioural control*' has also been included in addition to perceived behavioural control (Fishbein & Ajzen 2005).

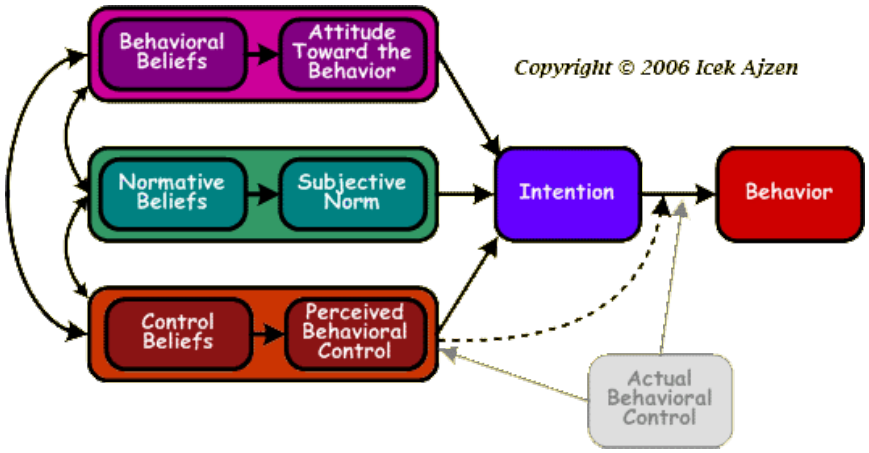


Figure 4. Theory of Planned Behaviour (Ajzen 1991; Fishbein & Ajzen 2005)

Like economic theories previously seen, the TPB offers a view of behaviour which is the outcome of a deliberative and linear process. In other words, it represents the internal procedure happening when someone *consciously think* about how to behave.

The main criticism the model received claims for the absence of any accounts for the role of habit in determining behaviour. *Habit* has been identified as a significant factor in influencing specific behaviours, especially in the transport sector (Verplanken et al. 1997). It is understood that the regular repetition of an attitude-based and thus deliberation-based behaviour, when it is performed again and again because repeatedly proves to be adequate and satisfactory, over time tends to occur unconsciously, without the person having to *consciously think* before performing it.

The Theory of Interpersonal Behaviour (TIB)

Habit has been explicitly included in the Theory of Interpersonal Behaviour (TIB; Triandis 1977), a social psychological theory originally created to predict interactions between people. The model asserts that it is not solely *intention* a determinant of behaviour, but that other two factors play a role as important as intention: *habit* and *facilitating conditions*. Habits and intentions interact with environmental factors that either facilitate or inhibit behaviour. It is argued the stronger the habit, the less the effect of intentions on behaviour, and the other way around.

In the model, habit is determined (and measured) by the frequency of past behaviour, while intentions are determined by *attitude* (as in TPB), *social factors* (*subjective norm* in TPB) and *affection* (see Figure 5).

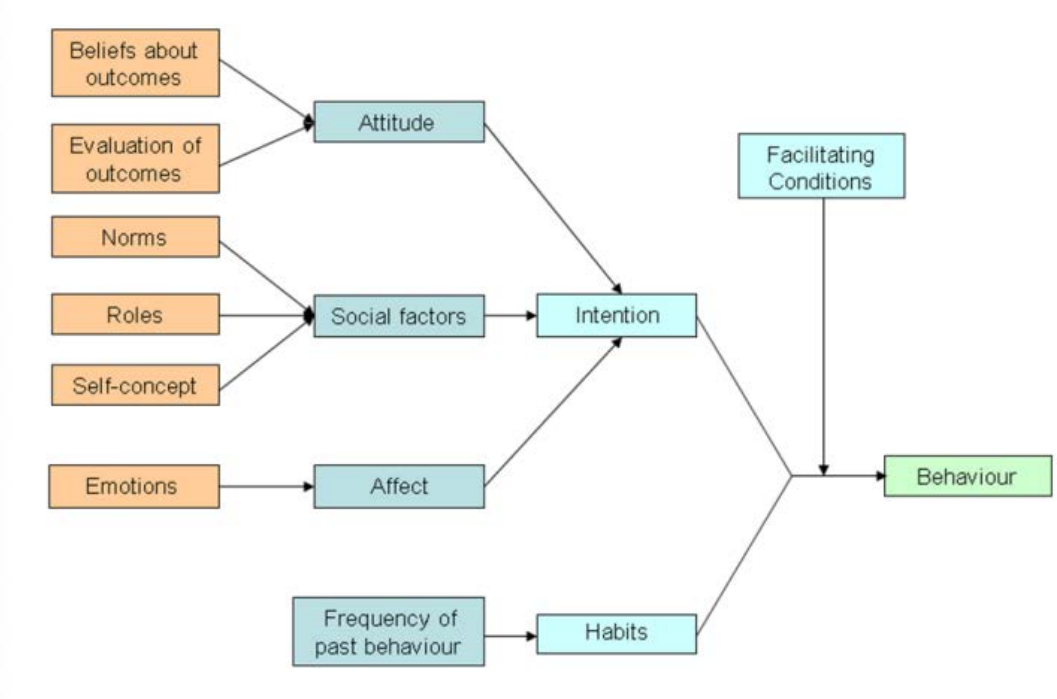


Figure 5. Theory of Interpersonal Behaviour (Triandis 1977; as reproduced in Darnton & Horne 2013)

Another element that differentiates TIB from the more deliberative and 'conscious' view of behaviour proposed by TPB is the inclusion of affection and corresponding emotions. Similar to habit, emotions do not require conscious thought to occur, but the emotions that the performance of a given behaviour evokes for an individual do have an influence on behavioural intention (Darnton & Horne 2013).

The Norm Activation Model (NAM)

Conceived to explain pro-social and environmental behaviour, another influential theory from the social psychology field is the Norm Activation Model (NAM) developed by Schwartz (1977; as cited in Anable et al. 2006). The theory proposes moral or personal norms as the immediate determinants of some behaviours (termed 'altruistic'), rejecting the hypothesis of intentions as determinants of TPB

and TIB. *Personal norms* (PC) are understood as feelings of strong moral obligation and are formed through an adaptation and internalization of societal norms. They are supposed to be activated only when the person becomes aware of the consequences of his/her behaviour (awareness of consequences, AC) and takes responsibility for them (ascription of responsibility, AR) (Klöckner & Matthies 2004; Jackson 2005).

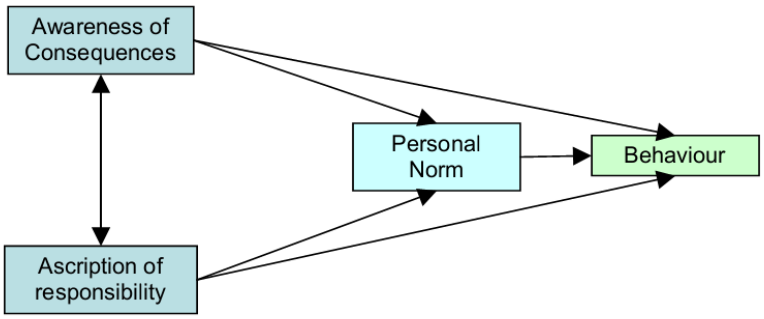


Figure 6. Norm Activation Model (Schwartz 1977; as reproduced in Jackson 2005)

Functioning also as moderators in the link between the personal norm and the behaviour, AC and AR factors are not just causal antecedents of the personal norm: they will strengthen the influence of personal norm in the case where one is aware of the negative consequences of not engaging in the pro-social behaviour and where one accepts responsibility for these consequences. The other way around, the influence will be weaker if one is unaware of the negative consequences and denies responsibility (Jackson 2005).

The NAM model has been updated and extended in various forms in order to explain general environmental behaviour. One of them is Stern's *Value Belief Norm Theory* (VBN; Stern 2000) which extends the domains of motivations for acting pro-environmentally including the egoistic motivation (self-interest) and the biospheric motivation (concern for the welfare of the non-human world), together with the social-altruistic one (concern for the welfare of other people).

Travel behaviour research has increasingly benefited from insights and theoretical advances coming from psychology's theories, providing evidence on the important roles that several psychological and social factors have on travel behaviours. These insights have been integrated with neoclassic economic theory in order to improve the explanation and prediction of the behaviour of travellers (Ben-Akiva et al. 1999; Avineri 2012; Vij et al. 2013). Many aspects of travel behaviour have benefited from psychology-informed studies, making transport studies more textured than those in most utilitarian analyses of behaviour (Schwanen et al. 2011).

Nevertheless, when it comes to develop models able to guide policy interventions aimed at changing people behaviours from current choices to more sustainable ones, several problems have been identified with approaches exclusively informed by social psychology theories, as it is described in the next section.

2.1.2 How conventional approaches address the cycling consideration problem

Theories reviewed in the previous section have been developed with the main aim to predict behaviour and their application to predict modal or other travel behaviours has been described. They base their working mechanisms of the characteristics of actual and common behaviours, or they explain why an alternative behaviour is not chosen in a hypothetic comparison between actual and alternative behaviours. However, they are not so clear at explaining how actual behaviour could change from common to marginal choices or at providing good guidance for the design of policy interventions aimed at modifying crucial determinants of actual behaviours.

Considering the behaviour under examination in this thesis – the choice of cycling for commuting purposes, that is a marginal choice in our socio-technical systems of urban mobility (Horton & Parkin 2012) – we may examine now how this particular behaviour has been conceptualized under the distinct theories and models reviewed above.

The choice of cycling according to economic approaches

The utility-maximizing framework of economic approaches, as applied in travel-behaviour research, conceptualizes modal behaviour as discrete choices and explanatory factors as the attributes of those choices (Handy 2005). Accordingly, in order to consider the choice of cycling is important to take into account the *detailed attributes* of this mode, together with the attributes of alternative travel choices as walking, driving a car or riding public transport. Through the use of the Multinomial Logit Models, the probability of cycling mode is calculated as a function of the utility of cycling relative to the utility of all choices considered. Utility of cycling is thus assumed to be a linear function of a series of its attributes, each with a coefficient that reflects the relative importance of that attribute (the generalised cost of travel). Under the broad utility maximization framework, cycling can be chosen by individuals only when its expected utility overcomes the expected utility of the other available alternatives. Since utility, in turn, is assumed to depend in large part on the generalised cost of travel, this approach tends to emphasize factors at the environmental level. Examples for cycling would embrace mainly *travel distance* or physical effort necessary to cope with *hilliness* for example.

The strength of these approaches is their focus on the mechanism by which the attributes affect the choice. Therefore, they allow the decision-making processes of individuals to be laid out in separate components, to make generalisations and to identify regularities in the mechanisms at the population level by positing an average or representative subject. They do not, however, provide specific guidance on how to think about cycling behaviour as a set of discrete choices or on what attributes might be relevant to those choices (Handy 2005).

The drawback of these approaches is that they are based on a *static* rationale. Since they cannot explain the causal relationships between mode attributes and actual behaviours, what they are modelling are **the choices made in a stable context**, with **fixed preferences**. Consequently, they are

not adequate to indicate which elements should be changed in order to foster cycling behaviour. In short, following the words of McFadden:

> *"only by explaining the causal relationships can the model be used to forecast the effects of future changes in the performance of the transportation system. Otherwise, the model will simply replicate the effects of the transportation system that existed when the model was originally calibrated."*
>
> (Domencich & McFadden 1975, p.4)

In addition, it has been observed that cyclists often do not prioritize the type of variables commonly included in the theoretical utility (as time and cost) and they generally give more importance to other variables that are often hidden and not measured. Not to mention phenomena that have statistical distributions that differ from the normal or the Gumbel distributions, who have unknown mathematical integration into the utility function, and which are common in constructs measuring perceptions or emotions, for example (Fernández-Heredia 2012).

The choice of cycling according to psychological approaches

Psychological approaches, distinctly from utility maximization framework approaches, focus on identifying and defining key psychological and social variables which are meant to determine behaviour. The most known of such theories, the **TPB**, identifies beliefs as determinant. Doing so, this theory does not posit a significant role for the built environment in explaining a modal choice such as cycling, except for what are called control beliefs (the perception of the ease of difficulty to perform the act of cycle). Then, for cycling for example, such factors might include the presence or absence of dedicated cycleways or the level or speed of automobile traffic. Such factors are considered as individual's beliefs – or perceptions – about the existence and attributes of the same factors. At the end, it is the reflection of such objective factors in perceived control beliefs – rather than the objective existence and attributes of the same factors – what explains behaviour.

Nevertheless, the TPB poses much greater attention on attitudes toward the behaviour than on control beliefs. Evidence has been provided on the relationship between attitude toward cycling and actual behaviour: if people have more positive attitudes toward cycling, they will have a higher probability of cycling, as detected by Heinen et al. (2011).

Attitudes toward a specific behaviour are usually defined as the sum of all key beliefs about the characteristics of such behaviour multiplied by the importance that individuals attach to these characteristics (Ajzen 1991). Applied to the bicycle commuting behaviour and its characteristics, the computation of attitudes would be given by:

$$A_{cyc} = \sum_{i=1}^{N} b_i e_i \qquad (1)$$

where b_i is the level of agreement with each of the N beliefs which are prominent in the consideration of bicycle commuting and e_i is the importance given by the person to each belief. A simplified diagram on the application of TPB to the commute cycling behaviour is depicted in Figure 7.

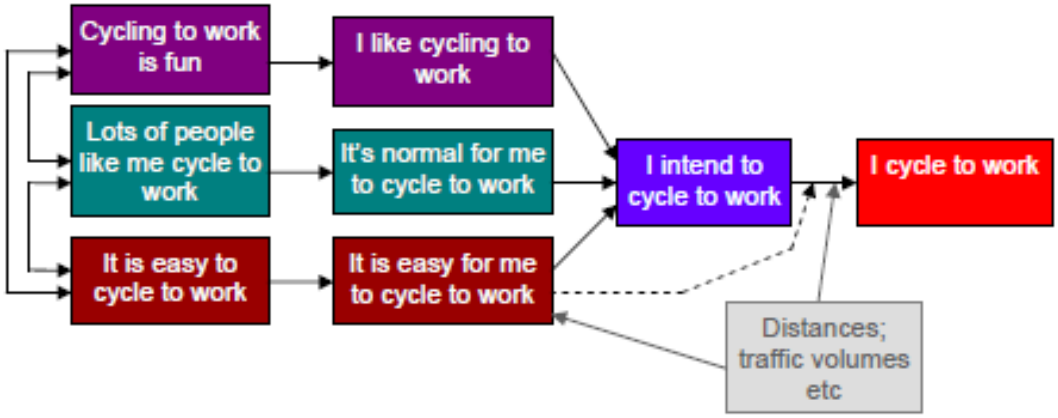


Figure 7. Example of applying Theory of Planned Behaviour to cycling for commuting (Department for Transport 2011)

In the same fashion, according to the TPB, perceived social norms are also key factors affecting the decision of using bicycle to commute, although empirical evidence on this subject is mixed (Bamberg et al. 2003; de Bruijn et al. 2009; de Geus et al. 2008). Non-attitudinal characteristics of individuals, such as gender and age, and the built environment are not explicitly included in the model, as it is assumed that attitudes are derived, at least in part, from these characteristics (Heinen et al. 2011).

Many other studies give evidence on why people decide to travel by bike (for example Fernández-Heredia, Monzón, et al. 2014). It has been noted, however, that it is unclear if cycling is a result of holding specific attitudes, or whether such attitudes are a result of the act of cycling (Heinen et al. 2010; Handy et al. 2010). In fact, doubts emerge when the same model is applied to the opposite (and more common) *choice of not cycling* as depicted in Figure 8.

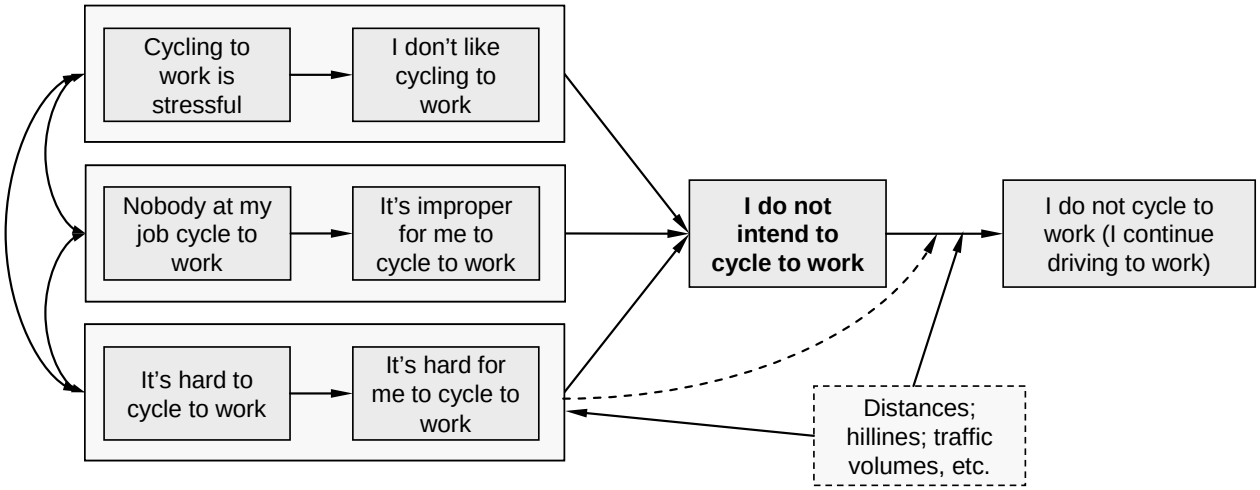


Figure 8. Example of applying Theory of Planned Behaviour to the choice of not cycling for commuting (adapted by author from Department for Transport 2011)

Specifically, it is unclear:

- where the origins of negative attitudes toward cycling lie
- and also, in the literature little is understood about how preferences around bicycling are created and shaped (as we will see in Chapter 3).

In addition, as already noted, the model does not include a relationship between behaviour and habits, and an increasing number of studies exist criticising the TPB for failing to consider how habits mediate the link between behavioural intention and actual behaviour (Verplanken et al. 1997; Aarts & Dijksterhuis 2000).

The commute cycling behaviour is seen slightly differently under the **TIB** (see Figure 9). In the example taken from the Behavioural Change Toolkit elaborated by the UK Department for Transport (2011), the behavioural outcome (*'I cycle to work'*) is the same as for TPB example shown above, but this time a wider range of factors are important in determining the behaviour, including: emotions/affect (e.g. *'I enjoy cycling to work'*), past behaviour and habit (e.g. having cycled to work many times before), facilitating conditions (e.g. short enough distances between home and work and low enough traffic volumes / speed on the route to work).

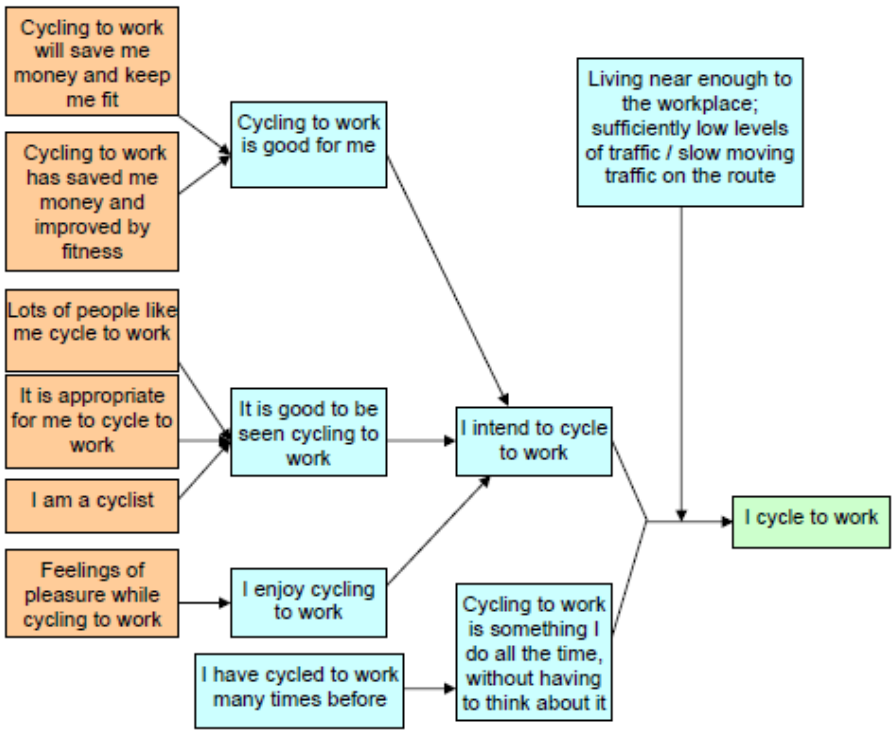


Figure 9. Example of applying Theory of Interpersonal Behaviour to cycling for commuting (Department for Transport 2011)

The TIB has had less application than TPB in the travel behaviour research and practice (Anable et al. 2006), although it has been shown to be a better predictor of behavioural outcomes than other models in behaviours where there is a significant habitual component – such as daily commuting by

car (Bamberg et al. 2003). In their review, Anable et al. (2006) define this fact "surprising" since the framework includes notions of habit, self identity, affective/emotional response, and situational constraints –all of which are omitted from the more commonly applied TPB and NAM models and all of which are extremely relevant in the travel context. Jackson (2005) suggests this is partly due to its complexity. For these reason the application of TIB to the choice of cycling for commuting has the potential to produce better performances than the TPB in explaining choices of (not) cycling.

Following the same strategy applied above for the TPB, the model should be able to explain also the mechanisms determining the opposite (and more common) *choice of not cycling* (see Figure 10).

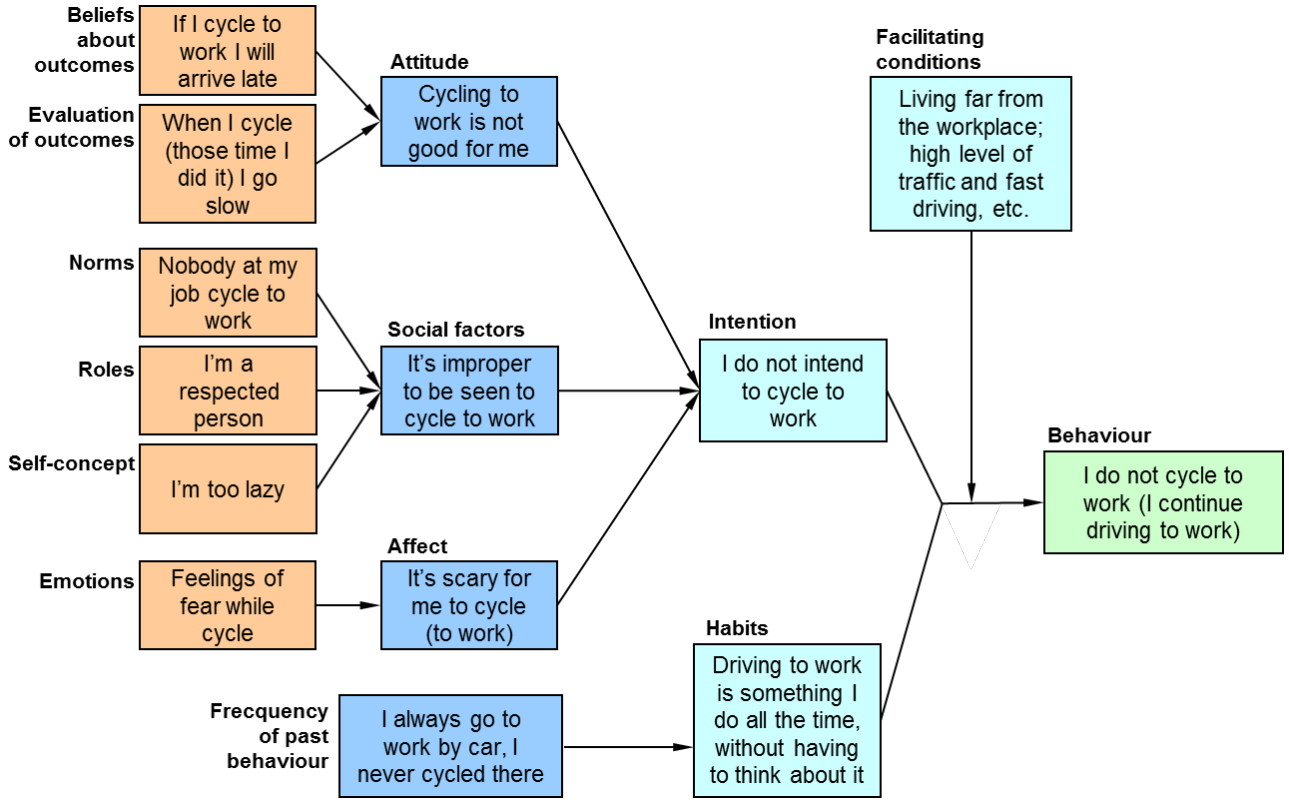


Figure 10. Example of applying Theory of Interpersonal Behaviour to the choice of not cycling for commuting (adapted by author from Department for Transport 2011)

However, in this case also it is unclear if not cycling is a result of holding a specific combination of the three antecedents depicted by the TIB (intentions, habits and facilitating conditions), or whether such antecedents are a result of the act of not cycling, postulating backward relationships as hypothesised in this research. As in the TPB application, it is unclear where negative beliefs toward cycling have their origin and also, how preferences are created and shaped. Although the model does include a relationship between behaviour and habits it is not clear how new habits are formed or may be elicited (Anable et al. 2006; Line 2008).

When it comes to analyse the application of **NAM** to the commute cycling behaviour, the task is more difficult because there have been very few and mixed results in the application of this model in

studies about travel behaviour in general terms. For example, Bamberg and Schmidt (Bamberg & Schmidt 2003) found no significant relations between moral beliefs and car use, while Wall et al. (2007) found evidence of personal norms informing car use reduction goals (Anable et al. 2006).

A particular form of application of this theory to the choice of bicycle has been carried out by Bamberg and colleagues (2011; 2012), through the integration of NAM and TPB in the so called Stage Model of Self-Regulated Behavioural Change, which will be described in Section 2.1.3.

Other drawbacks of conventional approaches

Apart from the drawbacks already mentioned, other shortcomings of conventional approaches exist and they are particularly significant for the problem this thesis poses. In their critical review of scientific research in transport sector, Schwanen et al. (2011) consider at least three issues of psychology-informed travel behaviour research that are inherently expelled into invisibility:

> *First, because of their totalising ambitions, the **degrees of freedom** in terms of the number of factors impinging on behavioural intentions and the structure of relations between those factors are limited. There are clear restrictions on the extent to which differences between people and between situations in terms of drivers of intentions can be captured.*
>
> *Second, models such as TPB and NAM are **static**, as the dynamics over time and feedback processes are generally not considered.*
>
> *Third, those models intellectualise behaviour (Reckwitz, 2002) as they assume that behaviour is first and foremost driven by conscious thought. However, work in sociology, human geography and other fields – known as practice theories (Reckwitz, 2002) and theories of affect (Thrift, 2007; Clough, 2008) – has shown that **conscious thought is but one of many factors involved in behaviour**; semi-conscious factors, embodied capacities and tacit know-how are often at least as important.*
>
> (Schwanen et al. 2011, p.1001, enphasis added)

It is argued that one of the effects of this marginalisation of important aspects of human behaviour may be a factor explaining one of the main challenges of psychology-informed travel behaviour research: the fact that they fail to explain the ***value-action gaps*** between stated values and intentions on one hand and actual behaviour on the other (Blake 1999 as cited in Anable et al. 2006; Shove 2010). Value-action gaps, also known as attitude-action gaps, arise when people do something different to what they say (stated values and intentions). In fact, many behaviour change approaches work on the premise that if people's attitudes and values can be modified (by policy interventions, e.g. awareness and promotion campaigns) they will also alter behaviours of individuals making choices that are (for instance) good for their health or the environment. However, research has shown that despite people state pro-healthy or pro-environmental attitudes and values not necessarily these beliefs are carried through into everyday life because of the many barriers and constraints that block action (Pooley et al. 2013). Value-action gaps are particularly significant for transport related behaviours, being these behaviours strictly linked to stability and lock-in at the level

of socio-technical systems (Kemp et al. 2011; Geels 2012) which generate constraints and barriers unlikely to be overcome by individuals.

Why conventional approaches fail to address the cycling consideration problem

Problems of psychology-informed travel behaviour models not only refer to the aspects highlighted above (i.e. the degrees of freedom, the neglected dynamics of change, the predominance of conscious processes, the value-action gaps). Those drawbacks are mainly related with the cycling *adoption* problem, which is wider and more complex of the problem posed here.

More significantly for the scope of the present study, the shortcomings of conventional approaches refer inherently to the cycling *consideration* problem, as it has been formulated in Chapter 1. The reasons why conventional approaches fail to address the cycling consideration problem may be synthesised in the following:

- First, because **antecedents of beliefs** and attitudes are often neglected, and then they are assumed as given, i.e. no insights on their origins are developed nor conceptualised.
- Second, because **potential backward relationships** between behaviour and its supposed antecedents are neglected as well, and then they are not considered, either theoretically or empirically.

The two concerns are discussed in more details in Section 2.3 on research gaps, after a review of studies dealing with the cycling consideration problem.

2.1.3 The contributions of new models to understand cycling consideration

Conventional approaches have proven to exhibit some limitations in order to tackle the cycling consideration problem as described in Chapter 1. This section will then introduce two theoretical shifts which, questioning traditional assumptions, have been considered to give useful insights for the development of our research and to best guide this thesis. Firstly, the contributions of behavioural change models are introduced. Those models emphasize the importance of considering *time* in models, in order to conceptualize 'change' and they move from the purpose of simulating (hence, predicting) behaviour at a single point in time toward the aim of understanding how change may occur, when is more likely to occur, and what are the conditions for change to take place. Following, the contribution of social ecological models is described. In this case the shift is away from theories which assumed that behaviour could be explained exclusively by internal mental states, towards theories suggesting that external conditions (environmental, social, cultural and institutional ones) are just as important in influencing human behaviour.

The contributions of behavioural change models

Considering cycling as a transport option in current systems of urban mobility implies necessarily a change. While the behavioural models described above tend to focus on explaining and predicting behaviour *at a single point in time*, they present limits when it comes to provide an explanation on how current behaviours can *change over time* or how they can be changed by policy measures. In other words, they lack a dynamic approach. In fact, especially from a policy oriented point of view, an understanding of behaviour alone provides not enough clues to base effective processes for changing behaviour, especially when societal goals urge to make people change from undesirable behaviours such as short distance commute car driving to a more desirable one, i.e. using public transport or riding a bicycle.

The limitations posed by social-psychological models developed to *predict* current behaviours have been highlighted by research in the health promotion domain long before the recent interests rose in the transport field. Back in the mid-20th century scientists and practitioners from the health sector began studying models to *change behaviour instead of just predicting it* because they realized how interventions to promote healthier behaviours failed to bring about a lasting change. Especially for behaviours characterised by strong habits, they noted how the internal cognitive determinants of behaviour such as intentions were often blocked and behaviour change not performed.

Including the variable of time in models, change in behaviour has been conceptualised as a process instead of an event, from distinct disciplines and following distinct approaches. They include social-psychological models which feature a certain progression (showing behaviour, and change, over time), whether this is staged or based on feedback loops. These latter models also feature in *systems thinking* (Bronfenbrenner 1979; Senge 1994), itself a hybrid of disciplines, but developed distinctly from psychology. The literature also includes *learning theory* (sometimes drawing on formal educational theory), showing how people learn and change (both perceptually and behaviourally). When conducted in a group setting, learning can be directed primarily at achieving behaviour change, for instance in breaking habits, or pursuing organisational change. Diverse processes for achieving social change are also identified, based on social networks (for instance, theories of diffusion and social capital).

Here, we review some of those theories which conceptualize behaviour change occurring in stages or steps, because they deal with *intentional* behaviour change, then it is coherent with the social-psychological models discussed earlier (TPB, TIB, NAM and extended TPB). Also because some of the few studies dealing with behaviour change dynamics regarding cycling adopt this class of models (Gatersleben & Appleton 2007; Bamberg et al. 2011; Nkurunziza, Zuidgeest & van Maarseveen 2012; van Bekkum et al. 2011a).

Other approaches dealing with behaviour change dynamics regarding cycling also exists and they proved useful in exploring questions and issues left out of conventional approaches (Handy et al. 2014). Examples are qualitative based studies following the 'mobility biographies' or 'life course' approach to understanding travel behaviour (e.g. Bonham & Wilson 2012; Giele & Elder 1998;

Lanzendorf 2003). Particularly useful are the results obtained by Chatterjee, Sherwin, and Jain (2013), who examined the role of *life events* (e.g. having a child, child starts school, retired from job) as a triggers for changes in cycling behaviour. Such events resulted to be the triggers for a change in cycling when external changes to the bicycle environment played a facilitating role in enabling change.

Stage theories of behaviour change have firstly been developed in health promotion field and then extended to other sectors of knowledge and practice. They propose that the barriers people face in trying to change their behaviour will be different at different stages, qualitatively distinct one of each other. As they were developed as a guiding model for theory-based interventions, the main implication of these approaches is that one type of intervention would not be expected to work for everyone, because the barriers people encounter are different at each stage. Instead, these models propose that interventions will be most effective when they are *tailored* to an individual's current stage in the progression toward change.

The Transtheoretical Model of Health Behaviour Change (TTM)

One of the most well-known models of stage-based behaviour change is the Transtheoretical Model of Health Behaviour Change (TTM), also known as the 'Stages of Change' model, developed by Prochaska and Di Clemente (1984, cited in Prochaska et al. 2008). The model aims at integrating processes and principles of change across more of 300 theories of intervention, hence the name 'Transtheoretical'. The model was originally built for smoking cessation interventions and postulates that, in attempting to change a (addictive) behaviour, a person typically moves through a series of stages, sometimes several times before terminating the undesirable behaviour and establishing an alternative one.

The key organizing constructs of the model are six *Stages of change* defined as follows:

1. *Pre-contemplation***:** in which people are not intending to change or take action
2. *Contemplation***:** in which people are intending to take action within the next six months, but are not ready to take action. Doubts about the effectiveness of action and of uneven costs and benefits may stall people at this stage for some time (in a state of **'***chronic contemplation***'**)
3. *Preparation***:** in which people are intending to take action in the next month; they are very aware of the costs and benefits of change and some behaviour change may already have taken place, including having a plan of action.
4. *Action***:** in which people have made or are making specific observable modifications to their behaviour, usually begun within the last six months.
5. *Maintenance***:** in which people are actively working to prevent a relapse to the previous behaviour, having made the change at least six months previously.
6. *Termination***:** in which the new behaviour has become the 'norm' and there is no chance of relapse.

Progression through the stages is seen as sequential although *relapse* to an earlier stage can occur. The stages are then presented in a cyclical rather than a linear fashion, since movement through these stages is neither unitary nor linear, but rather cyclical, involving a pattern of adoption, maintenance, relapse, and re-adoption over time. A common representation of the model is as follows:

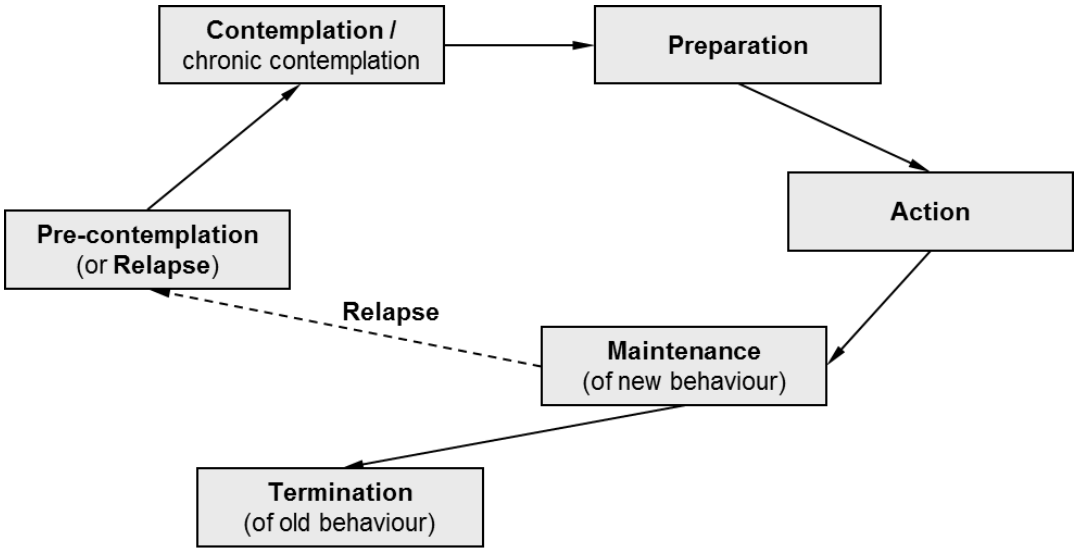


Figure 11. Prochaska and Di Clemente's Transtheoretical Model of Health Behaviour Change (1984, adapted by author from Darnton 2008)

In addition to identifying these stages of change, the TTM proposes that there are ten *Processes of change* (Prochaska et al. 2008), namely, some specific tasks that a person is confronted with in each of the stages:

Between pre-contemplation and contemplation stage

- *Consciousness Raising:* Efforts by the individual to seek new information and to gain understanding and feed-back about the problem behaviour (observations, confrontations, interpretations, reading books).
- *Dramatic Relief [Emotional arousal]*: Experiencing and expressing feelings about the problem behaviour and potential solutions (psychodrama, grieving losses, and role playing).
- *Environmental Re-evaluation [Social reappraisal]*: Consideration and assessment of how the problem behaviour affects the physical and social environment (empathy training, documentaries).

Between contemplation and preparation stage

- *Self Re-evaluation [Self reappraisal]***:** Emotional and cognitive reappraisal of values by the individual with respect to the problem behaviour /(value clarification, imagery, corrective emotional experience).

Between preparation and action stage

- *Self-Liberation [Committing]*: Choice and commitment to change the problem behaviour, including belief in the ability to change (decision-making therapy, New Year's resolutions, logotherapy techniques, commitment enhancing techniques)

Between action and maintenance stage

- *Stimulus Control [Re-engineering]***:** Control of situations and other causes which trigger the problem behaviour (adding stimuli that encourage alternative behaviours, restructuring the environment, avoiding high risk cues, fading techniques)
- *Helping Relationship [Supporting]*: Trusting, accepting, and utilizing the support of caring others during attempts to change the problematic behaviour.
- *Counterconditioning*: Substitution of alternatives for the problem behaviour (relaxation, desensitization, assertion, positive self-statements)
- *Reinforcement Management [Rewarding]*: Rewarding oneself or being rewarded by others for making changes (contingency contracts, overt and covert reinforcement, self-reward).

These are activities or events that people participate in to overcome the barriers they encounter and progress toward their desired state. For example, finding out more about the effects of the behaviour (consciousness raising), learning alternative behaviours (counter-conditioning), seeking support and help from others (helping relationships) or rewarding themselves for making changes (reinforcement management). Furthermore, the different stages are associated with different beliefs (assessment of the 'pros' and 'cons' of the behaviour and self-confidence in ability to change the behaviour).

Further work undertaken by the model's authors (Prochaska et al. 2008) suggests that behaviour change can only take place in the context of an enabling or supportive environment. Their model has also been shown to have relevance for understanding, among other things, patterns of physical activity participation and would have relevance in bringing about change in travel behaviours.

The main implication posed by the TTM is that the effectiveness of the different processes of change will vary according to the stage the person is in, and then it claims for 'tailored' interventions, which take into account the current stage which the individual has reached in the change process. These will be more effective and efficient than 'one size fits all' interventions.

Nevertheless, the above claim has not always been supported by empirical studies. In fact, evidence for the efficacy of the TTM model in describing behaviour change in the context of health behaviours is somewhat mixed. It has been strongly critiqued on conceptual grounds (West 2005) and a number of meta-analyses of intervention studies have suggested that stage-based interventions may be no more effective than those based on other models (Bridle et al. 2005). However, other studies suggest that it is useful, at least for some people (Hawley et al. 2006) and it remains the most widely used model in the health promotion literature at the extent that it is commonly taught to healthcare professionals. Moreover, the few stage-based intervention studies in the transport sector to explore the change of travel mode (e.g. Bamberg 2006) have been designed around the TTM.

In spite of criticism from practitioners inside the health promotion field, the attraction of stage-based models in other field of behaviour change lies in their intuitive and theoretical plausibility and in their ability to explain why interventions aimed at large groups or the general public, such as mass media or community interventions, may not result in widespread behavioural change.

The application of staged models to the transport research field

Contrary to the health sector, it is only in the last decade that the transport sector has begun to use psychological models as relevant tools for explaining travel behaviour and modal choice. Due to the later development of the field in transport sector in comparison to the health sector, research for the former has benefited from and built upon the latest models developed for the latter. Particularly, the recent research in transport is mainly based on two theories, i.e. the Theory of Planned Behaviour (TPB) and the Transtheoretical model (TTM) (Forward 2014).

Some studies in the transport sector have taken the TTM model as is, applying it to the process of shifting travel mode, from car use to more sustainable modes such as public transport or cycling. The basic assumption was that also the shift from one mode to another could be described as a gradual process instead of stand-alone event, and then it could form a basis of transport-specific research. In fact, a transport intervention is not expected to cause immediate changes in the travel behaviour of a person; it is rather expected that step-by-step changes in the attitude will occur, before any actual behaviour change is observed.

TTM has then been used to perform market segmentation of individuals into groups corresponding to each stage, depending on how far advanced they are in switching from one behaviour to another (e.g. from driving to cycling; Anable et al. 2006). Three classes of individuals are distinguished: i) those who have not yet decided to change their behaviour; ii) those who have decided to change and iii) those who are already changing. Doing so, these models mix the fundamental variable of intention (considered in the reasoned action models like TPB) with a measure of actual behaviour (revealed or stated). For these reasons the TTM model has had somewhat incoherent application because of being hard to operationalise for researchers (Brewer & Rimer 2008). Such as in the health promotion field the model aims to enable therapists to tailor therapy to a person's needs at a particular point in the change process, similarly, it was thought to help policy makers to develop more effective behaviour change strategies in relation to altering undesirable travel behaviours (Gatersleben & Appleton 2007).

An exemplar application has been the survey conducted in UK to inform the Climate Change and Transport Choices segmentation model (Anable et al. 2006), which included questions aiming to allocate those who currently drove for commuting into one of the 'Stages of Change', both in relation to using public transport and cycling to get to work. Overall, the findings suggested that those who travelled to work by car were most likely to be in:

- The 'pre-contemplation' stage in relation to using public transport (meaning they had not considered using public transport or cycling to get to work)
- The 'chronic contemplation' stage (meaning they had considered using public transport or cycling to get to work but had decided not to)
- The 'relapse' stage (meaning they had tried using public transport or cycling for commuting but had decided not to continue).

In contrast, far fewer were in the 'contemplation', 'preparation' or 'action' stages. Such findings highlight the importance of the so called **'**Moments of Change**'** (Thompson et al. 2011; Darnton et al. 2011). Moments of change have been described as periods of transition such as starting university, starting work, moving house, changing job, or retiring. A key aspect of moments of change is that activities that were previously habitual (i.e. performed unconsciously, without questioning) suddenly come under scrutiny. The individual consciously questions how such activities should be done in the new situation. For example, someone getting a new job in a different location may suddenly question how to travel in order to get to (the new) job. In this sense, moments of change represent a 'window of opportunity' for those seeking to enable particular choices (Thompson et al. 2011).

The Stage Model of Self-Regulated Behavioural Change (SRBC)

A recent effort to transfer models originated in other fields to the transport-specific change process of shifting mode has been made by Bamberg, Fujii, Friman and Gärling (2011). In their Stage Model of Self-Regulated Behavioural Change (SRBC), they propose a theoretical grounding of soft transport policy measures that aim at promoting voluntary reduction of car use.

The model explicitly conceptualizes shifting travel mode as a transition through a time-ordered sequence of the following four qualitatively different stages: pre-contemplation, contemplation, preparation/action and maintenance. Each of the four stages is characterised by the attempt to solve a specific task, as well as the problems people typically encounter when they try to solve them: in the first stage habitual car users must consciously re-evaluate their current behaviour. If e.g. they come to the conclusion that they want to change their current behaviour (e.g. reduce their car use), in the second stage they have to select a suitable behavioural strategy for reaching this change goal (e.g. walking or cycling instead of car use). If they decide to test cycling, in the third stage they have to plan the steps necessary for actually implementing this behavioural strategy (e.g. organising a bicycle, finding a good cycling route, finding solution for where to park the bicycle, deciding how to deal with bad weather conditions). In the fourth stage they have to evaluate their experience with the new behaviour. If this experience does not fulfil their expectations, they have to modify their behavioural strategy. If the experience is satisfying, they may develop a new cycling habit.

In addition, the model postulates that the transition through the stages is marked by three critical transition points: the formation of a *goal intention* marks the transition from the pre-contemplative to the contemplative stage, the formation of a *behavioural intention* marks the transition from the contemplative stage to the preparation/action stage and the formation of a *implementation intention* marks the transition from the preparation/action stage to the maintenance stage (Bamberg et al. 2011).

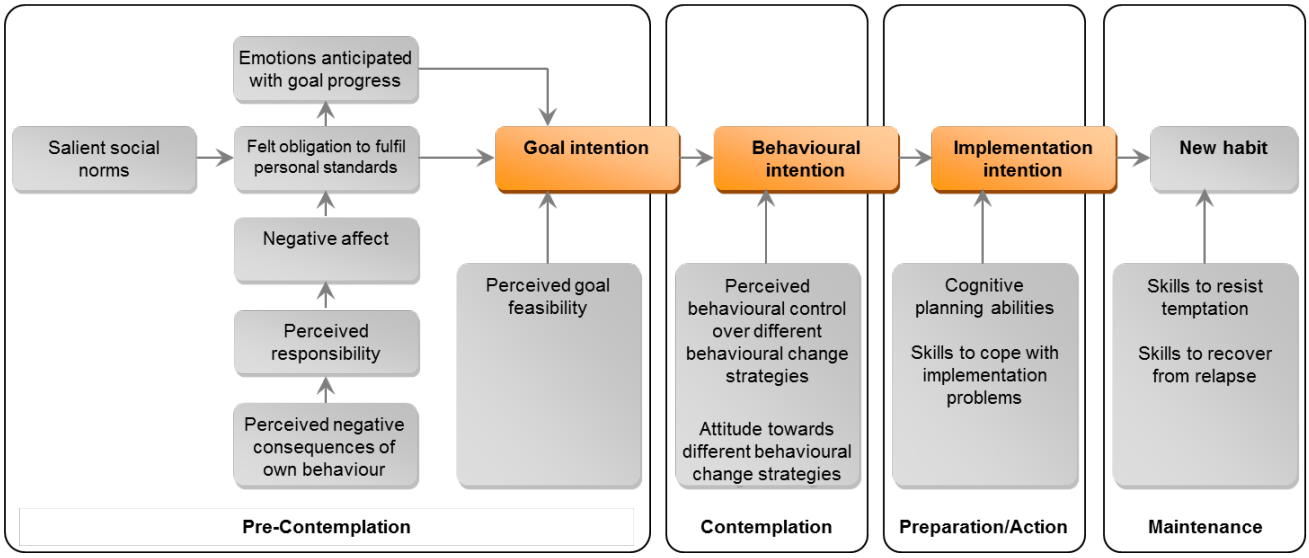


Figure 12. The Stage Model of Self-Regulated Behavioural Change (Bamberg et al. 2011)

Proceeding along this way, the model incorporates an extended version of the TPB model described in the previous section for modelling the decision to cycle or not to cycle (Figure 4), assuming that, in order to change mode, the forming of an "intention is the only direct determinant of [new] behaviour" (Bamberg 2012, p.236).

Doing so, the model assumes that in the pre-contemplative stage habitual car users start to consciously reflect on their current behaviour, when they become aware (e.g. through talk with important reference people or through the media) that their personal car use contributes to damaging the environment. If people accept their personal responsibility, they will experience negative emotions such as feeling of guilt. The internal attribution of responsibility may also raise people's concern about what 'important others' might expect them to do (making social norm salient). Together, negative emotions and social concerns raise self-awareness, a psychological state in which people automatically compare their actual behaviour with important self-standards. The stronger the perceived discrepancy between these self-standards and current behaviour, the stronger should be the feelings of obligation to change this behaviour (activated personal norm). The activation of a personal norm is accompanied by the expectation of positive feelings (pride, satisfaction) resulting from bringing behaviour more in line with personal norm. If personal norm and anticipated positive emotions are strong, and the perceived feasibility of changing current behaviour is high, a goal intention is formed which marks the transition into the next contemplation stage.

In the second contemplative stage, a person considers the personal consequences (attitude) associated with alternative behavioural options as well as perceived difficulty in performing them (behavioural control). The behavioural intention, marking the transition between contemplative stage and preparation/action stages, results from the person weighting of the pros and cons of different behavioural options for reaching the change goal, as well as the perceived difficulty of performing these options.

Once a behavioural intention is formed, the person enters the preparation/action stage. The main task of this stage includes initiating the actions necessary for enacting new behavioural intentions. For this purpose plans have to be made for when and where to act to complete the intended new behaviour. Here cognitive planning abilities and skills to cope with real or anticipated implementation problems are relevant variables. At the end of this stage an implementation intention (e.g. "tomorrow I will check my bicycle and the next day I will use it at 7:30 am for my trip to the university") is formed and the behaviour is actually performed.

The final stage – maintenance – comprises stabilising the changed behaviour and implementing new behavioural routines or habits based on the changed behaviour. The task in this stage consists of coping with unpleasant experiences with the new behaviour and the resulting temptation to fall back to the old behaviour. For this purpose skills to resist this temptation and – if a relapse happens – skills to recover and re-establish the new behaviour are necessary.

As anticipated above, one important practical implication of viewing behavioural change as a transition through a sequence of qualitatively different stages is that, instead of one single intervention for all people, specific intervention packages should be matched to the needs and barriers of people in specific stages. Interventions targeting people at earlier stages of change are likely to be more successful if they concentrate on providing information that can increase both problem awareness and perceived personal responsibility.

The contributions of social ecological models

The theoretical frameworks presented so far focus on individuals; they display and try to model the factors influencing behaviour from within an individual's own psyche. However, the choice of cycling as a mode of transport and its consideration for commuting, has a lot to do with external factors. Being an activity with strong transactions with the physical and natural environment (e.g. distance between home and activities; speed and volume of traffic on route; terrain; weather; etc.), and also with social and cultural characteristics that are beyond individuals, it would be logical to think that one should also look towards those factors conditioning human behaviour from outside one's perceptions as well as psychological factors.

Some of the featured variables by social-psychological models – those relating to self-efficacy and control – incorporate external and contextual factors, but in most cases these do not appear explicitly on the models. Models of this type bring an inherent risk for those trying to understand behaviour change dynamics, namely that they may overlook or underestimate the importance of addressing factors beyond the individual's control or perception.

This potential drawback can be counteracted through reference to another class of models, those developed in the social-ecological perspective which, reverting the relative emphasis on internal and external factors, highlight people's interactions with their physical and socio-cultural environments.

The social ecological perspective is based, not on a singular discipline or theory, but rather on a broad, overarching paradigm that bridges several different fields of research (Stokols 1996; Sallis et al. 2006).

These models focus explicitly on the factors influencing individuals' behaviours from higher levels of scale; they include individual-level behavioural processes as one corner of a chart designed to demonstrate macro-level societal impacts on behaviour. While all the models of societal change feature factors working on multiple levels, some also include feedback loops, showing behaviour formation to be a recursive process between the individual and society.

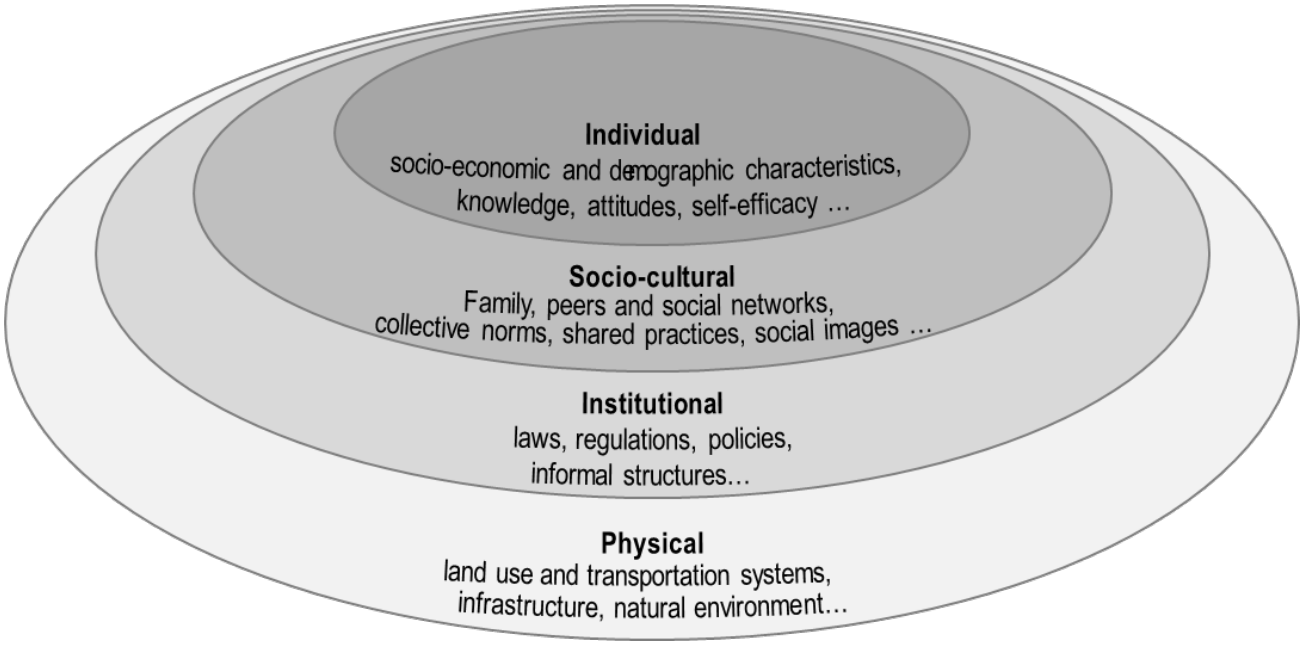


Figure 13. Levels of influence in Ecological Models

Ecological models generate from a long tradition in the behavioural and social sciences, through a progression from the concept that only *perceptions* of environments were important (Lewin and Cartwright 1951, cited in Sallis et al. 2008) to an emphasis on *direct effects* of environments on behaviour (Barker 1968, cited in Sallis et al. 2008). While first models were meant to apply broadly to a wide range of behaviours, more recent ones were created for application to specific health behaviour domains including transport-related behaviours (Owen et al. 2004; Sallis et al. 2006; Bull et al. 2006). Building upon categories and hierarchies of behavioural influences developed by Lewin, Bronfenbrenner, McLeroy, Stokols, **ecological perspective include both families of models**: those mainly designed to help explain behaviour (predict) and those models primarily intended to guide interventions (foster change).

Applications of ecological models to the understanding of influences on behaviour can be found in many branches of health promotion and education, such as tobacco control and diabetes management. One of the recent developments is their application to the domain of physical activity, which relates strictly with cycling for transportation purposes. Ecological models were found to be particularly suitable for physical activity research because physical activity occurs in specific places or contexts, and there is strong support for environmental effects or associations (Sallis et al. 2006;

Gebel et al. 2007). In this context, it is widely acknowledged that both the built environment and psychosocial characteristics are potential correlates, and both should be targeted in interventions.

As occurred with the behavioural change models described in the previous section, also in this case research on travel behaviour models in the transport sector benefited largely from the analysis and outcomes already obtained in the health sector. The transport sector caught up with that line of research and practice and adjusted resulting models according to its own needs and particularities. However, the jury is still out on the transferability of these models and their underlying mechanisms to the transport sector, where much less of a person's well-being is at stake. In any case, insights from this class of models is expected to be essential for the progresses of travel behaviour research as well as the effectiveness of policies aimed at changing travel behaviours (Forsyth et al. 2009).

Principles of the ecological perspective

Four core principles of the ecological perspective help to identify key influencing factors for promoting behavioural change (Sallis et al. 2008, p.470):

1. *Multiple levels of factors influence health behaviours.* Ecological models specify that factors at multiple levels, often including intrapersonal, interpersonal, organizational, community, and public policy, can influence health behaviours. Concepts that cut across these levels include socio-cultural factors and physical environments, which may apply to more than one level. Inclusion of all these levels of influence distinguishes ecological models from theories that primarily focus on one or two levels.

2. *Influences interact across levels.* The interaction of influences means that variables work together. For example, promotion campaigns to be physically active may work better when policies support traffic calming and employers provide facilities for going by bicycle to the workplace. This principle poses a challenge for research since it may be difficult to discern which of the possible interactions are the most important.

3. *Multi-level interventions should be most effective in changing behaviour.* A direct implication of ecological models is that single-level interventions are unlikely to have powerful or sustained population-wide effects. Many examples of interventions targeting individuals have shown short-term effects. Educational interventions designed to change beliefs and behavioural skills are likely to work better when policies and environments support the targeted behaviour changes. Similarly, environmental changes by themselves may be insufficient to change behaviour. For example, providing bicycle parking in all workplaces may have little impact unless this change in the built environment is supported by communication, education, and motivational campaigns.

4. *Ecological models are most powerful when they are behaviour-specific.* Ecological models appear most useful to guide research and intervention when they are tailored to specific behaviours. Often, environmental and policy variables are behaviour-specific. The need to identify environmental and

policy variables that are specific to each behaviour is a challenge in the use of ecological models, because lessons learned with one behaviour, for example, promoting jogging or cycling for recreational purposes, may not translate to an apparently similar behaviour, for example, promoting walking or cycling for commuting. However, general ecological models can be used as the basis of behaviour-specific models that are needed for application to research and interventions.

The ecological model proposed by Sallis et al. (2006) synthesized findings and concepts from the fields of health, behavioural science, transportation and city planning, policy studies and economics, and leisure sciences (Figure 14). The model has a commonly used layered or 'onion' structure to represent the multiple levels of influence, but with three distinguishing features:

- First, the model is organized around four domains of physical activity, reflecting the principle that behaviour-specific ecological models are useful.
- Second, some types of relevant influences are not tied to settings where the behaviour takes place. For example, information environments are ubiquitous, and counselling in health care settings can influence physical activity done elsewhere.
- A third key feature is that social and cultural environments operate at multiple levels.

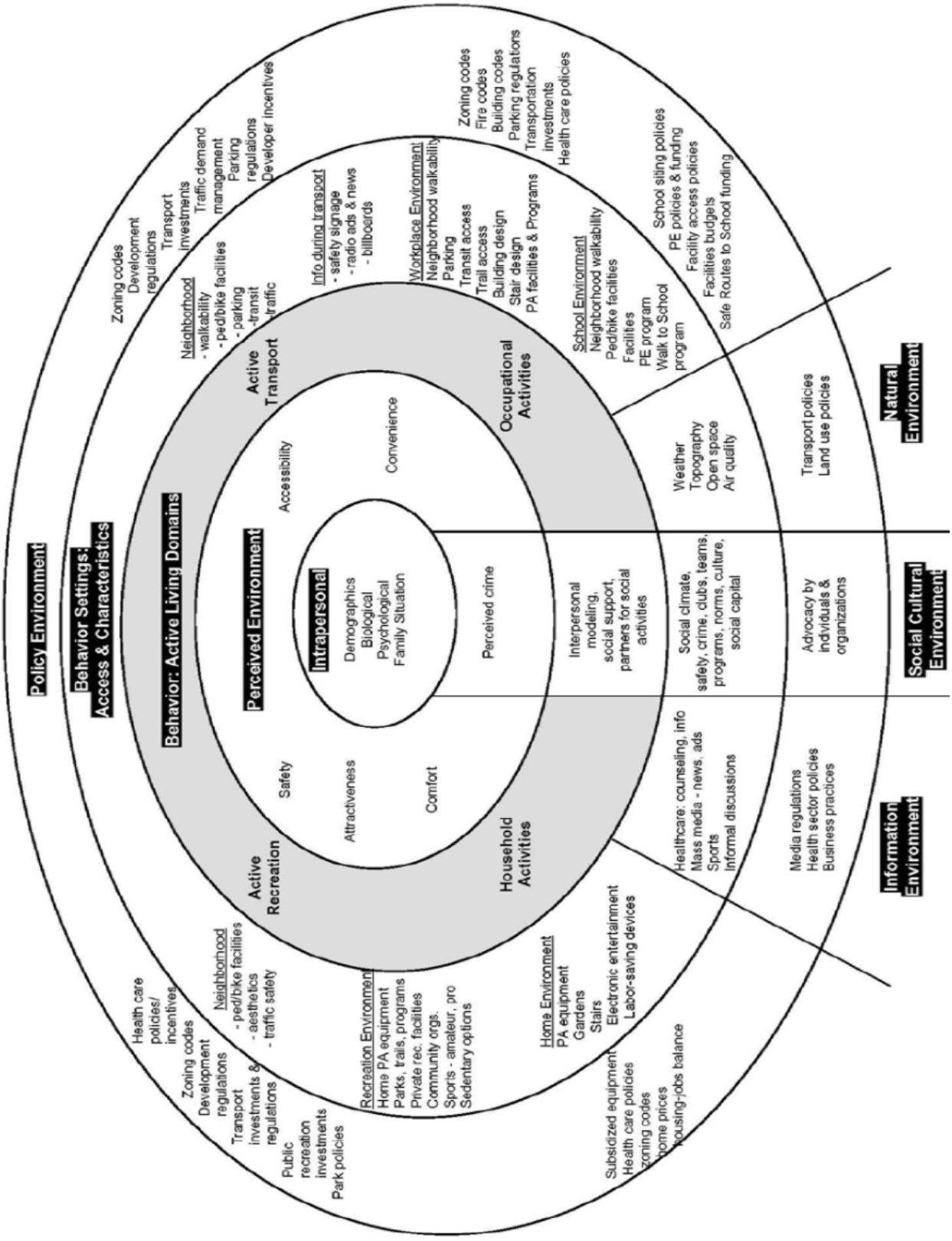


Figure 14. Ecological Model of Four Domains of Active Living (Sallis et al. 2006)

Applications of the ecological perspectives to the transport research field

Reviews of studies from the transportation and urban planning fields made through the use of this kind of theoretical frameworks have found consistent evidence of more walking (and possibly cycling) for transportation among adults living in 'walkable neighbourhoods' (Saelens et al. 2003; Cervero 2008). In neighbourhoods where people walk more, the following characteristics have been noted: land uses are mixed, homes commercial and institutional destinations are closer one from each other, and streets are highly connected, providing direct routes from place to place.

Recently, an ever increasing amount of studies is adopting the holistic conceptual framework of ecological models for research seeking to explain variations in cycling behaviour between individuals. For example, Xing et al. (2010) found that individual (socio-demographics, attitudes, preferences and beliefs, self-efficacy), social-environment (cultural norms), and physical-environment (land-use patterns, transportation infrastructure, and the natural environment) factors have important influences on the balance between transportation and recreational bicycling and on miles of bicycling for each purpose. Handy et al. (2010) confirm the same levels of influences on the decision to own and use a bicycle regularly, for transportation or non-transportation purposes, claiming that a multifaceted approach to increasing bicycling is needed, one that focuses on the individual level as well as the social and physical environments, since is likely to be more effective than strategies targeting only one of the three levels.

Characteristics of the physical environment are of particular interest, given the influence that planners and engineers have over these characteristics. Studies show that various characteristics of the physical environment influence transportation bicycling, though neither the characteristics examined nor the results are entirely consistent across studies. Bicycle infrastructure, including the number of separated bicycle paths and on-street bike lanes per kilometre, and the proportion of off-road routes seem to have a significant effect on bicycling (Parkin, Wardman, et al. 2007), though one study did not find any association (de Geus et al. 2008). Facilities such as bike racks or lockers have also been found to influence transportation bicycling (Stinson & Bhat 2004). Dangerous traffic conditions or larger traffic volumes were found to be determinants of not bicycling for transportation (Parkin, Wardman, et al. 2007), though de Geus et al. (2008) failed to find this association. Land-use patterns, such as population density and accessibility to the workplace or transit, were associated with bicycling for commuting (Stinson & Bhat 2004), but the relationship was unclear in de Geus et al. (2008). Parkin et al. (2007) found a significant effect of natural environment factors such as hilliness and weather.

In spite of enthusiastic acceptance through several research domains, according to extensive studies reviews (Panter & Jones 2010; Gebel et al. 2007) the majority of studies undertaken to date have explored the roles of either psychological or environmental influences as correlates of active travel. Few though have examined the influence of components from both domains together.

2.2 Cycling consideration and mode familiarity in the literature

In the previous section theories and models applied in travel behaviour research to the understanding of mode choice processes and potentially eligible to be useful to guide this thesis were reviewed and critically analysed. The exploration has permitted to see how theoretical frameworks are useful in categorising the factors influencing behaviour (and the links/relationships between these factors), although no single theoretical framework is able to explain properly travel behaviour in that no one framework includes all of the factors deemed relevant.

In order to further define the boundaries of this dissertation and drawing a map of current state of knowledge, in this section, a cross-section of the literature aimed at the understanding of the specific behaviour of urban cycling and/or dealing with the cycling consideration problem is presented, as well as a discussion on how findings obtained in those studies have contributed (or not) to the current understanding of the consideration of cycling and its eventual adoption.

Research on urban cycling has covered a wide spectrum of topics, using several types of methodologies under different theoretical and epistemological perspectives. Studies have ranged from identification of barriers and benefits as factors that block or foster bicycle use to extensive qualitative analysis based on interviews, group discussions, observation and other materials; from detailed case studies to analysis of aggregated data across various scales; from evaluation studies aimed at assessing the effectiveness of promotion measures and strategies to meta-analysis that examine the impacts of different sets of strategies across a large number of cases (Forsyth et al. 2009; Krizek et al. 2009; Handy et al. 2014).

Inside the heterogeneous corpus of the literature dealing with the use of bicycles, the studies that inherently invest the scope of this thesis are those addressing the individual decision to use a bicycle for utilitarian purposes, especially in urban contexts. Much of this literature moves around the attempt to **identify the set of factors** affecting bicycle use with the explicit or implicit aim to measure their relative level of influence to better guide policy instruments. Also within this bounded field, the studies are heterogeneous and they have been synthesized by several reviews under different theoretical and methodological perspectives (Handy et al. 2002; Heinen et al. 2010; Parkin, Ryley, et al. 2007; Panter & Jones 2010; Forsyth & Krizek 2010; Willis et al. 2014; Fernández-Heredia, Monzón, et al. 2014). This section refers to those reviews and to the corresponding studies with the aim of organizing evidence and results according to the objectives of the thesis.

Since our interest is the role that what has been called ‘mode familiarity’ has in the consideration of cycling as a mode for commuting, after synthetically reviewing the available literature in relation to bicycle use (Section 2.2.1), studies which have explicitly dealt with cycling consideration are reviewed (Section 2.2.2), as well as an exploration on the studies which have attempted to analyse the influence mode familiarity is presented (Section 2.2.3).

2.2.1 Research on factors influencing bicycle use

A high number of factors have been identified as influent on bicycle use from inside the transport field. Historically, a great attention has been devoted to those aspect related to the safety of cyclists, their objective and perceived risk, and on the possible solutions geared at increasing safety, mainly focusing on infrastructure provision (Abraham et al. 2002; Hunt & Abraham 2006; Akar & Clifton 2009; Pucher et al. 2010).

Continuing the tradition and the experience developed on the travel behaviour research, many studies have considered cycling in the same line of other modes of transport and so they have extended their attention on the effects of the natural and the built environment, or on the socio-economic characteristics of population and groups, or considering the very fundamental aspects related to the transport utility of the mode.

Along these lines, in order to identify factors and to what extent they influence the choice for cycling, authors have used techniques based on observation of actual behaviour or revealed preference surveys (Noland & Kunreuther 1995) or a combination of those with stated preference surveys, in which hypothetic scenarios are presented to the respondent (Ortúzar et al. 2000; Tilahun et al. 2007; Wardman et al. 2007; Stinson & Bhat 2003; Hunt & Abraham 2006; Monzón et al. 2008). Other kind of data sources have also been used (Pucher & Buehler 2011; Rietveld & Daniel 2004). Typically, demand models are estimated from surveys. They often are logit models (multinomial or mixed) in order to understand and predict the behaviour of users with a specific choice or to know the relative strength of each factor on choice or on the perception of some specific aspect. The collection of information has been used to analyse the variations of cycling use and perception (among population groups, in time, over space, etc.) and then, to identify which factors or actions are best suited to promote such differences.

One of the first studies modelling a large set of influencing factors has been the one carried out by Rietveld and Daniel (2004). They analysed municipal policies in various Dutch cities to know what and how much are they associated to differences in the use of bicycles. They perform a bivariate and multivariate analysis of the data obtained through surveys and information from various sources through which they conclude that the factors that influence differences in cycling are mainly related to the physical environment (altitude differences and city size) and to some characteristics of the population (proportion of young people). Among the variables related to transport policies implemented by local authorities the most important regard the number of stops at intersections that cyclists have to do, the obstacles in the street and the aspects related to traffic safety and personal security, showing more bicycle use where policies improve the attractiveness of cycling by reducing its generalised costs and, at the same time, they make competing modes more expensive.

After conducting a review of previous research related to influences on cycling behaviour, Hunt and Abraham (2006) developed a stated preference survey in Edmonton (Canada) to examine the influence of various factors on the use of the bicycle. The results obtained by the estimation of logit

models representing the choice behaviour indicate that time spent cycling in mixed traffic is more onerous than time spent cycling on bike lanes or bike paths; that secure parking is more important than showers at the destination; and that cycling times on roadways tend to become less onerous as level of experience increases.

To predict trends in the rate of workers commuting to their place of work by bicycle and the impacts of different measures to encourage urban cycling, Wardman et al. (2007) developed a hierarchical logit model for the trip to work, paying particular attention to cycling mode. The model combines data from revealed preference and stated preference surveys, concluding that the existence of segregated bike lanes positively influences the use of bicycles, as well as payments for cycling to work were found to be highly effective.

Another vast area of research focusing on the understanding of cycling behaviour is the interdisciplinary field of planning which focus specifically on practice, looking for the best ways to orient strategies for cycling promotion or more in general for sustainable mobility and sustainable communities.

Along these lines, Parkin et al. (2007) examine a range of quantitative analyses of cycling behaviours through the review of quantitative evidence discussing the relative contributions made by different factors to cycling levels. Factors explored include social and demographic elements such as class and age, physical factors such as climate and hilliness, and infrastructure design factors. They describe and evaluate findings from a range of quantitative analyses, recommending developments to enhance the contribution of quantitative methods to the understanding of the issues affecting cycle use.

Pucher and Buehler (2008) analysed aggregate data at the national level and cities of different sizes in the Netherlands, Denmark and Germany to demonstrate how traffic safety measures and policies to promote cycling associated to policies discouraging the use of motorized transport encourage the use of bicycles. Such integrated policies, acting coherently, are found to be the main factors that make levels of bicycle use in these countries much higher than those achieved by countries like the UK and USA.

Forsyth and Krizek (2010) draw on a comprehensive summary of the literature (300 studies) to understand better why people fail to walk or cycle more and, specifically, what planners can do to encourage these non-motorized modes. Through linking research to practical advice, they attempt to fills the gap between the two focusing on a broad spectrum of ‘levers’, both hard (physical) and soft (non-physical), comprising factors into six areas: community or urban design, infrastructure availability, infrastructure quality, information and education programs, pricing and convenience, and a final one dedicated to combined strategies. A similar approach is taken by Pucher et al. (2010).

In recent years, increasing has been the attention of researchers on the psychological aspects related to cycling, including attitudinal, affective and symbolic factors. Also the influence of the social environment has been a fruitful area of research, either looking at the cycling behaviour or else, taking the collective practices of cycling instead of the individual behaviours as the unit of analysis, dealing with cultural patterns and shared norms.

Titze et al. (2008) provide one of the first studies in this sense. They determine the association between context-specific built-environment, social-environment, and personal-level factors on the one hand, and bicycling for transportation on the other, within a representative sample of adults in a mid-sized Austrian city. Grounded on the conceptual framework of ecological models (Sallis et al. 2008), they highlight the importance of cycling-related social support and perceived benefits and barriers. Among context-specific built-environment factors, they find the significant influence of cycleway connectivity as a determinant of cycling as a means of transportation among adults.

Heinen et al. (2010) make an effort of subdividing the influencing factors into five groups and provide a discussion for each group with a special attention to those affecting cycle commuting. Studies on factors from the built environment, the natural environment, the socio-economic domain, the psychological sphere and a final set of further aspects related to cost, time, effort and safety are reviewed and discussed and research gaps are identified, especially regarding the need for the transport field to recur to other branches of knowledge in order to deepen the understanding on attitudes and people's social environments.

One of those different knowledge's perspective is the range of studies focusing on health promotion, exhibiting a special attention on physical activity and active travel. Along these lines, Panter and Jones (2010) describe current knowledge of the psychological and environmental determinants of active travel in adults, proposing ways in which the two domains may be integrated. They first outline the studies from both domains separately, then they identify those works which have combined both domains, before considering opportunities for better integration and exploring the potential for more inclusive models of active travel behaviour.

One recent attempt to develop a better understanding on the research needs identified by Heinen et al. (2010) –namely the influence of perceptions, attitudes, habits and social environments on cycling– has been made by Willis et al. (2014). They summarize what is known about the effect of these factors on the decision to cycle for transportation and the methods being used to measure these effects, overviewing the major theoretical models used in travel behaviour research. The findings highlight how social factors clearly affect the decision to commute by bicycle, highlight the importance of thinking beyond the role of physical and built environment factors when attempting to understand or predict bicycle use.

2.2.2 Cycling consideration instead of bicycle use as the object of study

Regardless of the factors that influence the choice of cycling as a mode for utilitarian transport or for commuting (i.e. its final adoption as behaviour which is revealed by mobility surveys), what is relevant for the disentangling of the problem posed in Chapter 1 is **the inclusion of the bicycle in the set of possible options to be chosen**, namely its *consideration* as a feasible form of transport. In fact, as observed by various authors (Gatersleben & Appleton 2007; Nkurunziza, Zuidgeest, Brussel, et al. 2012), in low-cycling contexts, cycling may not be considered as a feasible mode by all commuters, and then the problem is that often it does not even enter in the cognitive processes discussed in Section 2.1.

In contexts in which very few non-cyclists appear to have any intention of cycling (Dickinson et al. 2003) is the *perceived situation* of the reality what should be considered in order to understand and possibly act on the determinants of such perception (van Bekkum 2011). A need for this kind of studies is precisely recognised by Heinen et al.:

> *"[…] individuals in identical situations and in the same socio-economic groups choose to commute using different transport modes. This implies that an individual will base his or her choice not on an objective situation, but on their perception of that situation; their eventual decision is thus also grounded in internal factors".*
>
> (Heinen et al. 2010, p.83)

The studies aimed at analysing which factors influence perceptions and mental representations of the cycling mode constitute a distinct class of studies with respect to those reviewed in previous section. In this class, a large number of researches may be included.

A relevant number of such studies has 'intention' as the outcome of the models used, as in TPB and NAM models (Bamberg et al. 2003; Heinen et al. 2011; Forward 2014; Willis et al. 2014; Bamberg 2013; Gatersleben & Haddad 2010; de Bruijn et al. 2009; Muñoz et al. 2013; Sigurdardottir et al. 2013; Davies et al. 2001; Verplanken et al. 1997; Wall et al. 2007; Eriksson & Forward 2011; Whitmarsh 2009). Others deal with the construct of 'stage of change', as in TTM model (Gatersleben & Appleton 2007; van Bekkum et al. 2011a; Shannon et al. 2006; Crawford et al. 2001; Nkurunziza, Zuidgeest, Brussel, et al. 2012; Forward 2014). Some of them analyse the 'propensity' to cycle, without referring to any specific theoretical framework (Wardman et al. 2007; Parkin, Wardman, et al. 2007; also in Davies et al. 2001). Others again deepen into the concept of 'mode appraisal' (Börjesson & Eliasson 2012). Finally, another group of studies are those that developed the so called 'consideration models', or 'choice set generation models' (Fiorenzo-Catalano et al. 2004; Nurul Habib et al. 2011) but they are not focused on the cycling mode.

In all the cases, to be considered or not in the choice process is a situation that is measured in various forms, and that indicates that the object of choice (the final mode behaviour) is present or not in the choice set of options available. Consequently, whatever the conceptual model followed, the consideration construct is conceived as a result of the accessible beliefs hold by people about the

object of choice and what matters is whether the combination of those beliefs works for or against the performance of the behaviour. Hence, the construct of cycling consideration conceived in this thesis mirrors the decisional balance construct of TTM and the outcome expectancy construct of TPB.

2.2.3 Previous conceptualisation of mode and cycling familiarity

In the following a review on the studies which have attempted to analyse the influence of what has been defined as 'mode familiarity' is presented.

Research on mode familiarity

The concept of mode familiarity has been initially proposed back in the seventies. Mode familiarity, as well as mode satisfaction, is believed to be an obvious but very useful determinant of mode expectations. It is observed that people tend to choose a given mode and stay with it if they are satisfied, even though other modes may be more appropriate for them (Bostick & Todd, 1966). In fact, descriptive results show how individuals do not choose a mode of travel because they are not even aware that it exists, or know so very little about it as to ignore it (Sheth 1976). At that time, focus of travel behaviour research efforts was on the disequilibrium between the automobile system and the public transport system and a lack of mode familiarity was believed to interest the public transport services.

More recently, the general concept of familiarity with transport modes has been isolated and first measured by Diana and Mokhtarian (2009) in relation to multimodality. *Familiarity with different transport modes* could be expressed through measures of the real and the perceived relative intensity of use of different modes. From the point of view of an individual, his/her familiarity with a given mode is probably more related to the amount of time s/he spends in using it than to the distance travelled. Diana and Mokhtarian would say that, for example, "a person using a bike 2 h per day is **more acquainted** with bikes than a car driver using a car 2 h a week is with his car, although the weekly mileage could be comparable given the different mean speeds of the two modes." (Diana & Mokhtarian 2009, p.109, emphasis added)

For the aims of this research, a subsequent study by Diana is especially interesting (2010). Indirectly, he postulate a similar hypothesis that we posed: "self-related factors such as attitudes, lifestyles or personality traits seem to play and even greater role in a decision-making context where information on the new alternatives is incomplete. […] the mode choice scheme is particularly challenged because we simply cannot collect Revealed Preferences (RP) data from the field if the service is not existing, so that traditional model estimation and calibration processes could be jeopardized. An even greater concern can arise when the new service itself is not well known by potential users because of its technological content, so that usual theoretical assumptions concerning the knowledge of the

alternatives in the choice set are hardly met and methods such as Stated Preferences (SP) experiments may prove ineffective." (Diana 2010, p.430)

The latter problem is also mentioned by Marletto in the more general approach on socio-technical change (Marletto 2011, p.3): "Technologies are 'configurations that works' (Geels 2005, p.11): they are made of artefacts (if any) and routinized knowledge, and they fulfil one or more functions. Technologies are invariably systemic and almost always embedded in a specific environment of economic and non-economic organizations and networks."

Recently, Jacques et al. have used the same concept of familiarity with the travel options available (2012, p.632): "The number of years that an individual has been involved with McGill was used as an indicator of familiarity with the transportation options available to arrive at their destination", interestingly related to the concepts of **captive vs. choice** users of the modes of transport.

The concept of familiarity with a mode has also been used with respect to the freight mode choice of shippers: "We found that familiarity with a mode, especially trucking, also had a strong influence on mode choice behaviors […] some of the findings, especially the effect of the variables related to the decision-maker, such as the **past experience and familiarity with modes**, are unique and provide valuable insights into the mode choice behaviors." (Samimi et al. 2011, p.868).

Another field of application is in the *assessment of risk* in the choice of a travel mode. A riskier day-to-day activity might not receive the same kind of attention as an unfamiliar, yet statistically safer activity. Most people drive a car several times a week, but take a train, a boat or an airplane much more rarely. The experience gained as a driver or even as a passenger of a car usually teaches us that the risk of an accident is actually quite low – and most people get used to the irreducible amount of risk and do not even think about it most of the time. The same kind of experience is, of course, a lot more difficult to gain when it comes to other transport modes, in particular the air transport. The same is theoretically applicable to the choice of cycling: if a bicycle is used sporadically and only for a particular type of trips (e.g. recreational), the **assessment of its inherent risks** would be higher than a mode used daily.

The construct of familiarity has a long history in marketing studies, related to *product and service familiarity* (Whan Park & Parker Lessig 1981; Johnson 1984). In that field, valuable insights on the constitutive elements of mode familiarity have been developed and they can be useful to operationalise the construct in the current research. Hoeffler et al. define two dimensions of familiarity linked to experience: "we believe that experience is two-faceted. On the one hand, experience can be construed as **more intensive**. For example, consumers may have been interacting for years with a certain product. Thus, their familiarity is considered high in terms of the amount of experience. On the other hand, experience can be construed as **more extensive**. For example, a consumer may have enjoyed fewer consumption episodes in a given product category, whether in terms of frequency or quantity, but his or her spectrum of experience may be much broader. In this case, experience is considered high in terms of breadth or extensiveness. We investigate whether

extensiveness of experience leads to greater preference learning than intensiveness of experience." (Hoeffler et al. 2013, p.333, emphasis added)

Finally, an interesting progress with the concept of mode familiarity has been developed by Boeri et al. (2014, p.132, emphasis added): "[…] respondents who are **familiar with the attributes underlying the choice context** tend to adopt choice behaviour more in keeping with random utility (RU) maximization, while respondents who are less familiar with it are more likely to adopt choice behaviour consistent with random regret (RR) minimization. This finding appears to be in line with **previous work in consumer psychology**, where it has been argued that **regret minimization is a particularly important determinant of decision making when decision-makers find it difficult to make the right decision** (Zeelenberg and Pieters, 2007) **perhaps for lack of experience**. In our case results suggests that the more familiar a respondent is with the road (either as a driver or by proximity to it), the more he/she will choose maximizing his/her utility **without considering the performances of the non-chosen options**.". "In line with evidence reported in the literature from the field of consumer psychology, we find evidence corroborating the hypothesis that **lack of familiarity with the choice situation** (in this case, the traffic situation) **triggers regret minimization behaviour as opposed to utility maximization behaviour**."

Research on cycling familiarity

To the author' knowledge, no studies on the role of mode familiarity applied to cycling are available. Familiarity appears only as a research suggestion in Garrard et al. with respect to a "familiarity bias" that, together with "control bias", may reduce the perceived risk associated with car travel and increase the perceived risk for cycling: "in low-cycling countries, driving is a familiar activity but cycling for transportation is unusual" (Garrard et al. 2012, p.225).

Instead, a considerable level of attention has been given to **cycling experience**, as defined in various terms. This attention forms part of a more general interest in the role of *social and psychological factors* as opposed to *physical environmental factors*, which are claimed to receive a higher attention when studying the choice of cycling (de Geus et al. 2008; Willis et al. 2014). Among the range of personal factors considered, research has shown that the individual *level of riding experience* -both in terms of frequency of use and trip purpose- has an important role in defining user perceptions about barriers and motivators to cycling. Experience with a mode of transport has been conceived as new information that may change the cognitive foundation of intentions and behaviours (Bamberg et al. 2003). In fact, individuals acquire experience by living through different events and this experience provides them with new information, novelties, or knowledge (Ajzen 1991). By processing information, individuals participate in a synthesis or learning which subsequently contributes to a formation of perceptions, as well as attitudes and norms.

Previous riding experience is increasingly included in leading cycling research contributions. This is the case of the work by Geus et al. (2008), which provides evidence on the relationship between attitudes and bicycle use: external self-efficacy (as indicated by the willingness to cycle even if the

weather is bad) and ecological-economic awareness (agreement that cycling is cheaper, better for the environment, etc.) were associated with higher levels of bicycle commuting.

Another relevant research work is that of Stinson and Bhat (2003), which reveals how frequent cyclists using the bicycle for its systematic mobility - commuters - are much more sensitive to factors such as travel time than people with less or no use for the bicycle. Instead, commuters are much less sensitive to factors relating to the safety of the trip, although they still give value to this aspect. Stinson and Bhat (2004) also note that more experienced cyclists enjoy more comfort in their bicycle commute and they are also more comfortable riding with motorized traffic or carrying cargo. It has also been observed that the more a person cycles, the less he/she perceives having a traffic accident. Thus a greater willingness to use the bicycle as an urban transport mode may be due to a combination of increases in specific skills, experience, self-confidence and a modified perception of level of risk.

Considering the perceived barriers to cycling, it has been observed that such barriers are not static and vary from person to person and their experiences of cycling (Daley & Rissel 2011) or their progress from pre-contemplation to action stages (Gatersleben & Appleton 2007). In this sense, Nkurunziza (2012) shows that influencing factors have different effects on people depending on the stage of change of cycling behaviour these people are in. Different effects are reported on personal and environmental factors as well as perceived policy interventions.

A recent research about how perceived and actual cycling risk may influence cycling frequency shows that some barriers such as hilliness, distance and the necessity to carry objects or passengers are highly perceived and affect more according to cycling frequency in an inverse relationship, i.e. the more one cycles the less s/he perceives such barriers (Sanders 2013, p.55). The same research also points out how cycling frequency significantly affects support for bicycling, the desires to restrict it, and how cycling experience mitigates the influence of perceived traffic risks on the decision to bicycle, but tends to increase the frequency of worry (Sanders 2013, p.84).

Associations involving experience have also been found with the pleasure of riding a bicycle. Gatersleben and Uzzell found that cycling and walking are considered more relaxing and exciting compared to other modes like the car and public transport (Gatersleben & Uzzell 2007). Páez and Whalen (2010) also report that active travellers have less desire to reduce their commute time in comparison to car and public transport users, and they found that cycling frequency is the factor that increases satisfaction with cycling. Similar results are also found by Willis et al. (2013). In the same line, Lee et al. (2012) found that commuter cyclists take on different mode-choice behaviours depending on whether they have experienced leisure cycling prior to becoming a commuter cyclist.

Experience also influences the route preferences since, for example, inexperienced cyclists state a preference for flat ground much more pronounced than experienced ones (Stinson & Bhat 2003). Also sensitivity to cycling times on different types of cycling facility varies with levels of experience since times on roadways tend to become less onerous as level of experience increases (Hunt & Abraham 2006). Then, inexperienced individuals perceive major traffic roadways as much greater deterrent to choosing a route than those who are experienced bicycle commuters. In this sense, Haworth and Schramm (2011) report that many bicycle users ride reluctantly in particular locations, and that preference for riding location is influenced by degree of experience and riding purpose. Experience

also plays a role on the preference for particular cycling facilities given that inexperienced cyclists tend to consider bicycle facilities to be more important (Stinson & Bhat 2003; Akar & Clifton 2009; Garrard et al. 2008).

Factor	*Association with*		*Reference*
	'cycling frequency'	*'cycling for commuting'*	
Sensitivity to travel time	2,6,8,12,14	1,2,6,8,12,14	1. (de Geus et al. 2008)
Sensitivity to distance	4,12,14	1,4,12,14	2. (Stinson & Bhat 2003)
Sensitivity to hilliness	2,4,14	2,4,14	3. (Stinson & Bhat 2004)
Sensitivity to route traffic conditions	3,8,9	3,8,9,13	4. (Sanders 2013)
Sensitivity to type of cycling facilities	8,9,10,11	8,9,10,11	5. (Gatersleben & Uzzell 2007)
Sensitivity to ecological-economic benefits	12,14	1,12,13,14	6. (Páez & Whalen 2010)
Risk of having an accident	2,3,4,12,14	2,3,4,12,14	7. (Willis et al. 2013)
Difficulty of carrying objects/passengers	3,4	3,4	8. (Hunt & Abraham 2006)
Self-efficacy	3,12	1,3,12	9. (Haworth & Schramm 2011)
Travel satisfaction	6,7	6,7	10. (Garrard et al. 2008)
Comfort and convenience	3,12	3,12,13	11. (Akar & Clifton 2009)
Pleasure of cycling	5,6	5,6	12. (Heinen et al. 2011)
Support for cycling policies	4,14	4,14	13. (Sahlqvist & Heesch 2012)
			14. (Rondinella et al. 2012)

Table 1. Studies reporting associations between elements of cycling familiarity and specific factors

Table 1 synthesises the studies in which an association between the elements of cycling familiarity (i.e. 'cycling frequency' and cycling for commuting') and the specific aspects influencing choice and use of bicycles has been found.

2.3 Considering cycling for commuting: research gaps

After reviewing the knowledge on cycling consideration and cycling familiarity which emerges from current literature, it is now essential to identify the reasons why the problem posed in this thesis remains unaddressed with the use of the available knowledge. For this purpose, this section identifies the research gaps that impede to address the problem making use of current knowledge. The gaps identified will allow the methodological definition of this thesis, discussed in Chapter 3.

Research conducted especially in recent years and discussed above has permitted a profound advance into the knowledge of factors affecting cycling and the understanding of the complex processes of travel behaviour conducting to its adoption (or not) as a mode of transportation. Particularly, the studies into the reasons why cycling is *not* adopted are those who inherently interest the scope of this thesis, and especially those who have investigated the determinants of its

consideration, namely the inclusion of the bicycle in the set of possible options to be chosen. However, in this bounded field of research, many research gaps still exists and several challenges impede to give insights capable to address the problem posed in Chapter 1.

An important issue is the absence of theoretical models which permit to study **interactions between various domains of influence**: the individual, the social and the environmental one (Panter & Jones 2010). The developing of social-ecological frameworks which integrate environmental, social and psychological correlates within a single theoretical structure, like those introduced in Section 2.1.3 (e.g. Pikora et al. 2003) are a recent attempt to bridge the gap, suggesting that physical environmental components are multifaceted and may interact with psychological and broader societal determinants. However, to date, studies that address complex interactions between distinct domains and that explore such interactions in empirical work are still few for cycling (e.g. Titze et al. 2008; Ducheyne et al. 2012; Badland et al. 2013; Heesch et al. 2014) although they are rapidly increasing. The problem in many research efforts is that studies in the environmental domain have tended to ignore psychological variables and methodologies, while studies in the psychological domain have often ignored environmental ones (Panter & Jones 2010). A possible reason for such a separate development have been proposed by Diana (2010):

> *"[…] each discipline tends to consistently propose working methodologies to study possible actions that are effective above all within its exclusive field of competence. Thus, policy makers and engineers concentrate on the attributes and performances of the different modes because they have the possibility to shape the supply of transport through their planning activities. On the other hand, sociologists and psychologists are more keen to consider personal characteristics, since they can contribute for example in marketing and educational campaigns".*
>
> (Diana 2010, p.431)

In any case, in order to address the recursive cycle of cycling consideration, an exploration on how environmental conditions may influence beliefs and attitudes toward cycling as well as cycling behaviour itself is needed but, to the author's knowledge, it is still missing.

Another relevant aspect that is uncovered by current research is the hypothesised **presence of bidirectional effects** between cycling behaviour and its assumed determinants like preferences or attitudes (Handy et al. 2014). As discussed in Section 2.1 in fact, many studies probe the influence of attitudes and other psychological factors on the decision of riding a bicycle for transport; but, it has been noted that it is unclear if cycling is a result of holding specific attitudes, or whether such attitudes are a result of the act of cycling (Heinen et al. 2010; Handy et al. 2010). Handy et al. express such a lack of knowledge posing some questions which are still unanswered:

> *"Why do some people like bicycling and others don't? […] To what degree does the physical environment shape the social environment, and vice versa? Does the environment, physical and/or social, influence individual attitudes?"*
>
> (Handy et al. 2010, p.980)

And still:

> *"[…] people with a strong cycling habit are likely to cycle often, but cycling often, in turn, will also strengthen their cycling habit. To date, studies that address these subjective factors have only considered the one-way effects from attitudes to behaviour."*
>
> (Handy et al. 2014, p.6)

This kind of concerns have been recognized since the mid-1970s as key issues by several researchers in the transport research field (Tardiff 1977; Dobson et al. 1978; Golob et al. 1979; Golob 2001), but to date, as far as we know, no further research has been conducted on such antecedents of attitudes nor on such backward or bi-directional relationships, especially in the studying of cycling behaviour. The issue is then relevant not only in the understanding of the choice of cycling but for the whole set of travel behaviours.

The concerns have been already mentioned in Section 2.1.2 on "How conventional approaches address the cycling consideration problem", and here are presented in more details in light of the literature review conducted so far. Such concerns have to do with two distinct but interrelated aspects:

1. On the one hand, the significant role of individual attitudes shown in an overwhelming number of studies concerning cycling behaviour and its influencing factors suggests a **need for research into attitude formation** (Handy et al. 2010; Heinen et al. 2011; Handy et al. 2014; van Bekkum 2011). Most attitude theory-inspired studies assume attitudes as formed by a cognitive evaluation of beliefs, according to the expectancy-value model: "attitudes develop reasonably from the beliefs people hold about the object of the attitude" (Ajzen 1991, p.191). But in such models antecedents of beliefs are neglected, and then they are assumed as given, with no insights neither developed nor conceptualised on the origins of such beliefs. Inside the social-psychology field other theories exists which account for attitude formation (e.g. see review by Darnton 2008 on the role of affect, emotions or cognitive dissonance in other social-psychology models), but to the author's knowledge, no study on cycling behaviour has been conducted making use of such models. To date, only few studies have qualitatively investigated on how attitudes toward cycling are formed, exploring the role of past incident experiences (A. Lee et al. 2012) and of childhood experiences (Underwood et al. 2014).

2. On the other hand, the relationship between attitudes and modal behaviours poses **questions of direction of causation (if any)**, as highlighted by Diana (2010) in a study of the demand for

innovative transport services, which are supposed to suffer a similar recursive cycle of mode consideration as well as the cycling mode. He reviews how, concerning this issue, variegate positions exist. Some authors (Tardiff 1977) claim that modal selection decisions influence attitudes and not vice-versa, whereas others (Dobson et al. 1978; Reibstein et al. 1980) found empirical evidence of a bi-directional relationship or study the mediating role of other constructs such as behavioural intentions (Couture & Dooley 1981) and preferences (Koppelman & Pas 1980). Such positions have been somehow neglected since the more recent prevailing of theoretical frameworks grounded on versions of the above mentioned expectancy-value theory (see Section 2.1.1), namely the TPB (Ajzen 1991), which postulate a strong one-way attitude–behaviour relationship. On this issue, many researchers have raised concerns about the possible presence of feedback mechanisms (van Acker et al. 2010; Noar & Mehrotra 2011; Schwanen et al. 2012) but, to the author's knowledge no studies have been carried out to empirically explore such relationships.

Both aspects highlight specific gaps in the knowledge which so far constitute a barrier in the understanding of cycling consideration processes and their assumed cycles. Attempting to bridge such gaps is subsequently considered essential to disentangle the problem posed in Chapter 1. On such needs the motivation of this thesis lies.

3 Research approach and methodological design

This chapter now provides an overview to the research approach taken in this thesis in order to address the research gaps outlined in Chapter 2. Firstly, a set of research questions based on such gaps are expressed and, building on such questions, research aims and objectives for the thesis are set (Section 3.1). Secondly, the theoretical pathways among the concepts at stake are depicted, in the attempt to clarifying assumed linkages and stating the corresponding research approach and strategies undertaken (Section 3.2). Finally, initial insights on the role of cycling familiarity on cycling consideration resulted from a study in Madrid are synthesised and their relevance for the scope of this thesis are discussed (Section 3.3).

3.1 Research questions and aims

The research aims of this thesis emerge from the problem posed in Chapter 1 and from the research gaps identified above. The problem, as mentioned, is **the recursive cycle of cycling consideration** and for the reader's convenience is recalled as follows:

> In order to consider cycling in the set of possible options to be chosen, an individual needs to have positive beliefs about it. This is especially the case of 'low-cycling contexts'. However, positive beliefs seem unlikely to be formed with low levels of mode familiarity; at the same time, higher levels of familiarity are likely to be reached if cycling is practised over relative threshold levels of intensities and extensively across individual life courses. However, the latter condition is hardly met in places where cycling is little practised. In fact, inside the current conglomerate of technologies, infrastructures, regulations, user practices, cultural preferences that have grown around the automobile (the current "socio-technical system of urban mobility", see Urry 2004; Geels 2005; Geels 2012), cycling is commonly considered as *difficult* / *unsafe* / *abnormal* (Pooley et al. 2011). Consequently, the processes of

> familiarity forming remain disabled, and as result beliefs cannot rely on mode familiarity as a source of information and influence. Without cycling familiarity, origins of positive beliefs are supposed to rely only on personal traits (affect, values, identities, willingness, etc.), which, in low-cycling contexts, confine the possibility of cycling consideration (and eventual adoption) mainly to 'cycling enthusiasts' who are willing to 'go against the grain', as it results from previous research.

Such as formulated, the problem prompts several questions which are stated and discussed in the following.

Some questions concern the *downstream relationships* that the hypothesised construct of cycling familiarity may have in shaping or informing individual beliefs toward cycling, therefore addressing the first of the research gap identified: the need for research into attitude formation, in this case into the formation of beliefs on which the level of cycling consideration is based. This kind of questions will inform the main aims of the thesis and on them empirical research will be carried out.

Other questions relate instead with the *upstream relationships (the origins)* of this hypothesised construct of cycling familiarity, wondering about the nature and the domain of the elements that compose it. Since its initial construction hypothesises only components made of a set of revealed circumstances of the individual present and past behaviour (see Chapter 1), the attempt to answer such questions is addressing the second of the research gap identified: the direction of causation (if any) between attitudes and behaviours.

Due to the exploratory nature of the study, *the relevancy* of the possible answers to such questions does not lie on the exact quantification of the associations found (if any) between the two quite slack constructs of cycling consideration and cycling familiarity. Rather, it *lies in the indication of the possibility of a linkage between the two wide constructs under investigation*, in line with past research on the backward relationships between modal behaviours and attitudes above mentioned. In fact, causality linkages are impossible to be explained between such dependent and interrelated conglomerates of elements. Furthermore, the methodological tools required to address the questions are not at the availability of the author. Notwithstanding, with the analysis to be undertaken as a result of such questions, what we are aiming is **a hint on the nature of a possible and**, so far, **unknown relationship in order to build a conceptual framework for further research** on its understanding.

3.1.1 Main research questions on the downstream relationships of cycling familiarity

On the one hand, the following two questions deal with the **downstream relationships** of the hypothesised construct of cycling familiarity and its potential role in shaping or informing individual beliefs toward cycling, which is the main aim of the thesis.

- **Research Question 1.** *Are there differences in cycling consideration indicators according to levels of cycling familiarity?*

The first question arises from an initial observation on the variance of cycling beliefs among population. The heterogeneity of those beliefs was initially observed by the author in a study carried out in a university settings of Madrid, Spain (Rondinella et al. 2012) and described with more details in Section 3.3. The pattern of variance in the perception of barriers and motivators among population of a campus was found associated to the levels of cycling frequency and to the purpose of cycling trips (Rondinella et al. 2012). The observation of such patterns and the fact that statistical analysis supported the existence of differences in indicators concerning cycling consideration according to attributes of cycling use were a clue that originated further reflection on the problem of a possible recursive cycle of cycling consideration.

Although several studies in the literature support the existence of similar differences, as reported in Section 2.2.3 (e.g. de Geus et al. 2008; Stinson & Bhat 2003; Stinson & Bhat 2004; Hunt & Abraham 2006; and van Bekkum et al. 2011a, among others), much of the literature builds on samples taken from contexts where cycling is a normalised practice. In order to answer this first question at the light of the problem of recursive cycle of cycling consideration, such analysis needs to be carried out with populations in which cycling mobility is a minority practice, but, at the same time, avoiding the limitations of conducting the research in too bounded contexts. In fact, the difficulty to capture behaviours in places where these are performed by a small amount of people poses methodological challenges which lead researchers to draw on definite settings like university campuses or specific work-related contexts (Lavery et al. 2013; Shannon et al. 2006; Bonham & Koth 2010; van Bekkum et al. 2011a) when studying the psychosocial aspects of cycling. A research that were geared at answering such first question in a low-cycling context and which focused on the entire population of commuters is consequently needed.

- **Research Question 2.** *Are higher levels of cycling consideration associated with lower levels of familiarity? And, how much likely is such probability to occur?*

Answering the first question leaves the door open for a second one. In fact, the presence of statistical significant differences between different classes of people according to their levels of cycling familiarity does not exclude that, still, higher levels of cycling consideration may be associated with lower levels of familiarity. An analysis on the degree of association between these two extreme positions is needed to add another piece of evidence to the hypothesis that a recursive cycle of cycling consideration is at stake.

Subsequent to this question is a complementary one about the strength of such association, i.e. wondering about the quantification of the probability of occurrence of the two extreme positions (higher levels of cycling consideration and lower levels of familiarity).

Evidently, the presence of an association and the measurement of its strength is not enough to establish that cycling familiarity is a contributing driver or determinant of cycling consideration nor of its antecedents: it could be that the association is due to a third property, which we are not considering in this analysis and which is a contributing influencer of both cycling consideration and familiarity. Nevertheless, the measurement of such strength and its comparison with the opposite situation (lower levels of cycling consideration and higher levels of familiarity) tells a further more about the presence of a backward relationship between mode use and mode choice consideration in the case of cycling in a context of low use and low culture.

3.1.2 Additional questions on the origins of cycling familiarity

Besides the two main research questions presented above, another set of questions emerge concerning the **origins** or enablers of cycling and mode familiarity, namely on the how it has been theoretically constructed. In fact, we hypothesised that its components were all internal to the individual, i.e. that its nature were made of a set of revealed circumstances of his/her present and past behaviour concerning intensity and extensiveness of the practise of cycling across individual life courses. However, such as the problem has been formulated, we expect that the level of familiarity gained by those individual sources would be low for the majority of individuals in the so called 'low-cycling contexts', as they were defined in the introductory chapter. Consequently, an additional question that arises is the following:

- *Are higher levels of familiarity likely to be reached if cycling is practised with low levels of intensities and low extensiveness across individual life courses?*

This question is therefore wondering if all sources of cycling familiarity are to be found inside the individual level or if additional sources may be found outside the individual level of influence. That is, whether the conditions 'to familiarise' with cycling (or, more generally, with alternative modes of transport) are generated only by the individual choice or whether they may also derive from the opportunities and constraints of the social and the physical environment.

The emergence of such questions mobilises ideas and concepts from the social-ecological perspective, as it was presented in Section 2.1.3. The reframing of travel behaviours as the result of a complex network of influences across diverse ecological layers rather than solely on the responsibility of individuals triggers issues about the role of individual ability to enact behaviour change (Sallis et al. 2008). On this aspect Sallis et al. make an illuminating example to clarify the

relevance of social-ecological perspective on research and policy aimed at understanding and providing tools for behaviour change:

> *Consider how cigarette smoking has become widely viewed as an addiction with biological, behavioural, social, and economic determinants rather than simply an "individual choice." One could view ecological models as "robbing the individual of dignity" by attributing their behaviours to such a range of forces. Alternatively, one could view the ecological perspective as removing an unreasonable attribution of responsibility to the individual—a sort of victim blaming—by recognizing the many forces that shape each individual's behaviour. Ecological models transcend philosophical and political polarization over individual versus external influences. From an ecological perspective, individual level and many levels of external influence are integrated in a single framework, making it clear that* ***causation of behaviour is widely distributed****, not lodged in one or another source. Ecological models can enhance human dignity by moving beyond explanations that hold individuals responsible for, and even blame them for, harmful behaviours.*
>
> (Sallis et al. 2008, p.482, emphasis added)

Going back to the aim of this thesis, the example suggested by Sallis and colleagues may easily be translated to the travel behaviour domain. Viewing the choice of cycling as a solely 'individual choice' seems unrealistic and a great number of evidences supports the role that environmental, social, and institutional factors have on it (see literature in Section 2.2.1), although they are often treated as separate influencers as highlighted in previous section dedicated to research gaps.

In the same line of reasoning, also the conditions 'to familiarise' with cycling may be treated as the final behaviour, that is, their sources of influence are widely distributed and do not rely only on the individual level. In order to 'familiarise' with cycling, and specifically with commute cycling, one has to 'try out' the behaviour, he/she has to 'taste' its features and functioning. This 'tasting' is likely to not depend only on the opportunities and constraints hold at the individual level (propensity to cycle, riding skills and competences, bicycle availability, time budget, etc.) but also on opportunities and constraints set at higher levels, i.e. the availability and the quality of facilities and services, as well as the sense of acceptation, scepticism or regret of the community around the individual, or even the grade of recognition and dignity given by institutions and regulations.

Complementary to this question, which will be treated on a mere discussion bases, other general questions arise, which are related not only to cycling but to alternative modes of transport in general.

- *How are opportunities 'to familiarise' with alternative modes created? Are such opportunities created in similar ways for all the modes?*
- *Are they 'sufficiently' and 'properly' created for cycling in order to let individuals 'tasting a different behaviour' and gaining a minimum threshold of cycling familiarity?*
- *Are such opportunities accessible and 'choosable' at the individual level?*
- *How could those opportunities be influenced and enhanced by policy tools?*

Such questions are not directly addressed by this thesis, but the insights on the constitutive elements of mode familiarity generated by the methodological tools applied (see Section 3.2) may be an initial step to develop a path of research geared at providing possible answers.

3.1.3 Research aims and objectives for the thesis

In light of the issues identified as knowledge gaps in Section 2.3 and as a consequence of the questions presented above, the general **research aims** of this thesis are:

- **I.** To build a conceptual framework for the understanding of the cycling consideration problem, hypothesising the relationships at stake by the introduction of the hypothesised construct of *cycling familiarity*.
- **II.** To build, theoretically and methodologically, the construct of *cycling familiarity* at the individual level and to explore the possible influences this may have in shaping or informing individual beliefs toward cycling.

The specific **research objectives** of this thesis descend by expressed aims. They are the following:

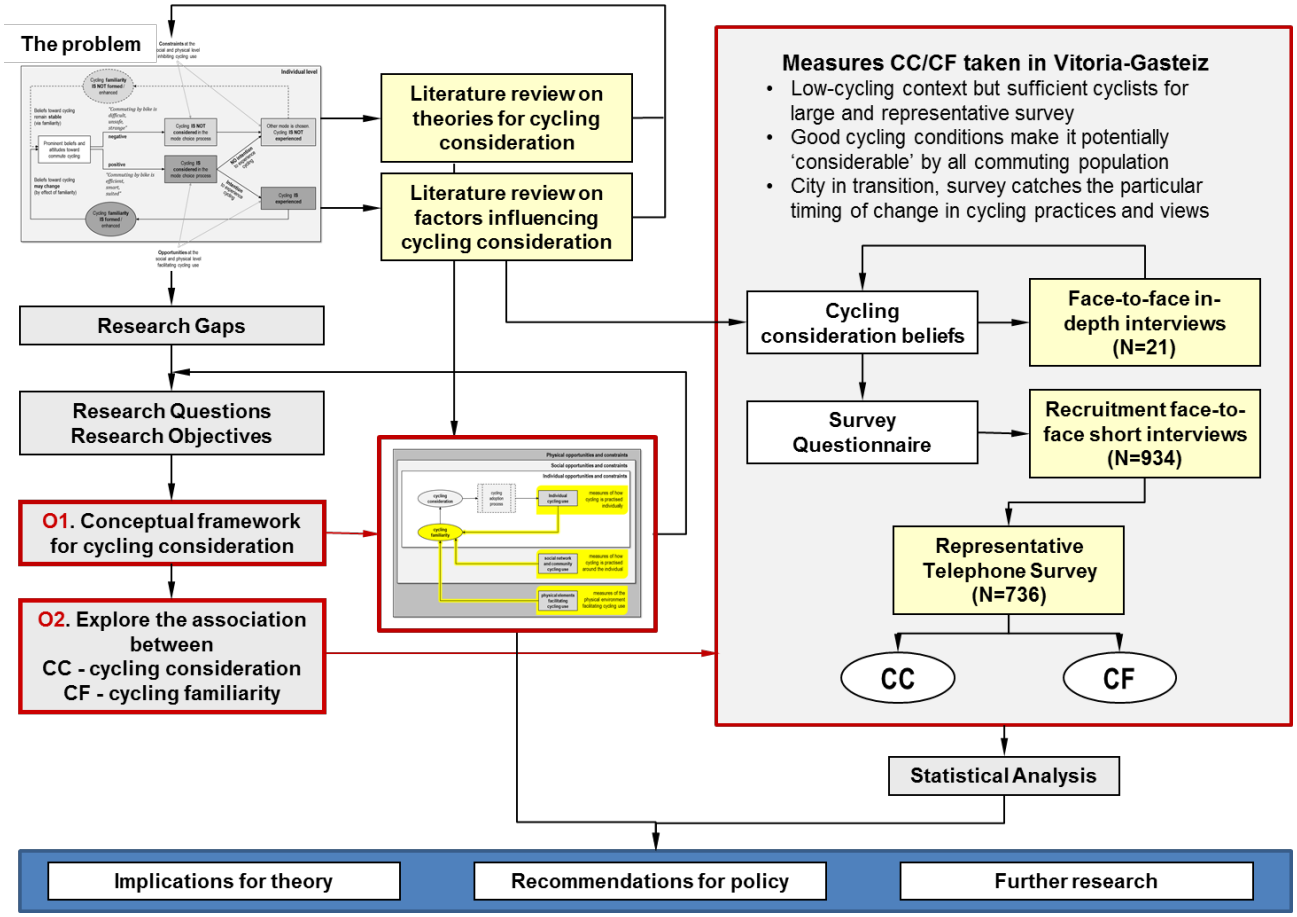
Research Objective 1. To depict the relationships at stake for the cycling consideration problem by the introduction of the hypothesised construct of *cycling familiarity* and to assess the potential role of the new construct to guide empirical research on such relationships by hypothesising which may be the elements for its measurement at distinct ecological layers.

Research Objective 2. To answer the two research questions set, empirically exploring the association between cycling consideration measures and cycling familiarity ones, by looking for:

> **2.a.** The differences in cycling consideration indicators according to levels of cycling familiarity.
>
> **2.b.** The possible extent of such association.

The distinct steps this research carries out are illustrated in Figure 15. The figure, besides the synthesis of the process described so far, anticipates the methodological design and strategies reported in the next sections.

Figure 15. Research outline



3.2 Theoretical pathways and research strategies

To achieve research aims and realize the whole set of research objectives set above, the building of a theoretical framework for cycling consideration is the first step, such as set by Objective 1. The methodology taken in this thesis is in fact based on the developing of a conceptual framework that comprehensively outlines possible pathways between the two constructs under analysis: cycling consideration and cycling familiarity. The aim is to clarifying assumed linkages among them in order to state the corresponding research strategies undertaken to analyse their relationship. Firstly, the broad structure of the theoretical framework is outlined, depicting which theoretical pathways between cycling consideration and cycling familiarity are assumed (Section 3.2.1). Subsequently, for the rest of the research objectives defined, research strategies are discussed (Sections 3.2.2 and 3.2.3), including a methodological definition of each of the constructs under analysis.

3.2.1 Building a framework for cycling consideration: the exploration of a circular relation

The conceptual framework of this thesis builds upon the basis of two previous conceptual models that are considered useful to structure the elements and the relations under analysis.

The first is the conceptual model developed by Fernández-Heredia et al. (2014) to understand cyclist's perceptions and geared toward the inclusion of individual perceptions into a wider modelling effort to predict the intention of cycling. The model addresses the perceptions of individuals – intended as attitudes and preferences – when they are faced with the decision process concerning the use of a bicycle for a specific trip. Figure 16 represents how the concept of cycling consideration relates with the *process of cycling adoption* which is understood according to such model. The term 'adoption' is here intentionally used instead of 'choice' in order to account for the research works on the value-action gaps described in Section 2.1. While 'mode choice' is widely intended as the revealed situation of the individual carrying out the act of using a specific mode (driving, riding public transport, walking or cycling), outside the field of transport studies it may be understood as the decision for using a mode but not the ultimate realization of such act due to some sort of constraints. The methodology taken in this thesis will not analyse the elements and the relations inside of the cycling adoption process, unless for the attitudinal component, extracted out from the process and considered as an input of such process.

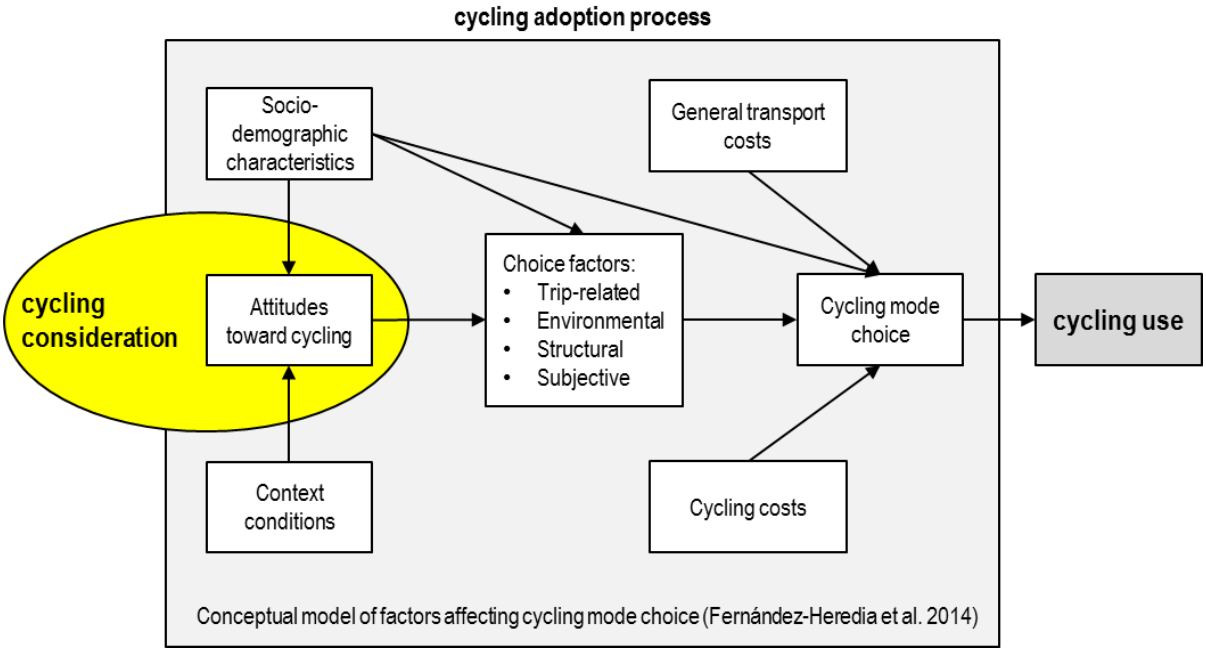


Figure 16. Conceptualization of cycling consideration and its relations with the process of cycling adoption according to the model developed by Fernández-Heredia et al. (2014)

While the model of Fernández-Heredia et al. (2014) is, to the author's knowledge, the most comprehensive effort to take into account and properly identify the psycho-social factors that make the bicycle eligible as a modal alternative in urban contexts, it focuses mainly on the *reasoned*

influences of the mode choice. Attitude toward cycling, as well as socio-demographic characteristics of individuals are believed to influence what are called the 'choice factors', namely the trip-related, environmental, structural and subjective factors that individuals consciously consider for the assessment of travel mode. However, as discussed earlier, other studies (e.g. Verplanken et al. 1994; Verplanken et al. 1998; Gardner 2009) emphasize that unreasoned factors appears as well, especially when it counts to behaviours which individuals are not constantly conscious of (Simon 1955; Schwanen et al. 2011) or –considering travel behaviours– when they involve a decision regarding unknown alternatives to more habitual behaviours and transport solutions (Diana 2010).

Moreover, it has been outlined how, in order to be able to conceptualize the complexity of travel behaviour and its dynamicity, models should include both *space* and *time* variables. To account for the *unreasoned influences* of the travel mode choice and for its spatial and temporal dimensions, a second conceptual model is taken into account. The model has been developed by van Acker et al. (2010) to combine and link together theories stemming from transport geography and social psychology. In such model, both theoretical backgrounds are conceptually brought together in the attempt to overcome the often too limited scopes of studies conducted separately, as commented earlier. The model recognises some important advances in travel behaviour research:

a) that individual daily travel behaviour is embedded in a *decision hierarchy*, which ranges from short-term decisions on daily activities and travel, to medium-term decisions on locational preferences, to long-term decisions on lifestyle;
b) that these behavioural decisions are the result of an assessment of *reasoned and unreasoned influences*, reflecting the twofold nature of behaviour with a reasoned component as well as an unreasoned component;
c) that individuals can *learn from previous experiences* and consequently, lifestyles, perceptions, attitudes and preferences are not fixed in time, but they may be influenced by the same previous behaviours.

Although the complexities of the numerous relationships considered in the model of van Acker et al. (2010) and the resulting direct and indirect effects on travel behaviour do not lead to corresponding research strategies and appropriate techniques in this thesis, the acknowledgement of such complexities is believed useful to properly frame the methodology here undertaken. The most acknowledged out of this kind of interdependencies is the last one: recognising that individuals can learn from previous experiences allows for the presence of feedback mechanisms from behaviours to its supposed reasoned or unreasoned antecedents. The latter addresses one of the main research gaps identified in Section 2.3, although in the cited model the recognition of alternative hypothesis of causation is just mentioned and empirical results that support the linkages are not provided. In this thesis an attempt to explore such feedback mechanism is performed via the hypothesised construct of cycling familiarity (see Figure 17).

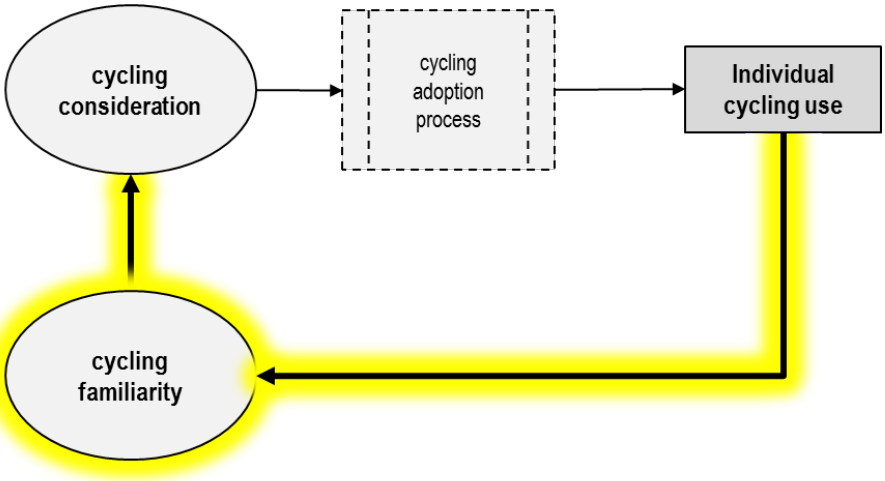


Figure 17. Conceptualization of a feedback mechanism between mode use and mode choice consideration via the hypothesised construct of cycling familiarity

In this way, 'familiarity' is conceptualised as a construct to account for a set of *unreasoned influences* that act on cycling consideration elements, contributing to their formation. This is the first step for the accomplishment of **Objective 1**. Initially, in order to allow the exploration of the relationship between cycling consideration and cycling familiarity, the latter is constructed with a set of revealed circumstances of the individual present and past behaviour. Such exploration corresponds to **Objective 2** and it is discussed in following Section 3.2.2. Subsequently, depicted pathways will relate to the nature and the domain of the elements that compose cycling familiarity, not only at the individual level but also at higher levels of influence. By doing that, the scopes of Objective 1 are readdressed and corresponding pathways are discussed in Section 3.2.3.

3.2.2 The relationship between cycling consideration and cycling familiarity

In order to build the hypothesised construct of cycling familiarity and to explore the relationships this may have in shaping or informing the construct of cycling consideration, both constructs should be defined, consolidating the initial theoretical definition given in Chapter 1. The methodological definition will allow the exploration of the hypothesised relationship between the two constructs, pursuing what have been set as Objective 1 and allowing the exploration posed by Objective 2.

The first steps are the operationalization of each of the two constructs under analysis through the identification of their measures (Steps 1 and 2 in Figure 18).

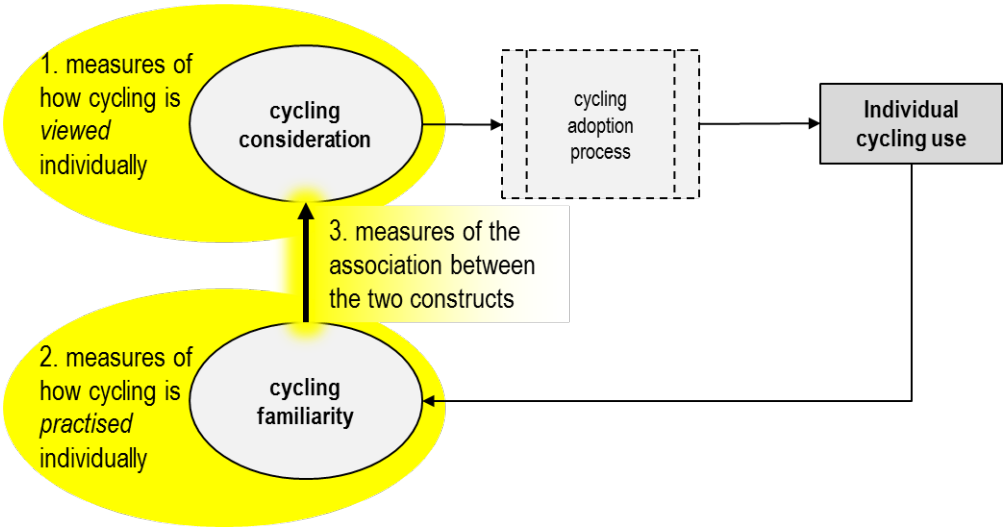


Figure 18. Operationalization of the constructs of cycling familiarity and cycling consideration through the identification of their measures

The research strategy undertaken is therefore the use of such measures in order to examine the association between the two constructs which they are measuring (Step 3 in Figure 18). The measure of the association is performed through the examination of the differences in cycling consideration indicators according to levels of cycling familiarity, besides the direct measure of such association through the use of non-parametric tests (see Chapter 6).

Methodological definition of cycling consideration

The methodological definition of cycling consideration builds upon the concepts initially outlined in Chapter 1. As anticipated, the thesis mobilises constructs taken from distinct traditions to refer to a wider notion, referring to the question of "**How cycling is viewed?**" For this purpose, the use of *beliefs* from the social psychology field seems the most suitable way to answer the question of how cycling is viewed. Following this approach, cycling consideration may be operationalized as in the sentences that start with: "**Cycling is …**" followed by the characteristics about the positive and negative consequences of cycling as they are perceived at the individual level. By doing this, cycling consideration is strictly related to the construct of *attitude* as in the theory of planned behaviour (TPB), whose the attitudinal component is one of the elements preceding the individual's intention to perform a behaviour (Ajzen 1991, see Section 2.1). As seen in the literature review, diverse works have revealed the utility of considering attitudes as a predictor of bicycle usage (or intentions), analysing beliefs about its advantages and disadvantages and the importance given to them by people (e.g. Gatersleben & Appleton 2007; Heinen et al. 2011; Heinen et al. 2010; Xing et al. 2010; van Bekkum et al. 2011a). The theoretical difference between attitude toward cycling and cycling consideration is that the former includes exclusively behavioural beliefs, while the latter may comprise also normative and control belief.

Figure 19 shows the conceptual framework for the building of the cycling consideration construct by means of measures of how cycling is *viewed* individually. Consistent with the notation which is usual in the modelling field, ellipses denote unobservable variables and rectangles denote observable variables. Due to the explorative nature of this study, arrows do not represent measurement or structural equations, but simply hypothesised connections to be tested by means of the empirical methods used. While solid arrows represent hypothesised connections tested in the present study, dashed arrows represent possible connections to be explored in future research.

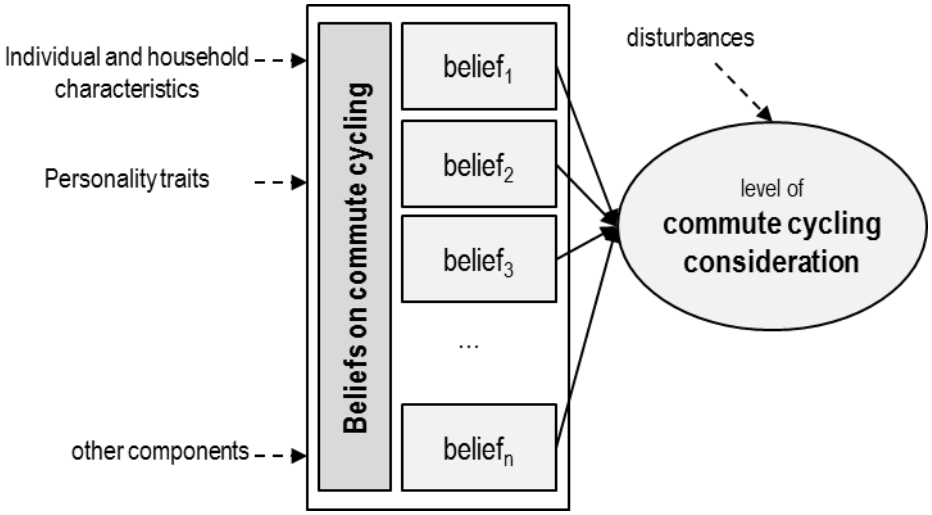


Figure 19. Measures of how cycling is *viewed* individually

Because previous literature on these kind of measures is the result of research conducted in other socio-cultural contexts, where cycling is more 'normalised' than in Spanish cities, the set of beliefs toward cycling to be included in the analysis cannot be taken from previous works on the matter. Beliefs are different from place to place and they vary across different cultural settings, then exploring and understanding what is shared and what is specific is considered essential for the development of this thesis. For doing this, an examination of beliefs about transport cycling in commuting journeys (to the workplace or study centre) in the specific context of Spanish cities is needed.

The research strategy to undertake is consequently two-folded. On the one hand, the use of **qualitative methodology based on interviews** is needed in order to study in depth the beliefs of different users and in different contexts. Beliefs about the advantages and disadvantages of cycling to work or to the study centre are reflected in the spontaneous discourse of people working and studying in a specific context, once individuals are elicited to consider this particular kind of behaviour. The interviews are geared at obtaining first-hand information without prior determinants imposed by the researchers. This methodology seems particularly useful, taking into account the scarcity of investigations on bicycle usage in Spain from a psychosocial perspective (Fernández-Heredia, Monzón, et al. 2014).

On the other hand, the use of **quantitative methodology based on surveys** is needed in order to accomplish the scopes of Objective 2, i.e. exploring the association between two constructs. The

information gathered with interviews, after being analysed through the use of content analysis (Corbin & Strauss 1994), is in fact used to create a questionnaire which will allow the building of a/some valid and reliable measure/s for cycling consideration in order to allow a quantitative study to explore assumed associations.

Methodological definition of cycling familiarity

The methodological definition of cycling familiarity also builds upon the concepts initially outlined in Chapter 1 and on the previous research works available on the matter (Section 2.2.3). As anticipated in Section 2.2.3, the general concept of familiarity with transport modes has been isolated and first measured by Diana and Mokhtarian (2009) in relation to multimodality. This research therefore will initially build upon such methodological effort to allow the exploration intended for Objective 2. Afterward, the nature and the domain of the elements that compose cycling familiarity will be further explored, in line with the scope of Objective 1 and 3.

Diana and Mokhtarian defined *familiarity with different transport modes* as some measures of the real and the perceived relative intensity of use of different modes (2009). In their work, mode familiarity is assumed to be related to the amount of time an individual spends in using a specific mode, gaining in this way a certain level of *acquaintance* with it. In this research, we build on that, considering as constitutive elements of cycling familiarity: a) the individual *frequency of cycling* and b) the individual *history of cycling*.

As done for the building of cycling consideration, also for the constructing of cycling familiarity we follow the recommendation of limiting as much as possible the behaviour under analysis, focusing on the specific behaviour of using a bicycle for commuting purposes instead of the general cycling realised also for other purposes (Giles-Corti et al. 2005). Subsequently, in order to better operationalise the theoretical concept at stake, we will define a ‘commute cycling familiarity’ construct instead of merely ‘cycling familiarity’. However, a ‘commute cycling familiarity’ is probably also related to the acquaintance gained in using a bicycle for other utilitarian purposes, such as shopping, making arrangements, going to the doctor, visiting, etc. Then, measures on these observable variables are included in the building of commute cycling familiarity. Acquaintance gained with cycling for non-utilitarian purposes, namely for recreational and leisure activities (having a ride, going for tourism, etc.) or for exercising and practising sports, is instead not included in the building of commute cycling familiarity because of the particular image of commute cycling in low cycling countries. In fact, commute cycling is viewed in low cycling countries as being dangerous, demanding and stressful as opposed to the calm, peaceful and liberating character associated to leisure cycling (Gardner 1998). In this case, the conflicting imagery is assumed to generate conflicting experiences as well, therefore introducing an unintended noise in the measures. For this reason, the elements of commute cycling familiarity considered in this research are:

- cycling frequency for commuting;
- individual history of cycling for commuting;
- cycling frequency for other utilitarian purposes

The whole set of elements comprises measurements about the revealed circumstances of the individual present and past behaviour, to be obtained through the use of **quantitative methodology based on surveys**.

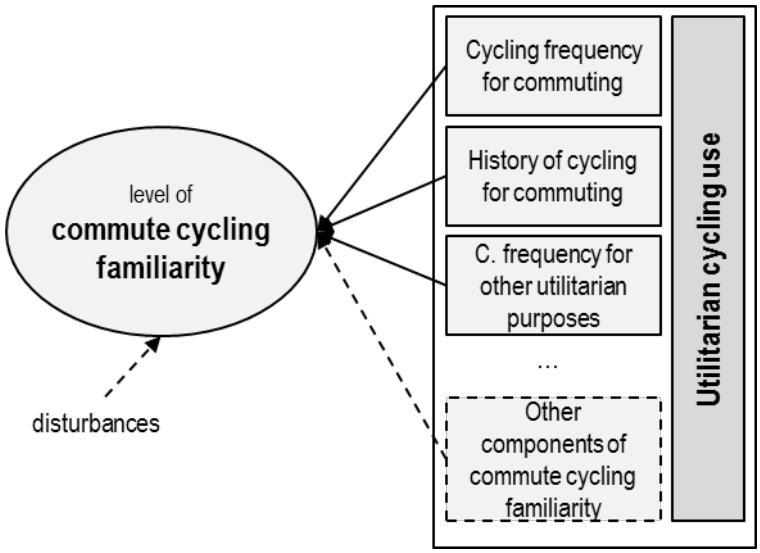


Figure 20. Measures of how cycling is *practised* individually

Figure 20 shows the conceptual framework for the building of the commute cycling familiarity construct by means of measurements of how cycling is *practised* individually. As previously mentioned, solid arrows represent hypothesised connections tested in the present study, while dashed arrows represent possible connections to be explored in future research.

A framework for the relationship between cycling consideration and cycling familiarity

The resulting conceptual framework, integrating the measures for the two constructs under analysis with the general theoretical framework for the conceptualization of the feedback mechanism discussed above (see Figure 17) gives the structure of current research strategies and methodological approach (Objective 1), allowing for the carrying out of Objective 2. All theoretical pathways are depicted in Figure 21. The framework includes the process of commute cycling adoption in a dashed box since the elements and the relations inside of it are not analysed in this thesis, as discussed in previous section.

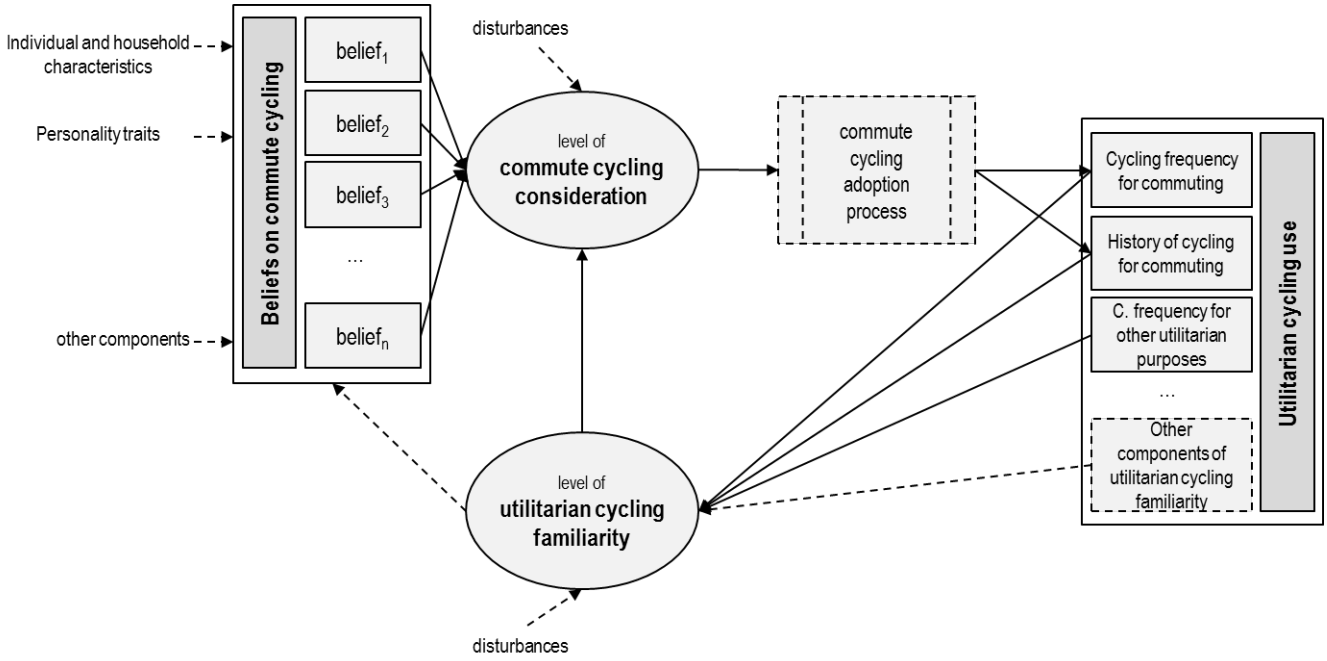


Figure 21. Conceptual framework for the representation of the cycle of cycling consideration

The framework provides a theoretical representation of the connections assumed for the cycle of cycling consideration as they are hypothesised in relation with the problem posed in Chapter 1. Such connections are currently unexplored and this research will attempt to provide a first investigation of the circular relation between cycling familiarity and cycling consideration, starting from the association between a construct assumed to precede behaviour and another which is based on behaviour measurements. In the following section the possible additional origins of the cycling familiarity are further explored, by extending the look at elements outside the individual level.

3.2.3 The building of the cycling familiarity construct outside the individual level

With the aim of gaining a deeper understanding of the possible additional *origins* of the cycling familiarity construct, an examination of the role of distinct ecological layers should be carried out. The analysis will hypothesise which may be the elements for its possible measurement, and by doing so, allowing the future development of a methodology for the measuring of the cycling familiarity construct.

So far, only influences at the individual level were taken into account. The cycling familiarity construct has initially been built with measures of how cycling is practised individually in order to allow the exploration of the relationship with cycling consideration. Those measures were all components internal to the individual, measured through a set of revealed circumstances of his/her present and past behaviour, as depicted in Figure 22.

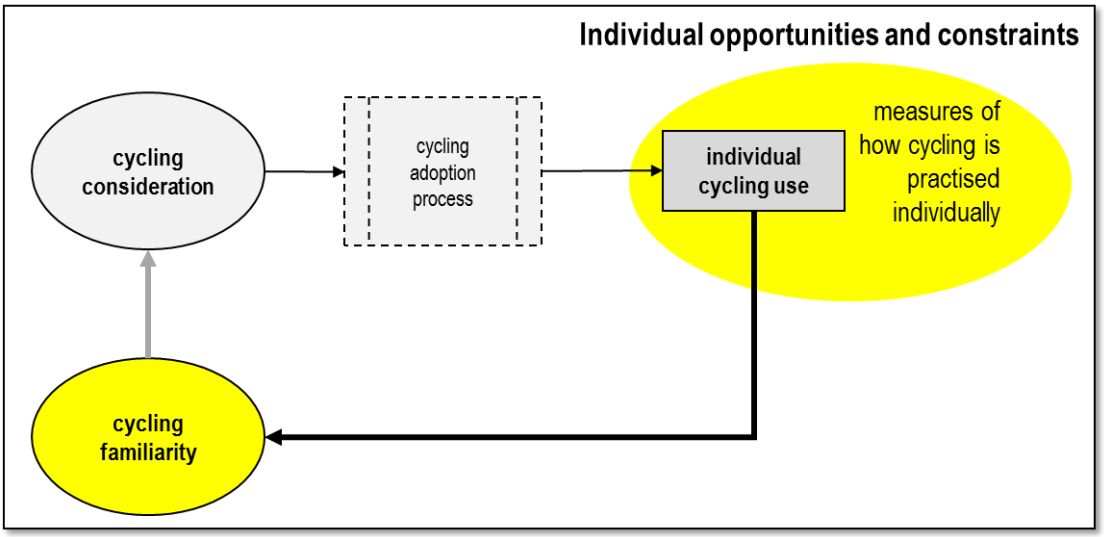


Figure 22. Influences of cycling familiarity at the individual level

Nevertheless, as previously anticipated in the section presenting research questions and aims (Section 3.1), viewing the choice of cycling as a solely 'individual choice' seems overwhelmingly unrealistic. Great is the number of evidences which support the role that environmental, social, and institutional factors on the adoption of cycling as a mode of transport (see literature in Section 2.2), and also the conceptual model referred to frame this thesis (van Acker et al. 2010) recognises the social and environmental layers of influences as one of the main constituencies of the proposed framework:

> *After all, the individual does not act within a 'vacuous space'. The individual is a member of a social network of family, friends and colleagues, lives within in a particular neighbourhood and travels to a specific destination. Consequently, the individual decision hierarchy and its underlying components must be considered within a social environment and a spatial environment.*
>
> (van Acker et al. 2010, p.230)

A natural consequence of such evidences would therefore be that, for the building of the hypothesised construct of cycling familiarity, a researcher should also include components of the social and the environmental domains, in line with recent research developments already discussed and recognised by the author in Section 2.1.3.

Consequently, together with:

- measures of how cycling is practised individually,

the construct of cycling familiarity should also include:

- measures of how cycling is practised around the individual (see Figure 23);
- measures of how cycling is fostered by elements of the physical environment (see Figure 24).

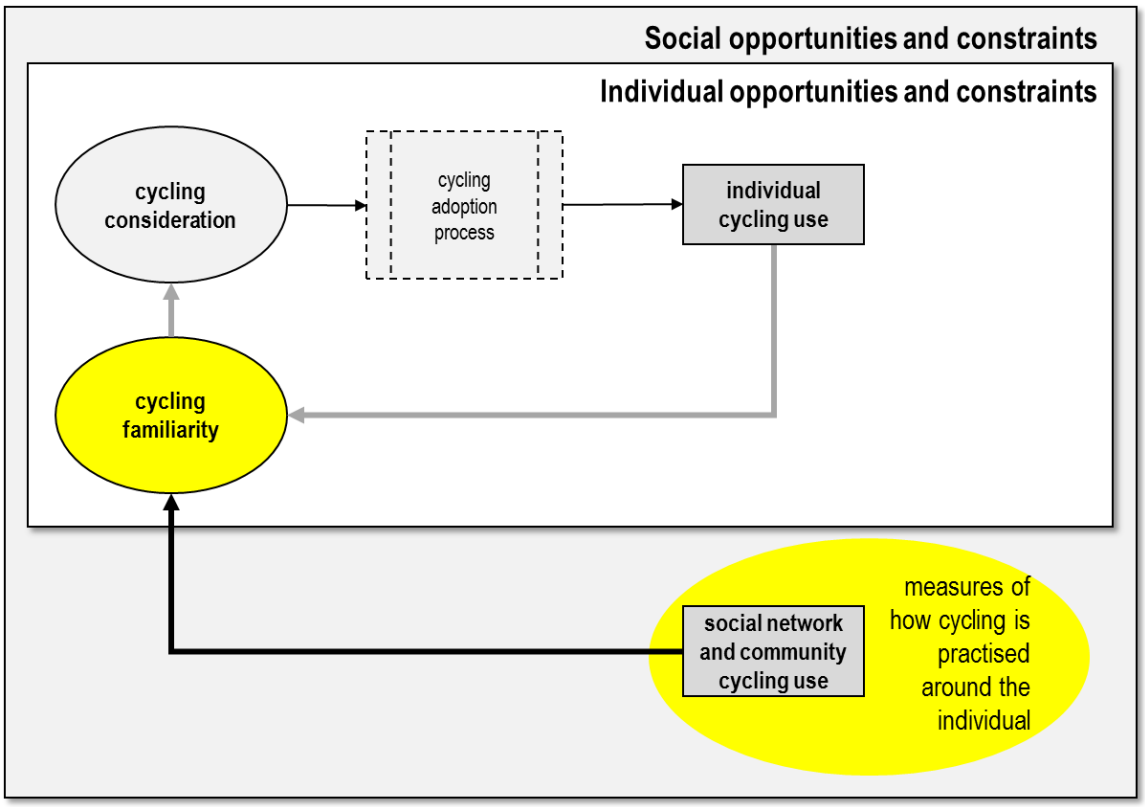


Figure 23. Influences of cycling familiarity at the social level

The construct of cycling familiarity may be conceptualised as a feature hold at the individual level but which is shaped at three distinct ecological layers:

- **Individual level**. Cycling familiarity intended as gaining acquaintance with the personal act of cycling (embodied, sensorial, cognitive, etc.) through riding (frequency, purposes, physical intensity, heterogeneity of situations and places, etc.), experiencing distinct solutions to encountered problems, and learning over time throughout distinct circumstances (often 'difficult' and 'hostile' circumstances in low-cycling contexts). At this level cycling familiarity shares similarities with the concept of Perceived behavioural control in the TPB (Ajzen 1991) and with Self-efficacy in Social Cognitive Theory (SCT; Bandura 1986).

- **Social level**. Cycling familiarity intended as gaining acquaintance with the act of cycling practised by people around the individual, either at the interpersonal, the community or the cultural environment. Regardless of whether cycling is practised individually, the acquaintance is gained through seeing other people riding and experiencing the normality of other people travelling by bicycle and resolving common needs of moving over space by bicycle. Such kind of influences may be even invisible and unperceived at the individual cognitive level but they do create an environment that is more or less 'prone' to commute cycling.

- **Physical level**. Cycling familiarity intended as gaining acquaintance with the way places are set up in order to make cycling doable, recognised and normalised. Regardless of whether cycling is practised individually, the acquaintance with cycling is gained through the reasoned and unreasoned processes by which the individual constructs his/her mental map of the environment integrating those natural or built elements that foster or hinder the use of bicycles.

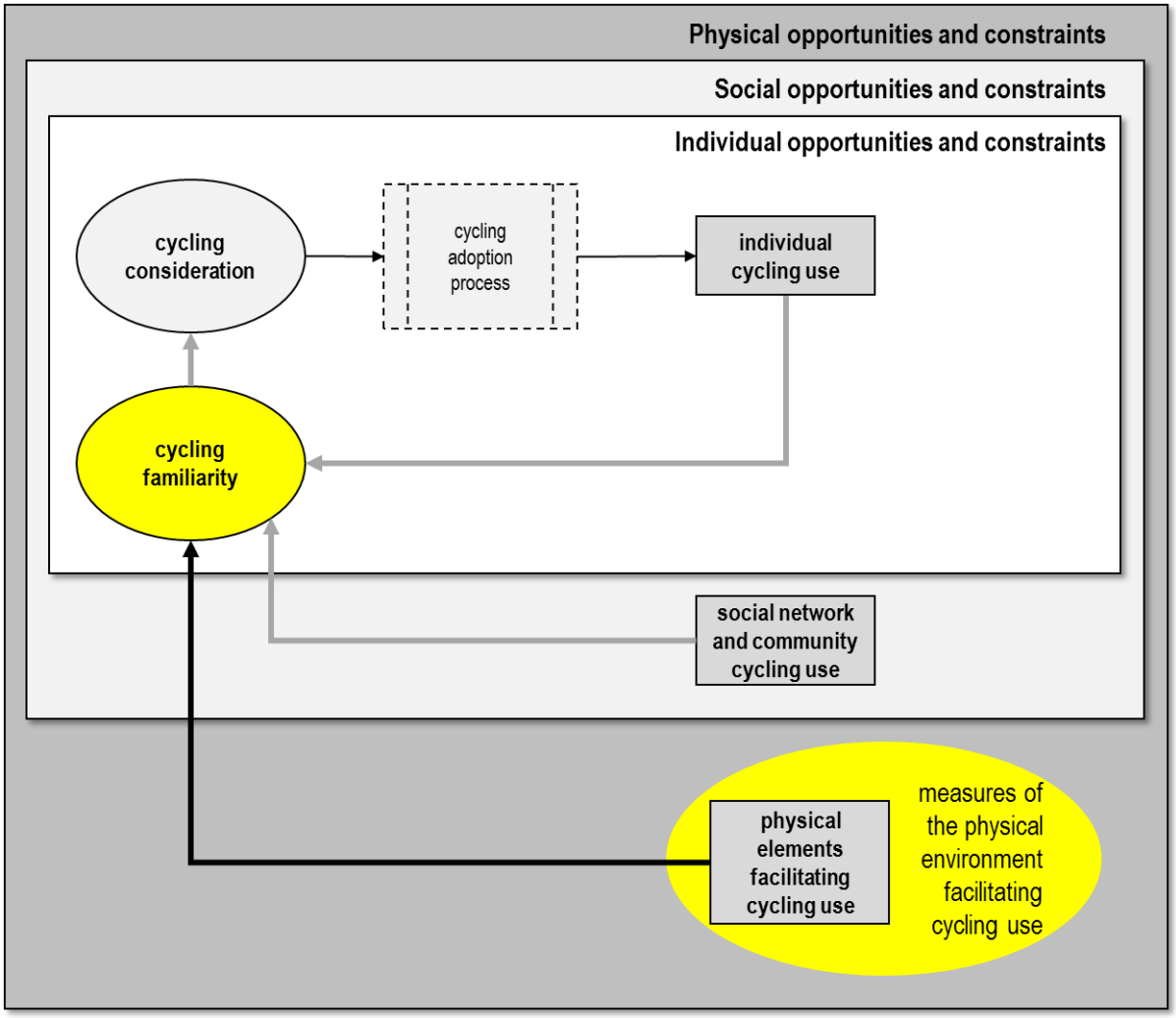


Figure 24. Influences of cycling familiarity at the physical level

Consequently, for the development of a methodology for the measuring of the cycling familiarity construct, literature as well as theoretical reasoning suggest to include higher level components.

Among the elements of how cycling is practised around the individual, the following may be included:

- perception of how much cycling (intensity, frequency and history) is practised among distinct groups of people (family, friends, co-workers/schoolmates, young/older people, public figures, immigrants, etc.) who interact with the individual or who constitute her social and cultural context;

Among the elements of how cycling is fostered by features of the physical (and institutional) environment:

- perception of physical elements believed to facilitate or foster the practice of cycling;
- perception of normative features believed to facilitate or foster the practice of cycling;
- perception of how much cycling is fostered and facilitated by public bodies and public policies.

The resulting measure should be a measure as much separate as possible from behavioural beliefs (e.g., "Cycling to work is ...") and behavioural attitudes ("I like / I do not like going to work by bike") in order to capture the perceived 'reality' of cycling from the viewpoint of the individual, since it should be obtained through the use of quantitative methodology based on surveys, as seen above.

Unfortunately, such kind of measures are not completely gathered by the survey carried out in Vitoria-Gasteiz (see Chapter 5) because of a misalignment between the different phases of current research. The survey design had to be realized at a time when the objectives for the thesis were not completely defined, then a mismatch between theoretical and methodological definition occurred, with research tools employed and the measures taken not entirely harmonised with research aims.

Because of that, questions on the origin and consequently the building of the cycling familiarity construct are not addressed by this thesis at an *empirical level*, because of those methodological limitations which forced to restrict the scope of current investigation.

3.3 Initial insights from a study in Madrid

The research on the role of cycling familiarity on cycling consideration had an initial sprout from a study in Madrid, Spain. An online survey that analysed factors affecting bicycle use in a University population (n=1356 students, n=1199 staff) living a low-cycling context produced results that grabbed the attention of the author and produced further reflection on the problem of a possible recursive cycle of cycling consideration. Such study supported the observation that people who have different levels of what has been called 'cycling familiarity' *do have* distinct beliefs and attitudes on commute cycling (Rondinella et al. 2012). Those results were an initial, and at that time unintended, answer to Research Question 1 of this thesis, therefore they are synthesised here in Sections 3.3.1 and 3.3.2. Afterward, relevance of those results for the scope of this thesis are discussed in Section 3.3.3.

3.3.1 Study context and methodology

The research took place under the scope of the UNIBICI project, a research study investigating potential cycling demand at the Madrid university main campus (*Ciudad Universitaria*). As previously noted (Lavery et al. 2013; Bonham & Koth 2010; Shannon et al. 2006; Lovejoy & Handy 2011), university settings lack generality, but compensate by displaying behaviours that would otherwise be difficult to capture. The case of cycling is one of those since bicycle use in Madrid is extremely low (0.6% of all trips in the city centre; Fernández-Heredia 2012). The campus comprises a total of 144 centres which represent an associated population of 112,871 people, including students and university employees. The objective of UNIBICI was to provide information on the potential of cycling trips in *Ciudad Universitaria* and to estimate the feasibility of a bicycle hire system on campus. The research is based on the responses of a selected set of items of the questionnaire from the UNIBICI project (Fernández-Heredia, Monzón, et al. 2014).

Research work was conducted in a set of steps. First, –using qualitative analysis techniques– a psychometric instrument was designed to evaluate barriers and motivators to cycling in low-cycling contexts. This instrument was then included in a larger online survey.

Factors considered influential for cycling in the specific context of a university setting and a low cycling place were identified and validated through a focus group. A total of 32 people participated, including students, teachers and non-teaching employees belonging to three universities present in campus. The resulting list of factors (see Table 2) were classified in two categories: barriers (B) and motivators (M) to cycling, and corresponding survey items were designed (Titze et al. 2008; Shannon et al. 2006). The comprehensibility and consistency of the 14 items design was tested by conducting a face to face pilot survey of 233 commuters at different locations within the campus.

Variable	*Survey questions and items*	*Mean*	*SD*
Barriers (B)	*"Please, assess the degree of importance of the following reasons that lead you to NOT use a bicycle, or to use it less than desired"*		
	Range: 1 = "not important at all"; 6 = "fundamental"		
(B1) Long trip distances	Distances to travel are too long	3.61	1.81
(B2) Accident risk	Risk of accidents or falls is high	4.09	1.65
(B3) Hilliness	Adverse topography needs too much physical efforts	3.42	1.54
(B4) Insufficient physical condition	My physical condition to ride is poor or insufficient	2.46	1.43
(B5) Adverse climate	Adverse weather conditions (rain, wind, cold, heat, etc.) are a constraint	3.63	1.43
(B6) Theft/vandalism risk	Risk of having my bicycle stolen or damaged is high	3.32	1.58
(B7) Lack of complementary facilities	Facilities for personal care and parking at home and destination are insufficient or do not exist	4.43	1.50
(B8) Discomfort	Comfort is lower compared to other modes of transport	3.18	1.55
Motivators (M)	*"Please, assess the degree of importance of the following reasons that motivate you to use a bicycle for your trips"*		
	Range: 1 = "not important at all"; 6 = "fundamental"		
(M1) Efficient	It avoids congestion, parking is easy, it allows door to door trips and it is faster than other modes in certain distances	5.08	.95
(M2) Flexible	It is free of time or frequency restrictions, it allows for route selection	4.87	1.07
(M3) Cheap	It avoids fuel costs, while vehicle acquisition and maintenance are very inexpensive	4.77	1.20
(M4) Environmental benefits	It does not emit pollutants or greenhouse gases, it generates little noise and makes little use of space	5.15	1.04
(M5) Health benefits	It is an active mode that can prevent certain issues due to inactivity	4.89	.97
(M6) Pleasant/fun	It is fun to ride a bicycle, it is more pleasant than other modes	4.13	1.29

Table 2. Factors used in the UNIBICI survey and corresponding ratings assigned to each factor by all respondents

A final online survey design was used to measure the degree of importance –on a 6-point Likert scale– of each barrier and motivator when considering the bicycle as a mode of urban transport. To recruit the sample, an e-mail was sent to the accounts of all the students, teachers and staff registered on campus. People was encouraged to participate in the survey through 1,000 reflective strips given to early participants and 10 folding bicycles raffled in a lottery among respondents. After rejecting incomplete or inconsistent questionnaires, the final sample was comprised of 2,555 respondents.

Variable	*N*	*%*	*Variable*	*N*	*%*
Female	*977*	*38.2*	*Household income*		
Age			*Less than 500€*	*1049*	*41.1*
18-24	*1044*	*40.9*	*500 - 2000€*	*994*	*38.9*
25-30	*477*	*18.7*	*More than 2000€*	*512*	*20.0*
31-40	*391*	*15.3*			
41-55	*528*	*20.7*	*Car ownership*	*1389*	*54.4*
> 56	*115*	*4.5*	*Bike ownership*	*1166*	*49.3*
University degree	*1706*	*66.8*	*Commute transport mode*		
Occupation			*Public transport*	*1357*	*53.1*
Student	*1356*	*53.1*	*Car / motorcycle*	*760*	*29.7*
Employed by University institutions	*955*	*37.4*	*Cycling*	*190*	*7.4*
Other	*244*	*9.5*	*Walking*	*248*	*9.7*

Table 3. Socio-demographic and mobility-related features of the UNIBICI sample

The gathered sample reflects the specific context in which the survey was undertaken, i.e. a university campus populated mainly by young students (see Table 3). People under 30 represent almost half of the sample, while 53% of the respondents are students. Another salient socio-demographic characteristic of the sample is the strong prevalence of graduate and postgraduate people (67%).

Low levels of car ownership through the sample (54%) are explained by the fact that two thirds of students do not have access to a car. Use of transport modes is also characterized by a strong prevalence of public modes (i.e. subway and urban buses) to access the campus (53%), followed by motorized private modes (30%), walking (10%) and by a much higher rate of cycling compared to the rest of Madrid city. Cycling trips *to Ciudad Universitaria* represent the 7.4% of all access trips registered through the sample, while in Madrid the most recent data estimate cycle mode share in 0.6% of all trips in the city centre (Fernández-Heredia, Monzón, et al. 2014).

Variable	*N*	*%*
Cycling frequency		
Frequent user (FU): those using their bicycle daily or several times a week	363	14.2
Occasional user (OU): those using it once per week or two or three times a month	728	28.5
Non-user (NU): those who never cycle	1464	57.3
Main purpose of cycling trips		
Commute	338	31.0
Other purposes	753	69.0

Table 4. Variables used to define groups according to respondent's bicycle use

Besides asking for usual socioeconomic and mobility-related data, the survey also gathered information on the specific object of the analysis, namely the previous users' riding experience. As seen, previous *cycling experience* is a proxy of what has been called 'cycling familiarity'. This experience has been measured in the survey in terms of *trip purpose* –i.e. if the individual has used the bicycle for commuting to work or school, or only for pleasure or sport–, and *trip frequency* –i.e.

if the individual has had much, little or no experience on a bicycle. Table 4 includes descriptive data about the characterization of the sample in terms of bicycle experience –in terms of frequency and trip purpose.

3.3.2 Study results

Data obtained from the UNIBICI survey were analysed to assess whether the perception of barriers and motivators differed across cycling frequency and cycling purpose groups defined above. All data analyses were performed using the statistical analysis software package SPSS version 20 (IBM, 2011).

Differences in perception of factors across cycling frequency groups

The Kruskal-Wallis' *H* test was used to analyse the differences in perception of factors across cycling frequency groups. This is a well-known non-parametric alternative to analysis of variance (ANOVA), when –as it is our case– the data do not comply with normality assumptions. Table 5 shows results of the Kruskal-Wallis test as well as descriptive statistics of the perceived barriers and motivators for the three frequency groups –as defined in Table 4. Since multiple significance tests are carried out, a correction has been applied to the α-level to control the overall Type I error rate (Wright 1992). Values of the Kruskal-Wallis test probe the existence of significant differences across trip frequency groups for all the eight barriers and for five out of the six motivators at p-value of .05 (adjusted results are highlighted in bold in Table 5).

Additional Mann-Whitney's *U* non-parametric test was carried out in order to detect between which pair of groups these differences exist. Lastly, the strength of the differences between pairs of groups –i.e. the size effect– was assessed using the Cohen's *d* test (Cohen 1988).

Table 5. Descriptive and statistical analysis for perceptions of barriers and motivators among cycling frequency groups

	Descriptive analysis						*Non-parametric analysis* [b]				*Size effect* [c]		
	Cycling frequency group [a]						Kruskal-Wallis' *H*	*U* test (Sig.)			Cohen's *d*		
	NU (N=1464)		OU (N=728)		FU (N=363)								
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Sig.	NU *vs.* OU	NU *vs.* FU	OU *vs.* FU	NU *vs.* OU	NU *vs.* FU	OU *vs.* FU
Barriers (B)													
(B1) Long trip distances	3.74	*1.85*	3.63	*1.75*	3.02	*1.68*	.000	.135	.000	.000	.06	.39	.35
(B2) Accident risk	4.18	*1.62*	4.11	*1.66*	3.66	*1.71*	.000	.371	.000	.000	.05	.32	.26
(B3) Hilliness	3.58	*1.54*	3.41	*1.49*	2.81	*1.44*	.000	.014	.000	.000	.11	.50	.41
(B4) Insufficient physical condition	2.62	*1.50*	2.48	*1.36*	1.82	*1.08*	.000	.129	.000	.000	.10	.56	.52
(B5) Adverse climate	3.55	*1.43*	3.71	*1.42*	3.75	*1.45*	.011	.013	.023	.721	.11	.14	.03
(B6) Theft/vandalism risk	3.20	*1.56*	3.47	*1.57*	3.50	*1.65*	.000	.000	.001	.722	.17	.19	.02
(B7) Lack of complementary facilities	4.36	*1.54*	4.59	*1.42*	4.39	*1.48*	.006	.002	.991	.029	.15	.02	.14
(B8) Discomfort	3.43	*1.59*	3.11	*1.41*	2.31	*1.33*	.000	.000	.000	.000	.21	.73	.58
Motivators (M)													
(M1) Efficient	4.97	*.97*	5.08	*.94*	5.49	*.74*	.000	.004	.000	.000	.11	.56	.46
(M2) Flexible	4.77	*1.10*	4.86	*1.04*	5.26	*.94*	.000	.092	.000	.000	.08	.45	.39
(M3) Cheap	4.72	*1.21*	4.78	*1.17*	4.98	*1.21*	.000	.388	.000	.001	.05	.22	.17
(M4) Environmental benefits	5.14	*1.01*	5.12	*1.10*	5.24	*1.02*	.049	.621	.014	.059	.01	.10	.11
(M5) Health benefits	4.84	*.99*	4.90	*.92*	5.04	*.98*	.001	.285	.000	.004	.06	.20	.15
(M6) Pleasant/fun	3.88	*1.30*	4.28	*1.19*	4.88	*1.09*	.000	.000	.000	.000	.32	.80	.52

[a] NU = Non-user, OU = Occasional user, FU = Frequent user

[b] Adjusted significance levels for 3 comparisons: $p < .0167$ (Significant differences are shown in bold)

[c] $d > .2$ are shown in bold

Overall, results show that a higher frequency is associated with a lesser importance of perceived barriers. Reversely, a higher frequency is associated to a higher importance of all the motivators considered. Detailed findings are included in what follows.

Differences in the perception of barriers (B)

The three groups differ in all pair-wise comparisons in the importance given to *discomfort* associated with cycling (B8) and to *hilliness* (B3). FU assess the importance of discomfort and hilliness significantly lower than NU (with an effect size of .73 and .50 respectively). To a lesser extent, similar differences occur also between FU and OU (d =.58 and d =.41). Statistical differences were found between OU and NU, although with weaker magnitudes.

The assessment of *long trip distances* (B1), *accident risk* (B2) and *insufficient physical condition* (B3) registers significant differences between NU and FU, and between OU and FU. Also in this case, a diminished importance of the three barriers occurs for FU as opposed to OU and NU (effect sizes range between .56 and .26). No differences were found between occasional and non-users for these variables. Finally, statistically significant differences among groups appear for *adverse climate* (B5), *theft/vandalism risk* (B6) and *lack of complementary facilities* (B7). The strength of those differences is weak, being effect sizes no higher than .19.

Differences in the perception of motivators (M)

The three groups differ in all pair-wise comparisons related to the importance given to *pleasure* associated with cycling (M6) and to *efficiency* (M1) as factors that motivate to use a bicycle, indicating an increased importance of these motivators when the level of frequency is intensified. The greatest differences occur for the perception of pleasure of cycling between non-users and frequent users (d = .80), between occasional users and frequent users (.52) and, to a lesser extent, between occasional users and non-users (.32). Differences between occasional users and non-users, although statistically significant for both factors, have a moderate magnitude only for the pleasant/fun factor. The *flexibility* of cycling (M2) results distinctly assessed only by FU, since NU and OU rate it in a similar way. Lastly, for the remaining motivators considered –*cheap* (M3), *environmental benefits* (M4) and *health benefits* (M5)– although a statistically significant difference exists in some comparison between pair of users, the strength of those differences is limited, being $d \leq .22$.

Differences in perception of factors across purpose of cycling trips groups

To analyse the differences in perception of factors across purpose of cycling trips groups a Mann-Whitney's U test was carried out and the Cohen's d measure of size effect was computed. Table 6 shows test's results along with descriptive statistics of the perceived factors for the two groups, i.e. commuters and cyclers for other purposes.

Table 6. Descriptive and statistical analysis for perceptions of barriers and motivators between purpose of cycling trips groups

	Descriptive analysis				*U test* [a]	*Size effect* [b]
	Purpose of cycling trips group					
	Cycling for other purposes (N=753)		Cycling for commuting (N=338)			
	Mean	*SD*	Mean	*SD*	Sig.	Cohen's *d*
Barriers (B)						
(B1) Long trip distances	3.61	*1.80*	3.03	*1.56*	.000	.33
(B2) Accident risk	4.13	*1.63*	3.57	*1.75*	.000	.34
(B3) Hilliness	3.33	*1.49*	2.95	*1.50*	.000	.26
(B4) Insufficient physical condition	2.36	*1.33*	2.03	*1.22*	.000	.26
(B5) Adverse climate	3.64	*1.41*	3.91	*1.45*	.004	.19
(B6) Theft/vandalism risk	3.54	*1.61*	3.36	*1.56*	.100	.11
(B7) Lack of complementary facilities	4.62	*1.40*	4.32	*1.52*	.003	.21
(B8) Discomfort	3.08	*1.41*	2.33	*1.35*	.000	.53
Motivators (M)						
(M1) Efficient	5.09	*0.95*	5.50	*0.73*	.000	.45
(M2) Flexible	4.87	*1.06*	5.27	*0.90*	.000	.39
(M3) Cheap	4.78	*1.17*	5.00	*1.22*	.000	.19
(M4) Environmental benefits	5.12	*1.10*	5.25	*1.00*	.062	.12
(M5) Health benefits	4.93	*0.94*	4.99	*0.95*	.274	.07
(M6) Pleasant/fun	4.36	*1.18*	4.75	*1.18*	.000	.33

[a] Significance level: $p < .05$ (Significant differences are shown in bold)

[b] $d > .2$ are shown in bold

Results of *U* test reveal the existence of significant differences between the two groups for seven out of eight barriers and for four out of six motivators (at $p < .05$, highlighted in bold in Table 6). Globally, people who declare to cycle for commuting purposes assess the importance of six out of seven barriers significantly lower than people who do not. Particular comments are included below.

Differences in the perception of barriers (B)

The largest differences appear with respect to *discomfort* (*d* = .53), *accident risk* (*d* =.34) and *long trip distances* (*d* =.33). Small size effects are found for *insufficient physical condition* (*d* =.26), *hilliness* (*d* =.26) and *lack of complementary facilities* (*d* =.21). Although statistical significant, the magnitude of the difference for *adverse climate* is low (*d* =.19). No statistical significant differences were found between the two groups with respect *theft/vandalism risk*.

Differences in the perception of motivators (M)

Differences also exist between the two groups for the importance given to factors that motivate the use of a bicycle, indicating an increased importance of these motivators when the purpose to cycle

is commuting or, reversely, a diminished weight of them when the commuting purpose is not associated to the practice of cycling. The greatest differences occur for the perception of *efficiency* (*d* =.45), for the *flexibility* related to cycling (*d* =.39), and for *pleasure* of cycling (*d* =.33). The motivator related to the *low cost* of cycling (M3), although presents statistically significant differences between the two groups of users, perform limited strengths for those differences, being *d* = .19. Finally, no significant differences are found for *environmental benefits* (M4) and *health benefits* (M5).

3.3.3 Relevance of the UNIBICI results for the scope of this thesis

The research synthesised in previous sections shows that the perception of barriers and motivators is strongly associated with the frequency and purpose of cycling trips. The tendency is that both a lower perception of barriers and a higher perception of motivators are associated with a higher frequency of bicycle use and with its use for commuting purposes. The fact that non-users (or people in the early stages of change in their cycling behaviour) perceive more barriers than regular or commuter cyclists supports the findings reported in other contextual settings (van Bekkum et al. 2011a; Nkurunziza, Zuidgeest, Brussel, et al. 2012; Shannon et al. 2006; de Geus et al. 2008; Gatersleben & Appleton 2007). However, the strength of these differences varies across the set of barriers and motivators, as discussed below.

First, the differences in perception *across frequency groups* were examined. The most pronounced differences are seen for factors relating to affective aspects, in line with the recent findings (Anable & Gatersleben 2005; Muñoz et al. 2013; Forward 2014). Indeed, the *pleasure* of travelling by bicycle is perceived significantly as a more important motivator for occasional than for non-users and in turn more for frequent than for occasional users. Similarly, the *discomfort* of riding a bicycle is significantly perceived a less important barrier for occasional than for non-users and even less for frequent than for occasional users. On the contrary, motivators such as the *low cost* of cycling, its *health* and *environmental benefits*, or barriers such as *theft/vandalism risk*, *adverse climate*, or the *lack of complementary facilities* are recognized to be at similar levels of importance across the levels of frequency considered, suggesting that their importance is recognized widely through the sample.

Slightly smaller differences are found in barriers like *insufficient physical condition*, *hilliness*, *long trip distances* and *accident risk*. This may be due to the underlying cognitive and behavioural processes highlighted by some qualitative active travel research. For instance, Daley et al. (2007) and van Bekkum et al. (2011b) found that people who cycled in urban environments perceived danger on the roads to be less of a barrier to cycling than non-cyclists, and hypothesised that cyclists used specific strategies to effectively deal with traffic risk (i.e. being vigilant and alert; clear signalling; making eye contact with other drivers; wearing high visibility clothing; and developing knowledge of alternative cycling routes). Such specific strategies are likely to evolve through the experience of riding a bicycle in real traffic conditions and may not be put into practice until a certain threshold level of frequency

is reached. In the same line, Joshi and Senior (1998) note that existing utility cyclists who have cycled in traffic have a diminished perception of danger than those who do not have such experience. Similarly, fear of accidents reduces with greater cycling experience (Snelson et al. 1993). In a recent study, Lawson et al. (2013) revealed that the perceived safety of cycling increases with regularity of use and with an increasing number of days cycled per week, as well as the probability of considering cycling as less safe than driving falls. Results from the UNIBICI study are coherent with those findings.

The same may be true for other barriers to cycling. Under a given threshold level of frequency, it can be assumed that the assessment of a barrier occurs either from a lack of practical knowledge of the specific circumstances relating to that barrier or –in case of occasional cycling– without repeated attempts that would consolidate learnings and coping strategies. This may be the case for the two motivators of *efficiency* and *flexibility*. Occasional and non-users may give less importance on these motivators because they are giving their ratings based on situations that can only be imagined.

Second, the role played by a second characteristic of the previous riding experience, i.e. the *purpose of cycling trips*, was examined. The perception of *discomfort* is the most dissimilar factor across trip purpose groups, suggesting a moderate association between the act of commuting and the lower assessment of cycling as an uncomfortable form of transport. Also in this case, non-commuting users may assign greater importance to barriers, as their ratings can only be imagined by extrapolating feelings experienced in other contexts. Commuting purpose is found to have a reinforcing effect on the association for high bicycle use frequency, suggesting that when the two situations occur simultaneously, the perceptions of eight out of the 14 factors considered reveal a substantial difference between those based on the *idea* of riding a bicycle compared to the actual experience of people who cycle (Fernández-Heredia, Monzón, et al. 2014).

These findings were the initial insights on the problem of a possible recursive cycle of cycling consideration and originated further reflection leading to initiate the research of this thesis. In fact, the observation that positive beliefs toward cycling are unlikely to occur with low levels of cycling use raised questions on the dynamics of attitude forming. The fact that positive attitudes were associated to riding experience and, at the same time, that experience forming may only be possible if cycling is used, focused the attention on the role of 'tasting' of the cycling experience. But 'tasting' results 'difficult' in low-cycling contexts, then further questions surged. Is the fact that people like cycling the reason for them to cycle? (**they cycle because they like cycling**) or is the fact that they do cycle the reason for them to like cycling? (**they like cycling because they cycle**). Or is perhaps a combination of the two? Or is neither of the two? This kind of questions generated the problem called as 'the cycle of cycling consideration' expressed in Chapter 1 and, subsequently, the motivation for exploring the circular relation between what has been called 'cycling familiarity' and cycling consideration. The following two chapters will describe the context, the methods and the procedures

used for this research, based on the theoretical pathways and corresponding research strategies outlined in previous Section 3.2.

4 Vitoria-Gasteiz as a case study

In the literature, few works on the psychosocial aspects of cycling have been carried out in the so called 'low-cycling contexts', i.e. with populations in which cycling mobility is a minority practice. As already mentioned, the difficulty to capture behaviours in places where these are performed by a small amount of people poses methodological challenges which lead researchers to draw on definite settings like university campuses or specific work-related contexts (Lavery et al. 2013; Shannon et al. 2006; Bonham & Koth 2010; van Bekkum et al. 2011a). The research presented above (Section 3.3), resulted from the study in Madrid and which generated the initial insights on the role of cycling familiarity on cycling consideration, shows similar limitations.

For this reason, the research of present thesis focuses on the entire population of commuters of Vitoria-Gasteiz, a medium-sized city in the North of Spain. The city displays the highest ratio of bicycle usage among Spanish cities and for this reason is the best suited for an investigation on bicycle commuting consideration in a low cycling country like Spain (nationally only 0.2% of trips are travelled by bike). Cycling in Vitoria-Gasteiz counts for almost 7% of the modal split and this figure is steadily increasing since 2001, when the rate was around 1.4% (City of Vitoria-Gasteiz 2011).

In Vitoria-Gasteiz the use of bicycles is favoured by its flat topography of the city, by the compactness of its urban development (6 km extension in maximum diameter) and by a good provision of infrastructure, programs, and services geared at increasing the role of sustainable modes. Rate of walking is another significant characteristic of the city's transportation system since it represents 54% of all trips, also increasing thanks to an integrated set of policies put in place to tackle the negative impacts generated by urban mobility patterns, a common element of all industrial developed cities (City of Vitoria-Gasteiz 2007).

Successfully implemented environmental policies, not only in the transport sector, and wide-spread sustainable practices among its citizens are some of the reasons that brought the city to be awarded European Green Capital in 2012 (European Commission 2011). The city is also characterized for its extensive environmental assets, such as a 700 hectares Green Belt, for its industrial-based economy, and for a compact and self-contained urban settlement, where a population of around 240,000 inhabitants lives over 33 km^2, and where 86% of the employed residents work in the same

municipality (GEA21 2009). The latter data is particularly significant for the scope of this thesis since it makes the option of commute cycling potentially feasible for the great majority of the Vitoria-Gasteiz's commuters.

This chapter describes in details the background context of Vitoria-Gasteiz with a special focus on how the practice of cycling is considered among its inhabitants. The description will frame the methods and procedures carried out in that city in order to undertake the empirical research outlined in Chapter 3.

4.1 The background context of the city

Vitoria-Gasteiz is a medium-sized city in the north of Spain. The city is the capital of the autonomous community of the Basque Country[3] and it holds the second core of population after Bilbao, with around 240,000 inhabitants. It is also the capital of Álava Province, concentrating 76% of its population (Andrés Orive & Dios Lema 2012).

The following sections present the background context of the city, synthetically describing the physical, socio-economic, cultural and institutional environments of people living there, in the aim of building a set of influences on cycling as a mode of transport across diverse ecological layers.

4.1.1 Landscape and climate

Situated in a wide flat valley at an altitude of 523 meters on the level of the sea, the municipality land of Vitoria-Gasteiz extends over an area of approximate 27,500 ha, 12% of them (ca. 3,300 ha) dedicated to the urban uses of the main city. Outside the main city, 64 small rural villages exist which are functionally related to the agricultural use which cover almost 40% of the municipality land. The rest of land (48%) is made up of mountain ranges with forests and grazing meadows (City of Vitoria-Gasteiz 2010).

[3] The Basque Country is one of the seventeen autonomous communities that, along with two cities enclosed in Morocco, form the Spanish state.

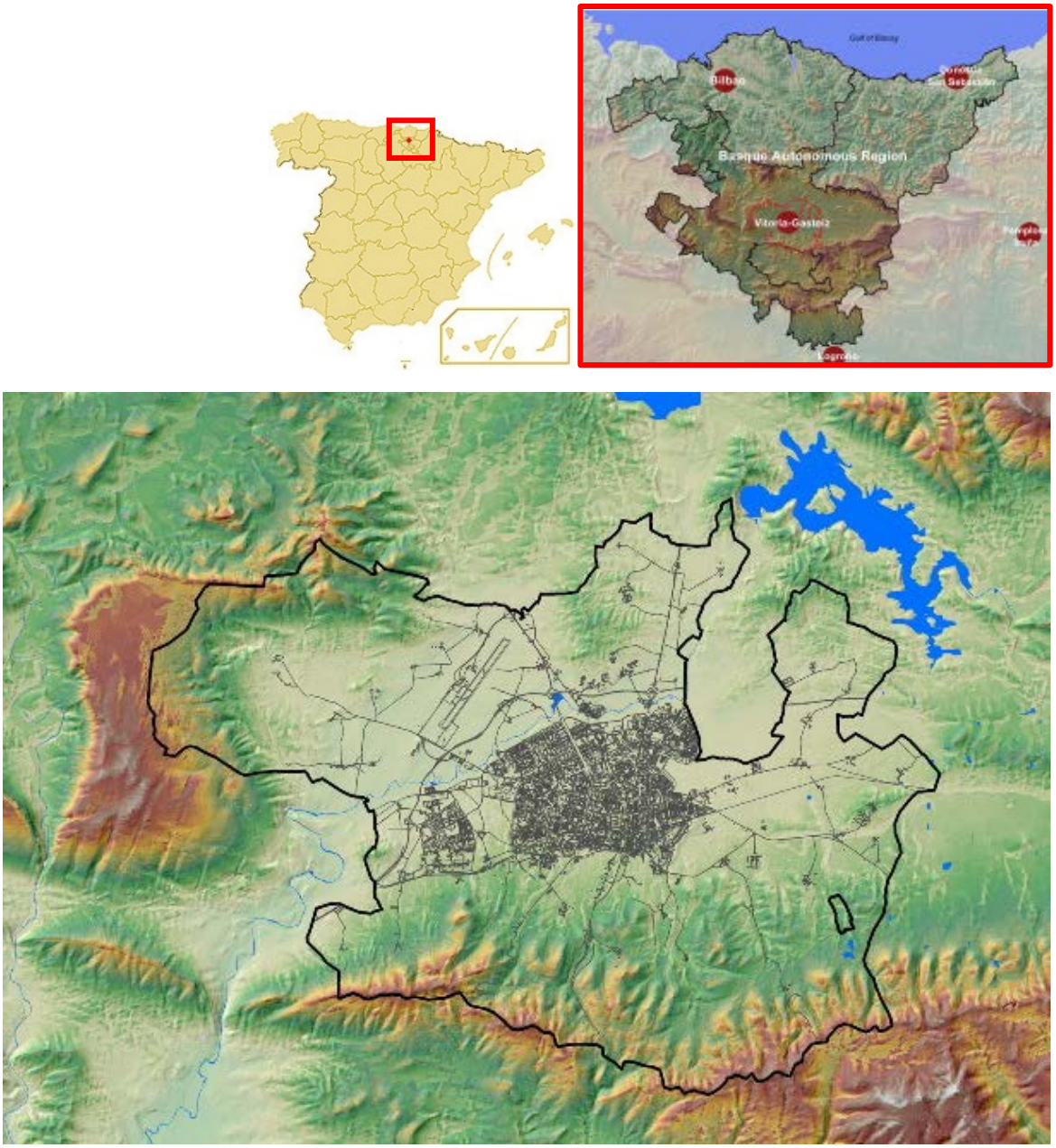
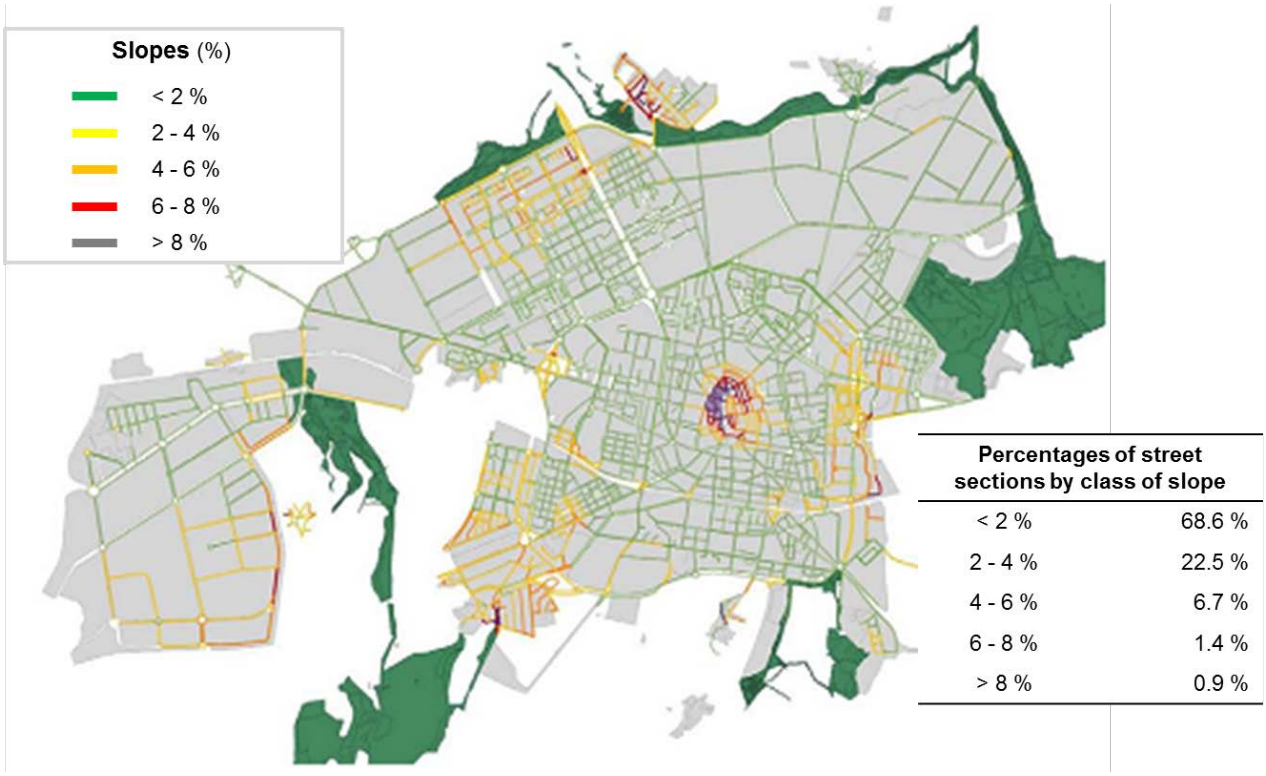


Figure 25. Vitoria-Gasteiz, in relation with the other institutional levels, the Álava Province and the Basque Autonomous Region (City of Vitoria-Gasteiz 2010)

The flat terrain of the city is reflected by the fact that the vast majority (67%) of the city's streets are without any slope (<2%) (see Figure 26). Only the old medieval town, situated on a hilly at the core of the city, has even steep slopes in its narrow and curvy streets and alleys, but these streets represent less than 9% of all sections and they are easily avoided due to the concentric nature of urban fabric.



Percentages of street sections by class of slope	
< 2 %	68.6 %
2 - 4 %	22.5 %
4 - 6 %	6.7 %
6 - 8 %	1.4 %
> 8 %	0.9 %

Figure 26. Map of slopes by street section (City of Vitoria-Gasteiz 2007)

The climate of Vitoria-Gasteiz is characterised by its geographic location and configuration, being surrounded by mountains which limit the Atlantic influence from north and the continental one of the rest of central Spain (GEA21 2009). As a result, the city has a temperate microclimate of cool, wet winters and cool summers, distinguished by a low rate of sunny days (a total of 28 per year) and a high humidity (71-84%).

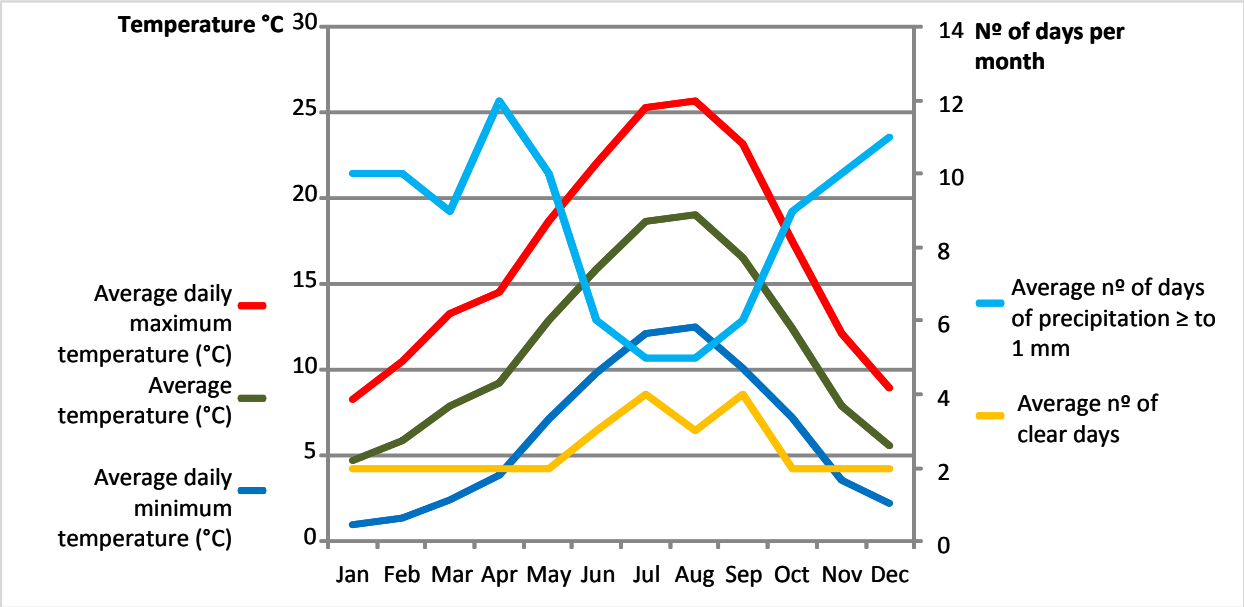


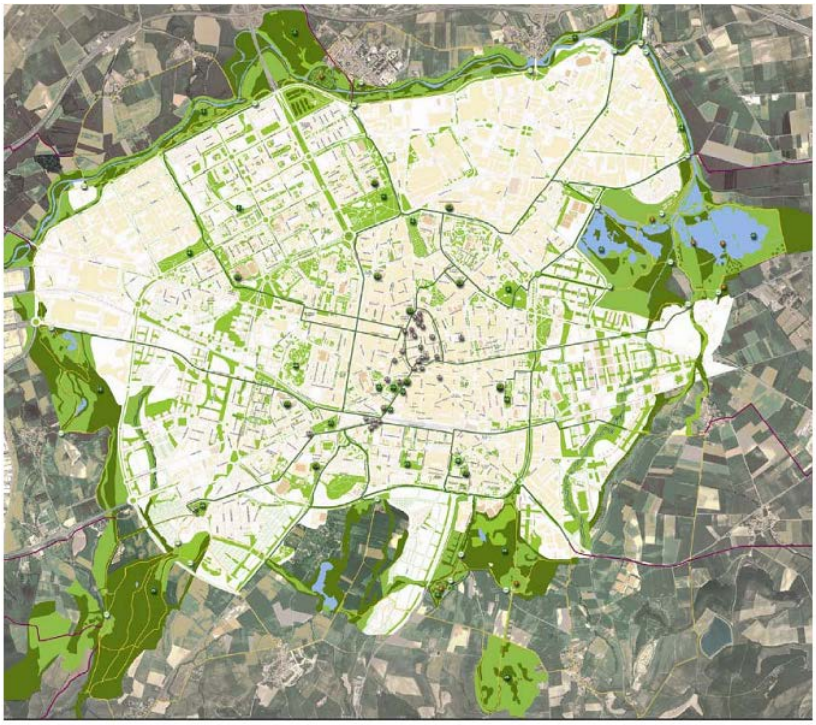
Figure 27. Vitoria-Gasteiz's normal climatic values registered in period 1973-2000 at Foronda-Txokiza station (processed by author based on data from Agencia Estatal de Meteorología - AEMET 2004)

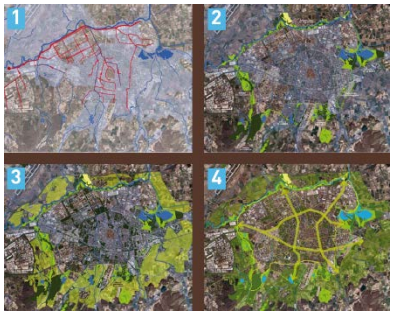
Rains are expected every month of the year, ranging from 5-6 rainy days in summer to 10-12 in winter and spring, totalizing 103 rainy days per year. Average temperatures recorded in winter range from 1°C to 9°C, while in summer season they are around 18°C with a maximum of 26°C in August. Days with temperatures below 0°C are around 40 per year (Agencia Estatal de Meteorología - AEMET 2004).

4.1.2 Land use patterns

One of the main characteristics of the built environment of Vitoria-Gasteiz is its compactness, with all urban uses neatly fitted into a delimited space, featuring a sharp separation between the urban fabric and the countryside. Despite a consistent expansion of the urban territory in recent years (increasing from 1,800 hectares in 1998 to 3,300 in 2009), planners of this city have largely relied on a compact model of urban development, successfully limiting sprawl (Andrés Orive & Dios Lema 2012) to the extent to be internationally recognised and awarded for its urban and environmental policies, as discussed later on.

The flagship of the city's compact nature is the so called Green Belt, a semi-natural strip of parks and other green space which almost surround the entire city. Partially recovered from degraded areas – such as gravel pits, burnt ground and drained wetlands –, the Green Belt started to be restored in the mid 1990s thanks to a large proportion of publicly managed land. Today the Green Belt consists of 613 hectares, with plans to be extended up to almost 800 hectares (City of Vitoria-Gasteiz 2010).





The Green Belt (2) is part of a series of environment infrastructures planned and partially implemented in Vitoria-Gasteiz: the water system (1), the agricultural belt (3), the four urban green axes. All of them are elements of city's long track in sustainability policies described in section below.

Figure 28. The Green Belt of Vitoria-Gasteiz and other environment infrastructures (Agencia de Ecología Urbana de Barcelona 2010)

Including the network of little parks, gardens and tree-line avenues inside the city fabric, the total provision of public green areas extends over one third of the urban areas (1,091 ha), supplying an average rate of 46 m^2 of green spaces per inhabitant (City of Vitoria-Gasteiz 2010). Excluding the Green Belt from the calculus, the ratio is of 14 m^2/inh, above the minimum recommended by the World Health Organization (10 m^2/inh), making Vitoria-Gasteiz the city with the highest surface of green zones per inhabitant in Spain (Agencia de Ecología Urbana de Barcelona 2010).

The compactness of the city is also reflected by the fact that almost all of its population (98%) live inside the perimeter of the Green Belt. In fact, of the current 242,147 inhabitants of Vitoria-Gasteiz, (according to the city census at 01/01/2013), only 5,025 persons live in the 64 rural villages outside the main city. This means that in an area of about 6 km in diameter most of city's uses are located, including the residential use.

This spatial configuration permits that around 32% of the population lives within 1,000 m of the nerve centre of the city (the Plaza Nueva), 74% within 2,000 m, and 96% within 3,000 m, allowing over 90% of the population to live within 300 m of the basic services such as education, health and cultural facilities (City of Vitoria-Gasteiz 2010). Figure 29 and Figure 30 maps the spatial distribution of population in Vitoria, with densities, land uses and radius distances from the city centre.

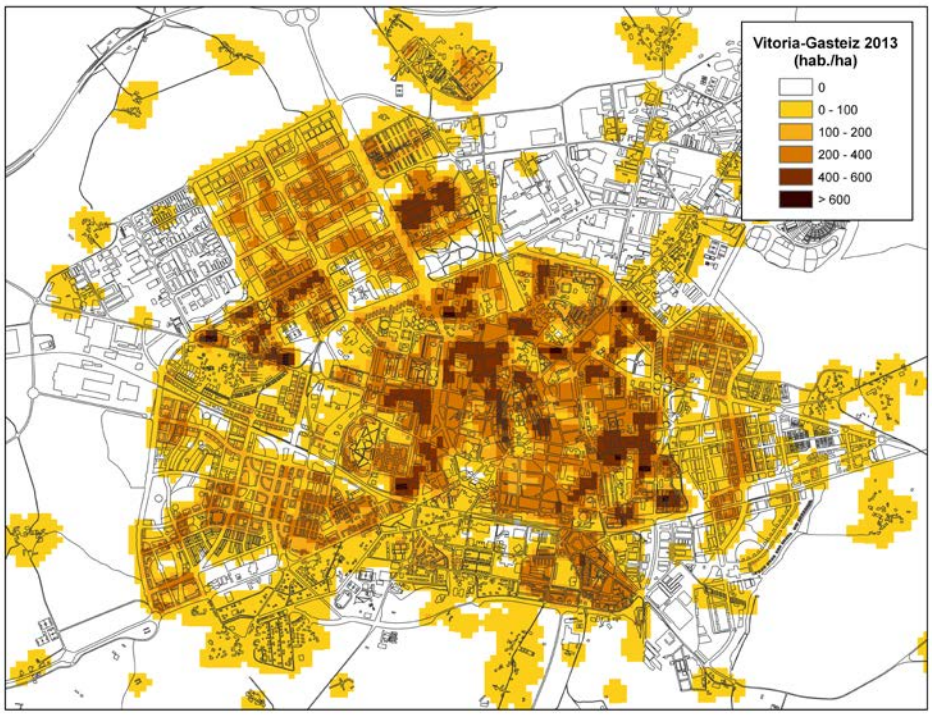
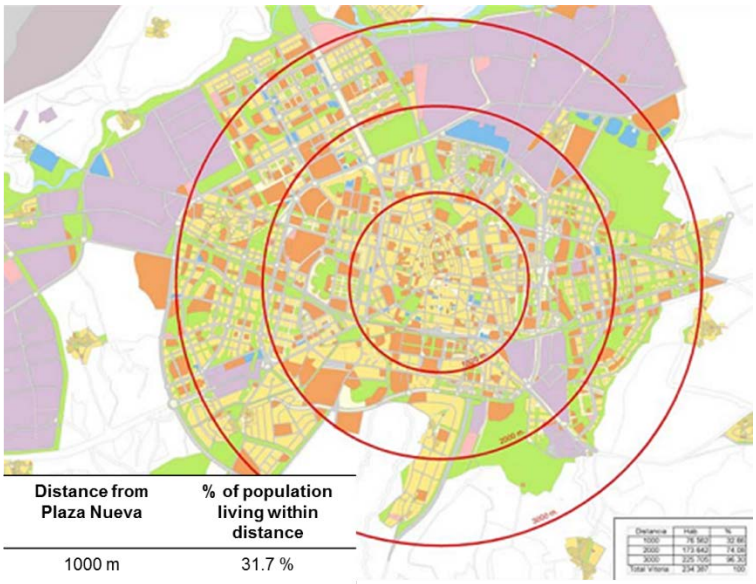


Figure 29. Population density in Vitoria-Gasteiz in 2013 (source: City of Vitoria-Gasteiz)

The population density reaches an average rate of around 67.5 inhabitants per hectare. Excluding green and water zones, built-up areas reach a mean population density of approximate 100 inh/ha, which does not tell very much about how Vitoria-Gasteiz is as a compact and relatively dense city,

because high densities of the built-up areas are mixed with large un-built and protected areas (City of Vitoria-Gasteiz 2010).



Distance from Plaza Nueva	% of population living within distance
1000 m	31.7 %
2000 m	74.0 %
3000 m	96.3 %

Figure 30. Radius distance from the city centre (source: City of Vitoria-Gasteiz)

In fact, the distribution of population in such delimited space is very uneven, with several types of urban setting associated to distinct typologies of urban fabric, ranging from the medieval city centre to the contemporary new neighbourhoods at the edges of the city. The pattern of land use configurations, with correspondent densities and intensities of uses, functions and people is not easily recognizable through a look at the land use map of the city shown in Figure 31.

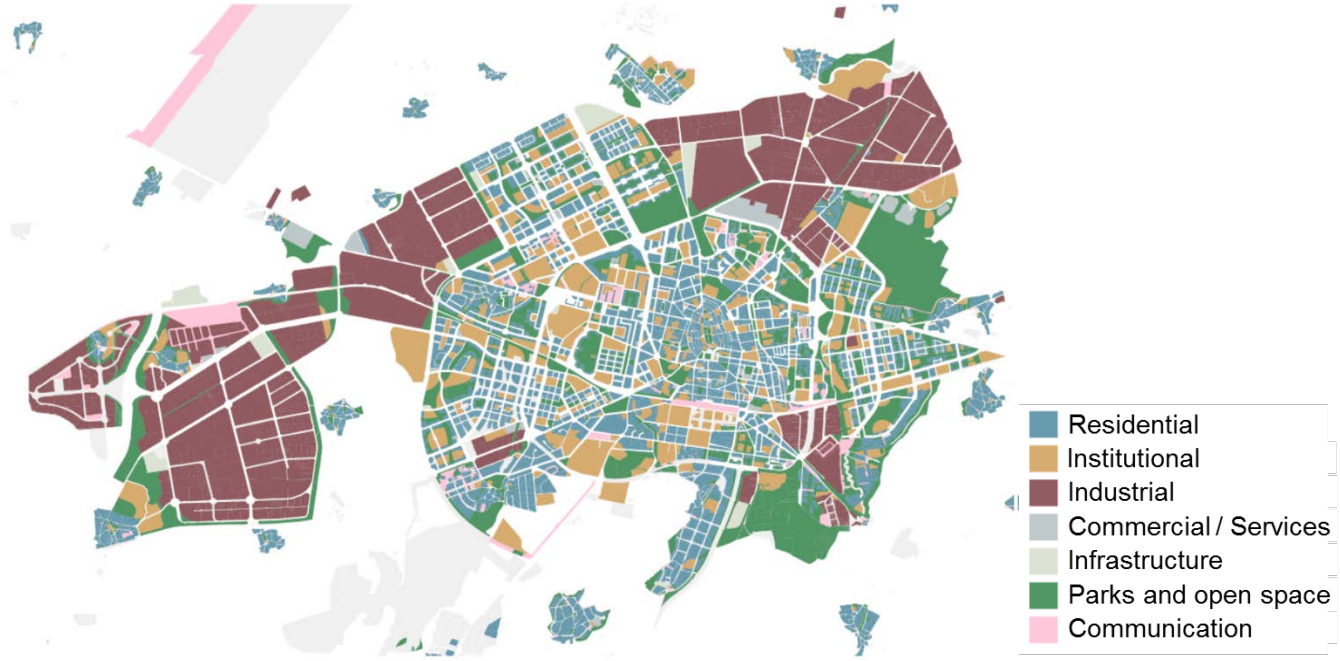


Figure 31. Land use map of Vitoria-Gasteiz (source: City of Vitoria-Gasteiz)

One classification of urban fabrics seems more useful for the scopes of this thesis. Considering population density and intensity of built surface (floor area ratios) as classification parameters, five typologies of urban fabric have been distinguished instead (Agencia de Ecología Urbana de Barcelona 2010):

1. The **central fabrics**, with high population densities (greater than 150 households per hectare, corresponding to densities greater than 300-350 inhabitants/hectare) and high building intensities (floor area ratios >1.5), are characterized by a high variety of uses and urban functions and they attract people (workers, tourists, residents, clients). They include the medieval old town, the 19th and the early 20th century expansions and part of the modernist open block developments.
2. The **medium fabrics**, with medium population densities (between 60 and 150 households/ha) and medium building intensities (floor area ratios between 1 and 1.5), are characterized by a predominant residential use and the presence of diverse commercial activities. These neighbourhoods surround the central fabrics and they are predominantly constituted by open block buildings.
3. The **residential fabrics**, with low population densities (less than 60 households/ha) and low building intensities (floor area ratios is less than 1), are characterized by an almost exclusive residential use and the presence of commercial activities for basic needs. Open block building typology is here mixed with one-household buildings and some kind of mixed typologies.
4. The **new urban sectors** correspond to the most recent developments in which new land for urbanization (about 610 hectares planned in 2000) has been filled completely or partially by several typologies of urban fabrics, from very low urban densities types recently combined with developments with much higher densities. The areas of Salburúa and Zabalgana represent the most important of those areas in which modifications to the General Plan aim at new re-densification scenarios, increasing densities from around 50 to 78 and to 87 houses/ha respectively.
5. The **industrial fabrics** correspond to those parts of the city for the industrial use. They cover more than 1,070 hectares (one third of the total urbanized area) and they are situated at the northeast and northwest edges of the city, with the Jundiz Business Park neatly separated from the rest of urban fabrics.

The classification based on typologies of urban fabrics made by the Plan of Indicators for Urban Sustainability (Agencia de Ecología Urbana de Barcelona 2010) is a useful tool to understand much of the processes the city is undertaking, through the understanding of dynamics which are hidden behind average values. Table 7 gives a synthesis of the distinct types of built environments present in Vitoria-Gasteiz, providing their localization, their main indicators and a photo example.

	Central fabrics Surface: 2,997,227 m² Population (2012): 74,551 Population density: >150 households/ha Building intensities: floor area ratios >1.5 Uses: high variety of uses	
	Medium fabrics Surface: 3,614,825 m² Population (2012): 68,003 Population density: 60-150 households/ha Building intensities: floor area ratios 1-1.5 Uses: mainly residential, commercial	
	Residential fabrics Surface: 7,926,345 m² Population (2012): 93,447 Population density: <60 households/ha Building intensities: floor area ratios <1 Uses: almost exclusively residential, only basic needs commercial activities	
	New urban sectors Surface: 7,173,207m² Population: 5,189 (2012), 65,709 (2014) Population density varies among sectors (48÷87 households/ha) Also uses vary among sectors, from exclusively residential to highly mixed	
	Industrial fabrics Surface: 14,593,652 m² Population (2012): 957 Uses: industrial	

Table 7. Typologies of urban fabric of Vitoria-Gasteiz (adapted from Agencia de Ecología Urbana de Barcelona 2010; updated with data from City of Vitoria-Gasteiz 2012a)

4.1.3 Population characteristics and dynamics

The spatial distribution of population of Vitoria-Gasteiz is concentrated in the central fabrics, where a 31% of the total population lives. These central fabrics reach density ratios greater than 200 households per hectares, corresponding to a total of 460 inh/ha, way above the threshold of 250-

300 inh/ha considered the desirable one for sustainable urban settings. By contrast, residential fabrics have densities well below recommended. The evolution of population by neighbourhood in the last ten years shows a strong shift of population from the districts bordering the centre to the periphery: toward Arriaga-Lakua, Sansomendi, Ali-Gobeo, Zabalgana and Salburúa.

Looking at how the distribution of population has evolved in time (see Figure 32), it can be noted how the population of Vitoria-Gasteiz surged during the 1960s, as job opportunities in the strong mechanical and metallurgy industries attracted more and more people from all over Spain. From a town of just 50,000 people in 1950, a rapid growth over two decades at an average rate of 4% per year brought the population to 200,000 people in mid 1980s. Since then, the city continued to grow in population at a much lower pace, featuring an average increase rate of about 0.4% per year until the turn of the century. The pace of population growth had an increase in the new millennium, with an annual growing rate of 0.88%, probably due to the huge supply of new houses permitted by the General Plan approved in 2000[4]. Year 2013 has registered the first population decrease in decades, mainly due to the global economic crisis and the consequent stop in immigration flows from abroad the UE (City of Vitoria-Gasteiz 2013).

With a stock of 109,427 houses in 2010, the average household occupation ratio is 2.46 people per house, with a strong increase of one-occupant houses in recent years, especially in residential fabrics and new urban sectors, shifting from a share of 19% in 2001 to 27% in 2010 (City of Vitoria-Gasteiz 2013).

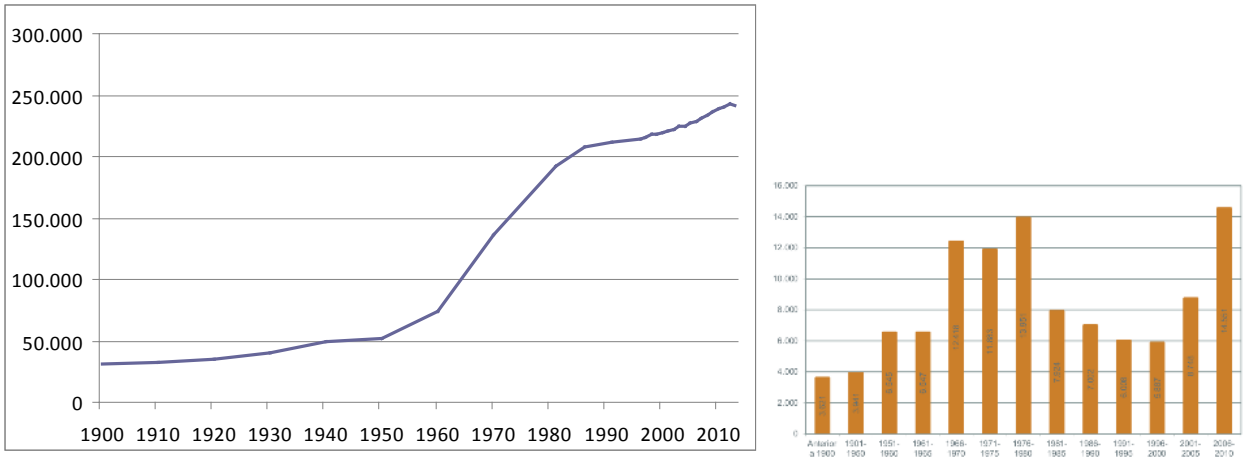


Figure 32. Vitoria-Gasteiz population, evolution 1900-2013 and demographic balance (City of V.G. 2013)

As in all developed countries of European Union, population structure in Vitoria-Gasteiz is now characterised by low fertility and low mortality, moderate population growth, increased migration and increasing proportion of older people (City of Vitoria-Gasteiz 2013). In the past twenty years the

[4] The General Plan of Urban Planning (PGOU in Spanish) extended the city's urbanized land adding 942 hectares of new land for development, 33% of which for residential uses, capable for 27,641 new homes (Luque Valdivia 2011). That planning tool has been largely criticized by subsequent policies and the land expansion planned has been recognized as an error to be recovered by new planning tools.

age structure of the population has changed significantly: the younger population has lost a third of its amount while the elderly population has doubled. The population aged 0 to 14 years shifts from a share of 22% overall in 1986 to a share of 14.1% presently, while the elderly population goes from 9% to 18.6%. Since the turn of new millennium, the people over 65 are more than those under 15 and the trend is increasing. The ratio between active and inactive population is 2:1, it means that every 100 active individuals, other 50 are inactive (22 are under 16, while 28 over 64) 2010 (City of Vitoria-Gasteiz 2013).

Although the birth rate is still high (10 births per 1000 inhabitants), the average number of children per woman barely exceeds 1 child/woman, and the number of women with children is narrowing (45% of women in 2006 between 16 and 64 had no children). The result is the existence of a large number of households without children (25%), single person households (33%) and households with people over 64 (30%).

HABITANTES	Hombre	Mujer	Total
AL 1/1/2013	118.937	123.210	**242.147**
INDICADORES	**Hombre**	**Mujer**	**Total**
Edad Media	41,15	43,73	**42,46**
Indice de Mayores (1)	16,61%	20,52%	**18,60%**
Indice de Vejez (2)	1,60%	3,60%	**2,62%**
Indice de Menores (3)	17,28%	15,77%	**16,51%**
Indice de jóvenes (4)	15,47%	14,93%	**15,46%**
GRUPOS DE EDAD	**Hombre**	**Mujer**	**Total**
De 0 a 14	17.490	16.578	34.068
De 15 a 64	81.691	81.351	163.042
De 65 y más	19.756	25.281	45.037
GRUPOS DE EDAD	**Hombre**	**Mujer**	**Total**
95 y más	103	413	516
90-94	447	1.254	1.701
85-89	1.350	2.766	4.116
80-84	2.819	4.148	6.967
75-79	3.980	4.907	8.887
70-74	4.550	4.808	9.358
65-69	6.507	6.985	13.492
60-64	7.119	7.646	14.765
55-59	7.530	8.259	15.789
50-54	8.303	9.099	17.402
45-49	9.332	9.523	18.855
40-44	10.134	9.687	19.821
35-39	11.260	10.261	21.521
30-34	9.924	9.414	19.338
25-29	7.467	7.318	14.785
20-24	5.523	5.377	10.900
15-19	5.099	4.767	9.866
10-14	5.217	5.035	10.252
5-9	5.754	5.559	11.313
0-4	6.519	5.984	12.503
Total	**118.937**	**123.210**	**242.147**

(1) Personas de 65 y más años sobre la población total
(2) Personas de 85 y más años sobre la población total
(3) Personas de 0 a 17 años sobre la población total
(2) Personas de 14 a 29 años sobre la población total

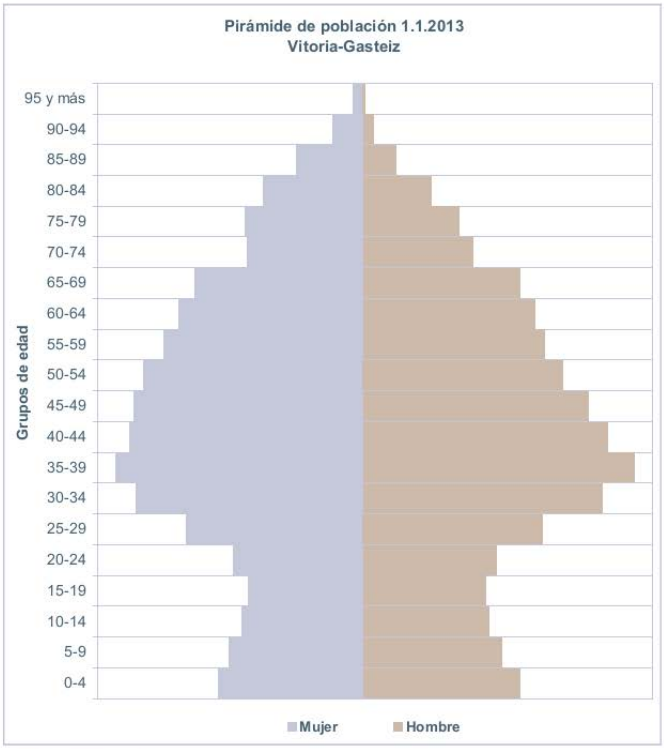


Figure 33. Vitoria-Gasteiz's main demographic data and indicators 2010 (City of Vitoria-Gasteiz 2013)

The percentage of persons from abroad has risen from 2% of the total population in 2001 to 10.4% in 2012, higher than the average of the Basque Country (7.1% in 2012) and lower than the state-wide immigration (14%). As mentioned before, year 2013 register the first population decrease ever and this phenomenon is due to a stop in migration flows. Foreign people are now the 9.6% of population of Vitoria-Gasteiz, approximately 32% were born in Latin America and 37% in Africa. The distribution of foreign population is homogeneous through the city, although is higher in the central fabrics, especially in the medieval town where it doubles its share (19.7%).

4.1.4 Jobs and activities

Vitoria-Gasteiz is traditionally an industrial city, prospered in the mid of XX century thanks to aeronautics, energy and manufactory firms plants (mainly automotive), although more recently new technologies services have gained importance. Four multinational firms have plants in Vitoria-Gasteiz: Daymler-Chrysler (Mercedes), Michelin, Daewoo and Gamesa. The industrial plants occupy more than 1,000 ha of the municipality with Jundiz Business Park as one of the largest in the north of the Iberian Peninsula.

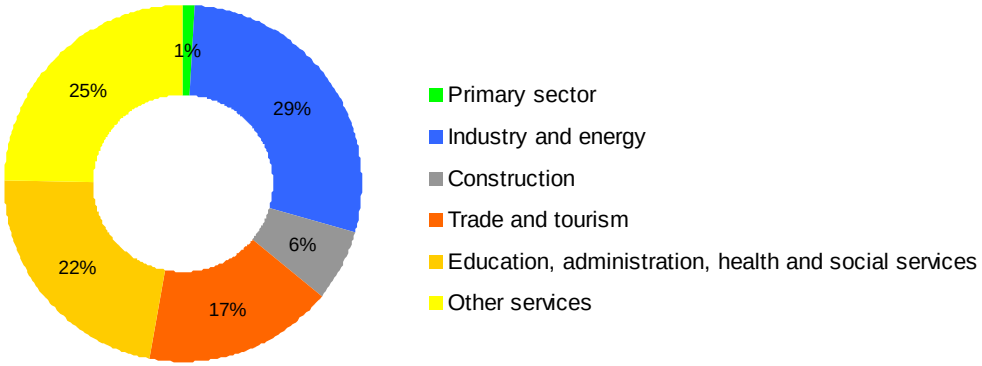


Figure 34. Active population of Vitoria-Gasteiz by sector of activity (City of Vitoria-Gasteiz 2013)

Another important sector for the economy of the city is the service sector, especially since in 1980 the city has assumed the title of capital of the Basque country. The service sector currently employs 64% of the active population of Vitoria-Gasteiz, while the industrial sector counts with 29% of resident's jobs, marking its strong industrial character if compared with other urban areas which have passed through heavy processes of de-industrialization (City of Vitoria-Gasteiz 2011).

Until recent global economic crisis, Vitoria-Gasteiz had a full employment situation, featuring a structural unemployment rate of less than 3%. After 2008, as in all European cities, many jobs were lost, reaching rates of 10% in 2011, especially among young people (25%). The data is lower than the rest of Basque country (11%), and way under the average of Spain (25% in 2012).

Figure 35. Unemployment rate in Vitoria-Gasteiz, evolution 1997-2011 (City of Vitoria-Gasteiz 2011)

In Vitoria-Gasteiz, according to Livelihood Survey (City of Vitoria-Gasteiz 2012a), 44% of the population is occupied and 16% is studying, with notable differences in rates of inactivity for women and men. A 48% of male workers have a dependent employment (33% for women) and nearly 22% are retired (15% for women), while one in four women work at home.

The city is characterized by a high level of autonomy in the jobs localization model, that is, with little dependence on jobs outside the municipality. In fact, the 85.6% of the Vitoria's employed residents work in the same municipality (City of Vitoria-Gasteiz 2012a). The data is particularly significant if compared with other cities: the other provincial capitals of the Basque country have values of 69% for San Sebastian and 63% for Bilbao. The self-containment rate has a special interest for analysing the transportation system because significantly affects mobility (trips generated) and quality of life of people living in the city as discussed in following sections.

Total jobs in Vitoria-Gasteiz were 108,507 in 2013, being 20.6% of them covered by people coming from outside the city (especially administrative personnel employed in the autonomous government and agencies).

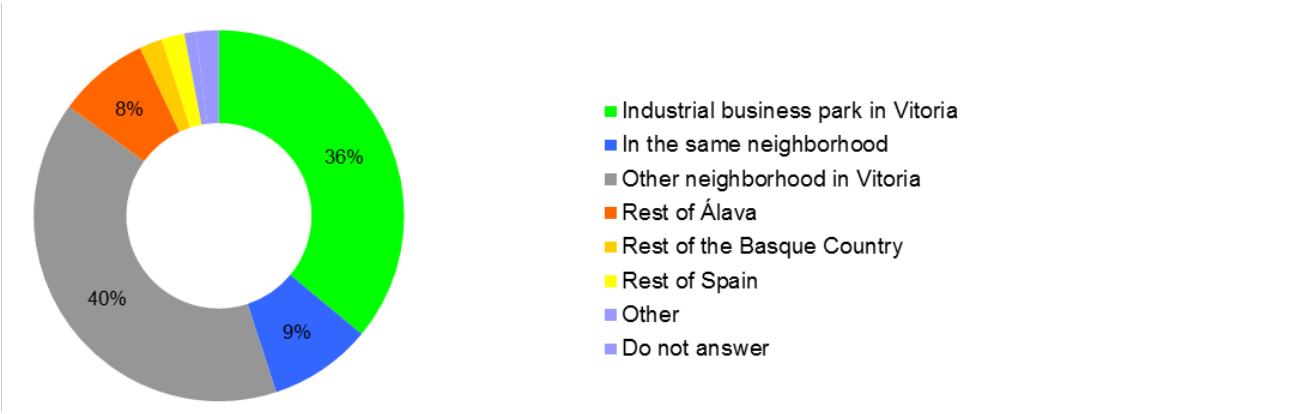


Figure 36. Localization of jobs for active residents of Vitoria-Gasteiz (Agencia de Ecología Urbana de Barcelona 2010)

Among the active residents of Vitoria-Gasteiz, 36% has a job in the industrial zones at the edges of the city, 40% works in a distinct neighbourhood from the one where they live, while 9% of them does not have to move from the neighbourhood where they live (City of Vitoria-Gasteiz 2012a).

4.1.5 Urban planning policies

Vitoria-Gasteiz has been well known in Spain and recently also internationally for its urban planning policies and practices. A tangible commitment to sustainability can be detected for over 30 years (Andrés Orive & Dios Lema 2012). For this commitment, which comprises both successfully implemented environmental policies and wide-spread good practices among its citizens, the city has

been granted with the European Green Capital 2012 Award[5]. The award has been based on three key pillars of the city's policies and achievements:

- the environmental asset of the Green Belt (mentioned above), conceived to tackle urban sprawl, land degradation and pollution from heavy industrialization and which has been a crucial element for an efficient green space management system;
- a sustainable water-management system, with significant investments aiming at reducing losses, rationalize consumption, improve quality and at reaching the ambitious target for domestic water consumption reduction to below 100 litres per person per day;
- a successful Sustainable Mobility Plan on which much of the sustainability policies are based, including a new bus network bringing wait-time to 10 minutes, a new low-carbon tram system, over 100 km of bike lanes and an extensive network of parks and walking itineraries, all them coherently aimed at cutting car use and improve public space liveability, as discussed later on.

All these environmental efforts have benefited from the fact that the political landscape has long been continually favourable to develop a common ground of goals and principles, making of sustainability policies a part of urban identity (Andrés Orive & Dios Lema 2012).

Key in this path has been the creation in the late '80s of the Environmental Studies Centre (CEA, *Centro de Estudios Ambientales* in Spanish) — an internal agency that has ended up contributing analysis and solutions into almost all areas of the government, not only the environmental ones.

An essential element of the good governance implemented in Vitoria-Gasteiz has been the involvement of the academic community, through a dialogue between policy-makers and academics which ensures that the questions studied by the latter have a connection with the urban reality the former have to manage, and vice versa (Smith 2011).

One of Vitoria-Gasteiz's avant-garde moves in sustainability policies was being one of the first European cities to sign (in 1995) the Aalborg Charter — a framework for local sustainable development that called on local authorities to engage in Local Agenda 21 processes[6]. Such commitment was one of a long series of planning initiatives which referred to a dense set of institutional documents paving the way to city's efforts (see Figure 37).

[5] The European Green Capital prize was launched in 2010 and is awarded, based on some straightforward criteria, to an applying city that: "Has a consistent record of achieving high environmental standards; is committed to ongoing and ambitious goals for further environmental improvement and sustainable development; and can act as a role model to inspire other cities and promote best practices to all other European cities". Vitoria-Gasteiz is the third city awarded, after Stockholm in 2010 and Hamburg in 2011. In 2013, the French city of Nantes received the international recognition.

[6] Agenda 21, adopted by over 178 governments at the 1992 Earth Summit, is "a comprehensive plan of action to be taken globally, nationally and locally by organizations of the United Nations System, Governments, and Major Groups in every area in which humans impact on the environment" (Agenda 21, UNCED).

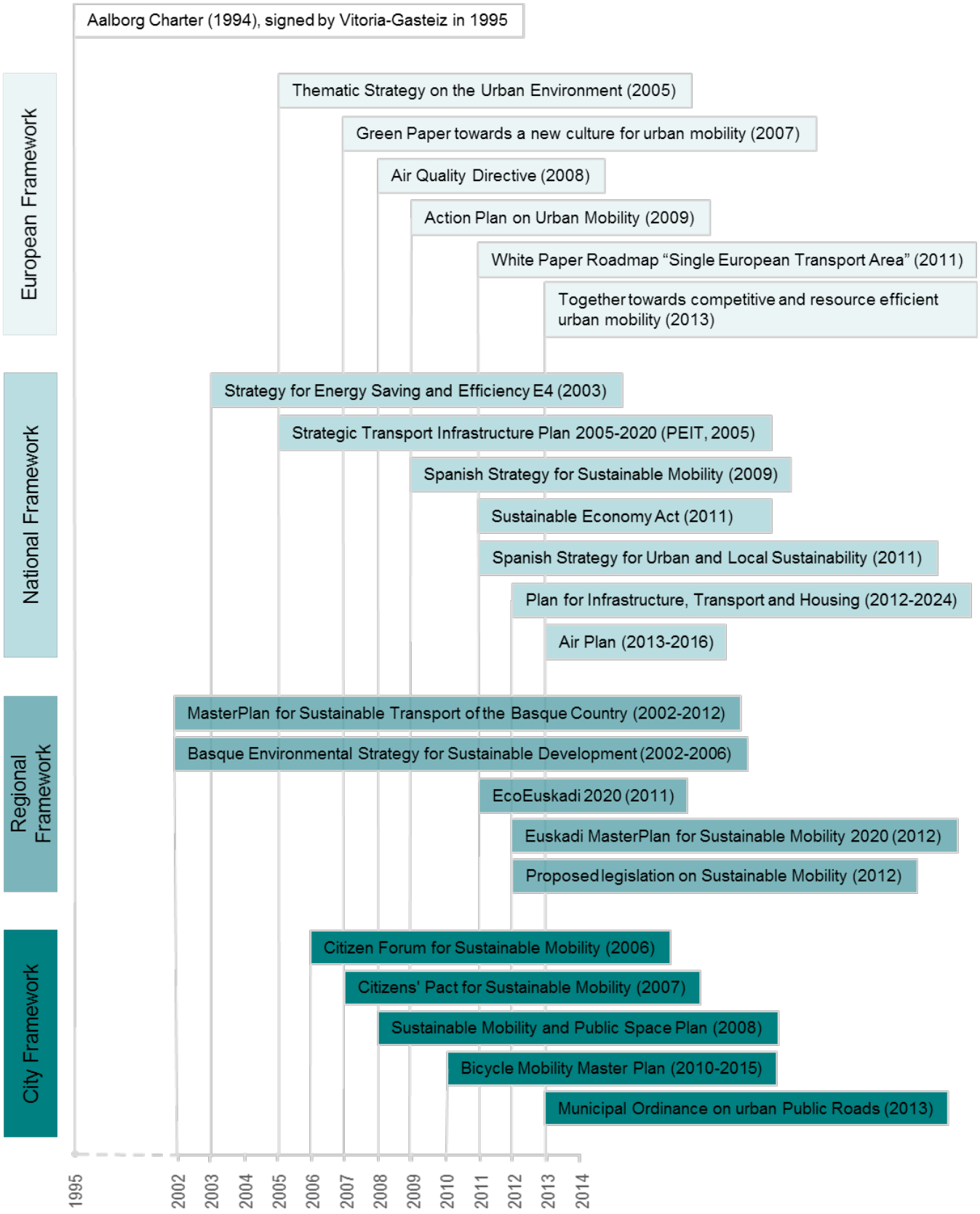


Figure 37. Timeline of the institutional framework for the planning initiatives of Vitoria-Gasteiz

The city's Agenda 21 was the inspiring initiative of such development, which in recent years lead to most of the actions on the transport system and mobility patterns discussed in next section. The

importance of Agenda 21 work was the inclusion of a thorough system of indicators to measure the level of achievement of its goals in various areas, including: pollution, traffic, water, energy, biodiversity and environmental risk, most of them referring necessarily to the transport sector. The system of indicators was created in 1998 and subsequently expanded in 2004 and 2009.

Vitoria-Gasteiz was also among the first cities to sign up in 2009 to the European Covenant of Mayors launched by the European Commission to encourage and support local authorities in the implementation of sustainable energy policies that are to help the European Union to meet its target of a 20% CO_2 reduction by 2020. Covenant signatories prepare a Baseline Emission Inventory and submit, within a year, a Sustainable Energy Action Plan (SEAP) outlining the key actions they commit to making. Vitoria-Gasteiz has prepared Sustainable Energy Action Plans to 2050 and is one of 12 Pioneer Regions in the ENNEREG Regions Paving the Way for Sustainable Energy in Europe initiative (Smith 2011).

The institutional environment of Vitoria-Gasteiz is then characterized by a high level of leadership and consensus on sustainable development among political parties, a strong environmental movement, and a strong support of citizens on such issues. In facts, the emergence in the '90s of a vocal green movement encouraged the city to take a lead in sustainable development with the consequence that respect for the environment has become a value that crosses party lines and – most interestingly– a value that crosses lines among sectors and areas of government.

One of such areas is transport, which has been governed with the sustainability principles mentioned and was one of the reasons, maybe the most important one, why Vitoria-Gasteiz has been awarded with the European Green Capital award in 2012, because of the strong commitment to tackle unsustainability trends at its origins, concentrating much of the efforts in designing a paradigm shift precisely in the local transport system.

4.2 The transport system and mobility patterns

As already described in previous sections, with its 6 km extension in diameter and with 86% of its population working in the same municipality, Vitoria-Gasteiz is a pedestrian-scale compact city, in which walking has long been and it is still the main mode of mobility. In fact, walking currently counts for 54% of all trips (City of Vitoria-Gasteiz 2011) and, if compared with similar European cities, the differences in the modal share are marked and outstanding, making it the most significant characteristics of the city's transportation system (see Figure 38 and Figure 39).

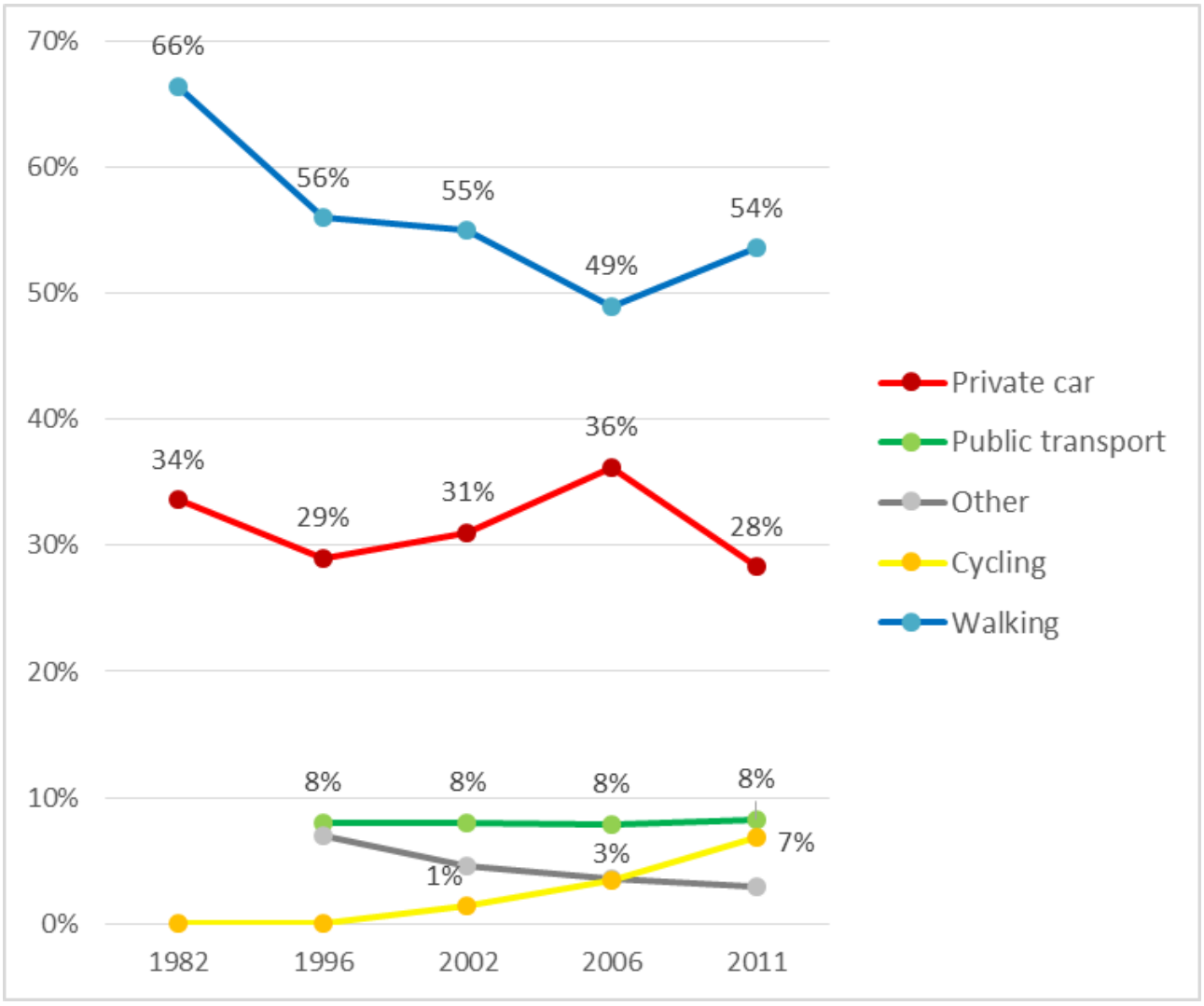


Figure 38. Evolution of modal split for all trips in Vitoria-Gasteiz (City of Vitoria-Gasteiz 2011)

Last mobility survey (City of Vitoria-Gasteiz 2011) says 54% of journeys within the city are on foot, 28% by car, 8% in public transport and approximately 7% on bicycles. The average number of daily journeys during a working day is 2.43, of which 0.89 are made by car. The proportion of journeys of less than 5 km by private car was 36% in 2011 (City of Vitoria-Gasteiz 2011). Compared with the average modal share scheme of similar Spanish cities (see Figure 40), Vitoria-Gasteiz has a much more balanced transportation system, with a less pronounced use of cars (29% instead of 37%), a stronger participation of the walking mode, and most interestingly for the scope of this thesis, a not negligible role of cycling trips as in the rest of cities. In fact, Vitoria-Gasteiz is the leader in Spain for the use of bicycles for urban trips, with its 6.9% of cycling share, being Seville the second one with an estimated 4% (City of Vitoria-Gasteiz 2011; Monzón & Rondinella 2010).

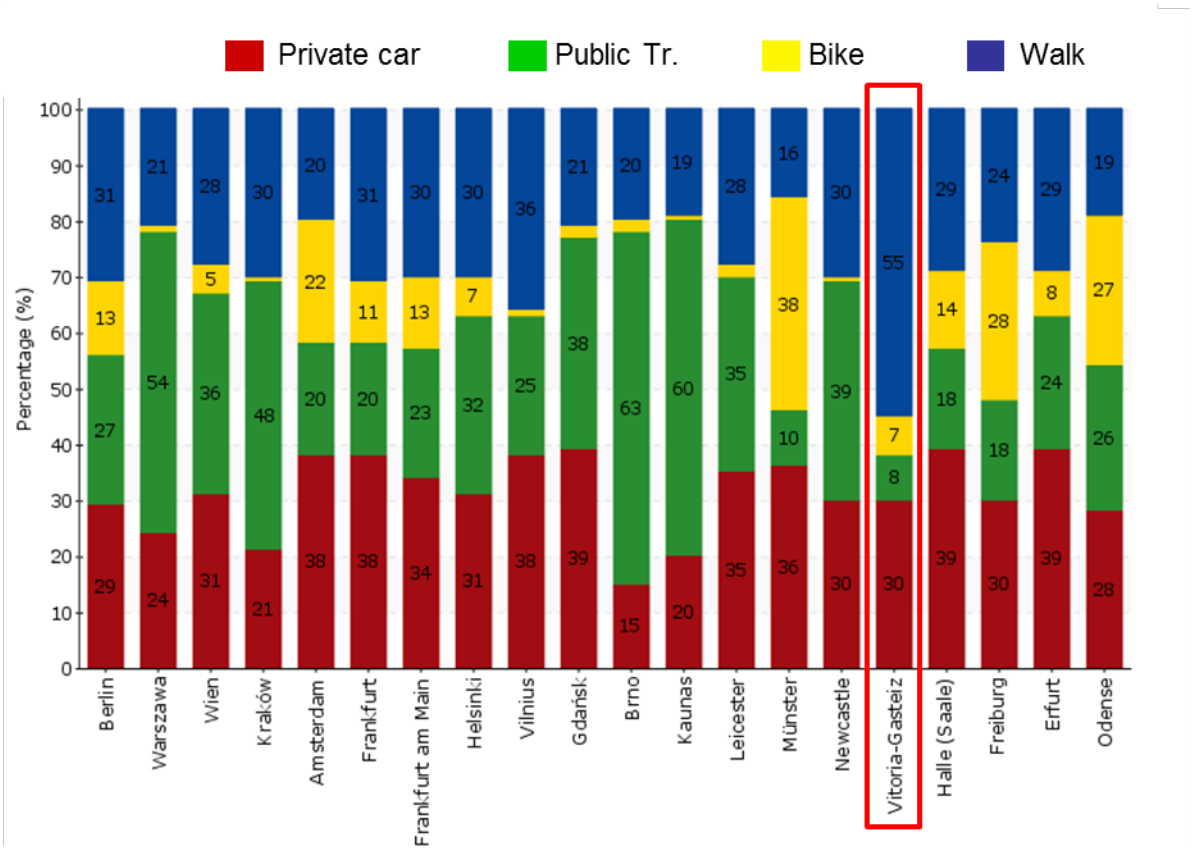


Figure 39. Comparison of modal shares among European cities similar to Vitoria-Gasteiz (EPOMM 2014)

Analysing other indicators, performance of Vitoria-Gasteiz in many aspects of sustainability are here decisively better than other Western and Spanish cities (City of Vitoria-Gasteiz 2011).

If the evolution of modal share patterns is analysed (see Figure 38), a relevant improvement in the trend of this crucial transportation system indicator is straightforwardly marked. Car use decreased from a figure close to the one reported as average for similar Spanish cities, while non-motorized modes (and in a lesser degree public transport) gained positions, with walking returning to the protagonist role which was starting to be in threat.

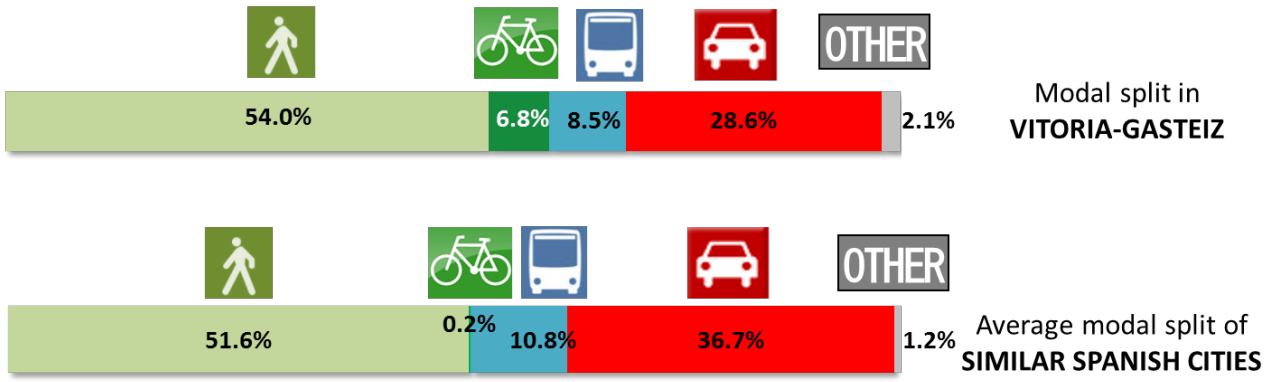


Figure 40. Comparison of Vitoria-Gasteiz's modal share with the average modal share scheme of similar Spanish cities (Observatorio de la Movilidad Metropolitana 2013)

4.2.1 The planning initiatives to manage and transform the transport system

It is impossible to understand the current transportation system and mobility patterns of this city without mentioning at the same time the policies implemented by the planning tools put in place to tackle the negative impacts generated by urban mobility patterns. In fact, as in all Western contemporary cities, also Vitoria-Gasteiz has suffered in different degree those processes of transformation of urban structure and modification of its metabolic systems generated by what is called as 'automobility' (Urry 2004). The high car ownership rates (558 cars per 1000 inhabitants in 2006) and the changes in lifestyle patterns of mobility have led also in Vitoria-Gasteiz to a constant increase in the use of motorized vehicles for everyday urban trips, generating the environmental, social and economic impacts well known in every developed urban setting: air, noise and soil pollution, congestion, accidents, energy consumption and dependency, climate change impacts, marginalization of mobility alternatives, loss of public space, etc. are some of these impacts, as many analytic and planning documents reported.

Negative impacts of car-based transport model generated, back in the mid of the 2000s decade, a wide-spread and common consciousness about the degradation processes in force and a strong will for change emerged. Public policies, initiated with a transversal political commitment, have then become to be created, producing a long series of planning initiatives, documents and action.

The main planning tool in this sector has been the **Sustainable Mobility and Public Space Plan** (**SM&PSP**). Initiated in 2006, the plan has the explicit aim of transforming the current model based on 'automobility', reversing the until then upward trend in the use of the private car and to promote cycling, walking and public transport. The plan surged from the recognition of the two major dysfunctions in Vitoria-Gasteiz's urban mobility:

- the unbalanced modal split (as seen above)
- and the uneven distribution of public road space (61% for vehicles vs. 39 % for pedestrian, see Figure 41).

While it is relatively common for urban transport planning tools to recognize and tackle the former problem, the innovative element of policies in Vitoria-Gasteiz is their focus on the latter. One of the reasons of this innovation rose from the recognition of the decay of walking in modal share. In fact, the trend for reduction of trips made by walking was evident, passing from 66% in 1982, to 56% in 1996, to 50% in 2006. The SM&PSP detected the distribution of public road space as the main determinant of mobility system dysfunctions. While cars where mainly used only for the commuting trips (50.3%), leaving its share minoritarian for other trip purpose (shopping, leisure, errands, etc.), the public space dedicated to the efficient flows and standing of motorized vehicles was overwhelmingly dominant in comparison with space dedicated to the other urban functions and as space for human relationships: the Plan of Indicators for Urban Sustainability (Agencia de Ecología Urbana de Barcelona 2010) measured in 39% the global space dedicated to the pedestrian mobility in 2009. With the exception of the old medieval town, where this share was the 85% by effect of

pedestrian zones, in every neighbourhood, including the central fabrics' ones, the share was systematically below 50%, with some neighbourhoods in the medium and residential fabrics under 30% (see Figure 41).

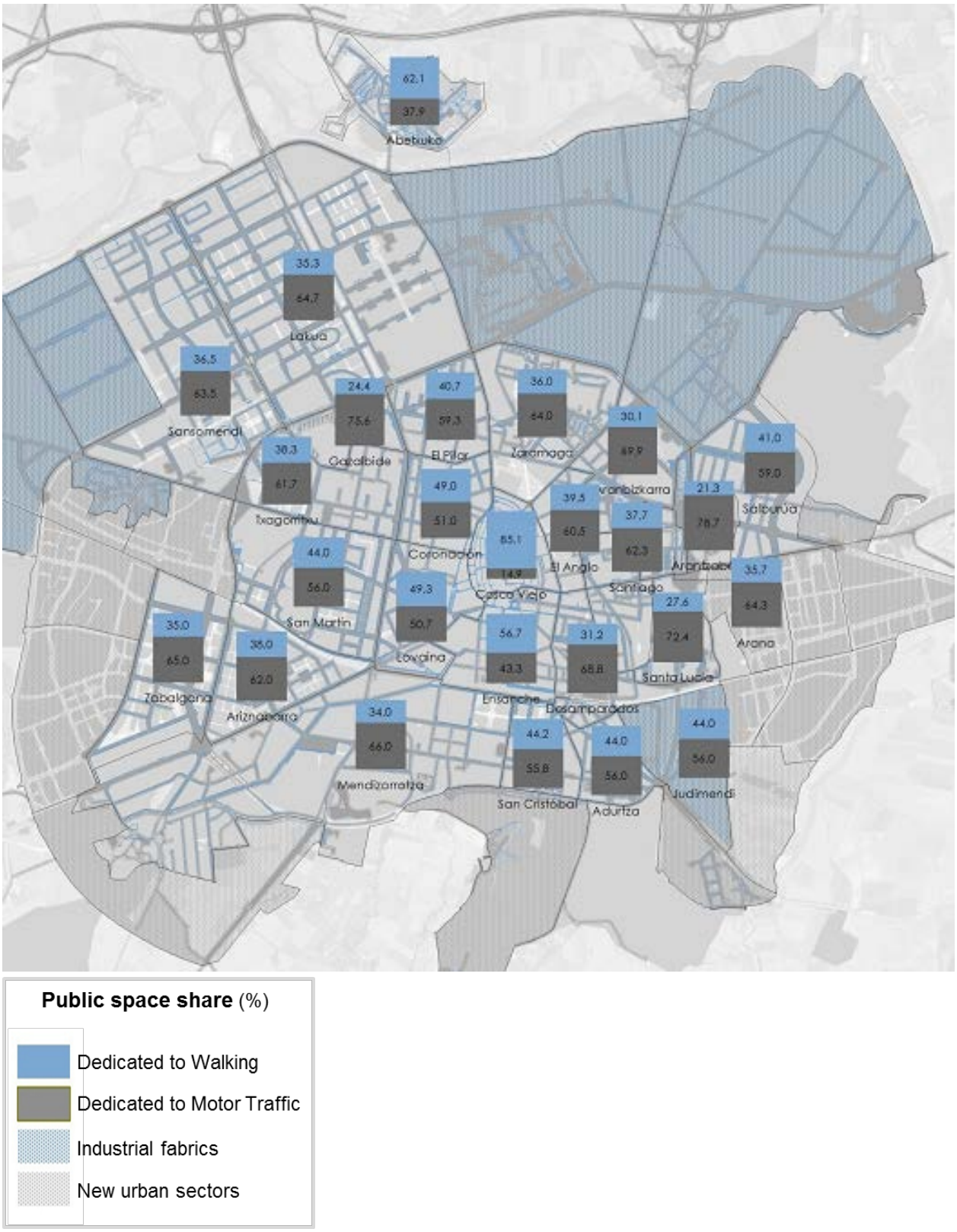


Figure 41. Distribution of public space: pedestrian share – vehicle share (A. Ecología U. de Barcelona 2010)

Based on a process of intense public participation (see Citizens' Pact for Sustainable Mobility in Box 1), the plan puts together a set of coherent measures to reverse negative trends detected, concentrating its strategy on two main axes:

- by one hand, recognizing the compact nature of the city, then the potentiality to shift the proportion of short journeys (of less than 5 km) made by private car;
- by the other hand, seeking to transform the public space in order to enable non-motorised transport modes to gain (for cycling) or recover (for walking) a leading role in urban mobility.

The process of the Sustainable Mobility and Public Space Plan

Planning phase (October 2006-July 2008):

- Citizen Forum for Sustainable Mobility (October 2006)
- Citizens' Pact for Sustainable Mobility (April 2007):
  - Signed by 54 representatives of associations, institutions, companies and other entities.
  - Endorsed by the full City Council (September 2007) and Social Council.

Implementation phase (September 2008-present):

- Technical-Political Working Group (40 meetings)
- Councils by sector of activity
- Councils by neighbourhood with the participation of associations and citizens' groups (30 meetings)
- Accompaniment campaign by volunteers

The Citizens' Pact for Sustainable Mobility

The Pact, signed in 2007 after an intense process of participation with city's stakeholders through the Citizen Forum for Sustainable Mobility, proposed a radical change in the way people move in Vitoria, adapting to the reality of a municipality with 63 local authorities and a city who walked a lot, it had tried to integrate cycling as alternative mobility and, at that time, in the process of urban expansion, needed to improve public transport system that was in decline and that was more important than ever to ensure efficient accessibility and mobility in the municipality. The Pact proposed a mobility model less dependent on the private car and where ways to move less energy intensive, less polluting and less wasteful of land had a greater specific role in urban mobility.

Some of the most relevant agreements of the Citizens' Pact for Sustainable Mobility (April 2007):

- To move to a new city model in which mobility is not a threat to the quality of life, the health of its population, the environment or the local economy.
- To promote non-motorized modes and reducing private vehicle weight.
- To put in place a system of public transport and effective renovated.
- To calm traffic in most of city's streets.
- To explore and put in practice alternatives to the current car-based model.

Box 1. Synthesis of the process of Sustainable Mobility and Public Space Plan and the Citizens' Pact for Sustainable Mobility

Accordingly, measures put in place by SM&PSP are all geared at increasing quality of life and reducing the number of vehicles circulating. Explicit main objectives are:

- To enable the maximum possible recovery of public space as a social space for the public.
- The application of the 'superblocks' model to provide a comprehensive solution to the organisation of mobility networks and to improve the quality of public space.
- The incorporation of public participation to crucial decisions of the plan.
- To reach a consensus among both the technical areas involved and the political stakeholders.

The transformation of public space is the central organizing axe of the SM&PSP and it is pursued through the **reorganization of a different transport network around a basic cell called 'superblock'** (*supermanzana* in Spanish). The concept – derived from the hierarchy of roads proposed by Buchanan in the '60s – classifies city roads in a core network for *traffic roads* (perimeter of the superblock) and *pedestrian-priority streets* (inside the superblock). The scheme aims at dissuading car through-traffic by limiting access and on-street parking inside the specified home-zones, promoting at the same time short distance modes (cycling and walking) through a safe and functional approach.

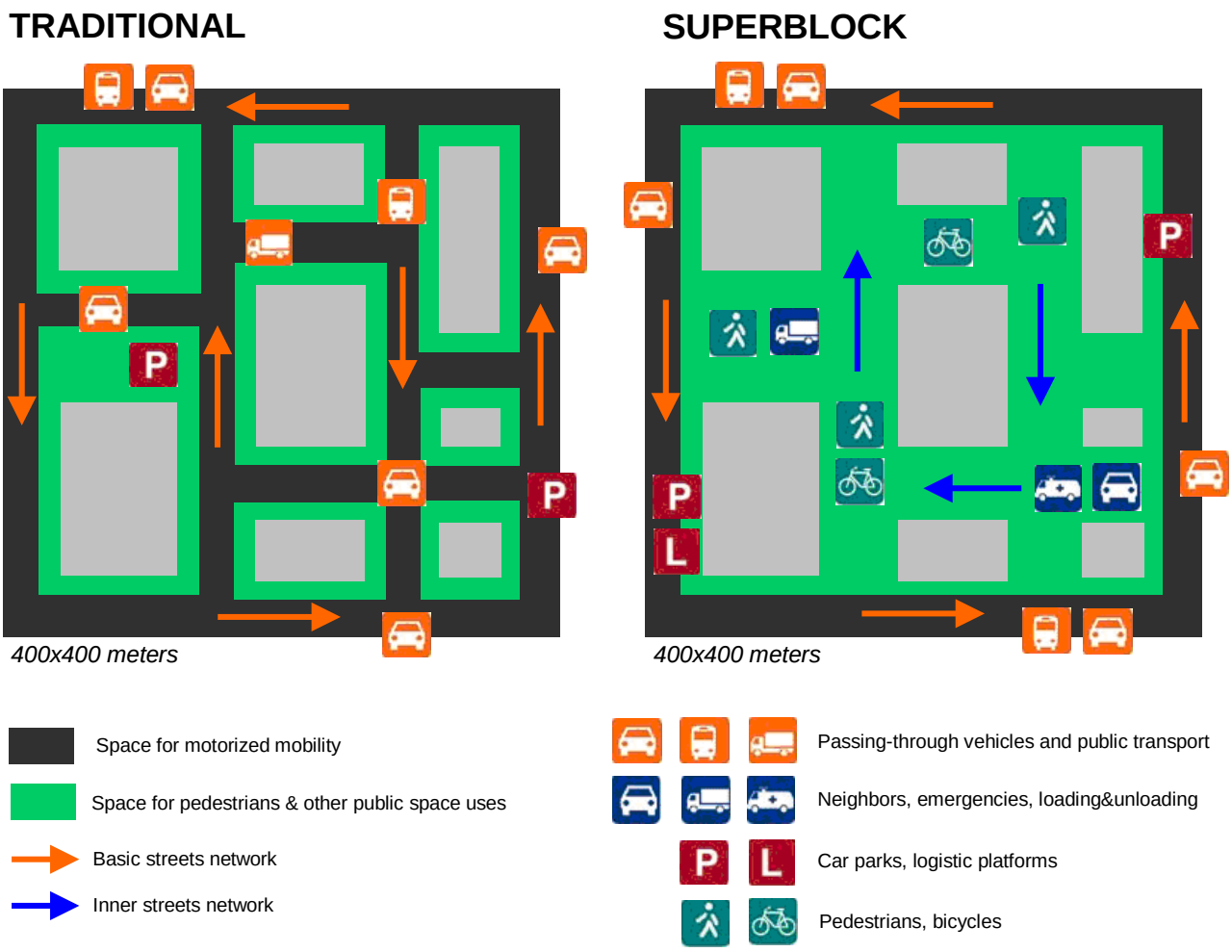


Figure 42. Scheme of superblock model proposed by the Sustainable Mobility and Public Space Plan (City of Vitoria-Gasteiz 2007)

The new urban unit, with an approximate average dimension of 400x400 m, permits to transform inner streets to become a preferential environment for pedestrians, cyclists and service, emergency and residents' vehicles, being transformed into unique sections with roadways and sidewalks at the same level and set out as low-speed zones at 10-20-30 km/h according to context (see Figure 42). On-street parking is gradually being reduced and freight distribution is subjected to a new form of management. This scheme is being applied to the whole city, starting with the city centre and the medieval town, as well as in each urban district undergoing redevelopment.

With the strategy described, the SM&PSP configures itself as an ambitious global planning initiative, which enables Vitoria-Gasteiz to realize significant changes in its mobility patterns in order to fulfil sustainability aims the city is highly committed to. The Plan articulates 26 actions to achieve the objectives mentioned above. Besides the implementation of 'superblocks' related measures, which act on the private vehicle network as well on other transportation networks, other important actions include:

- Restructuring the network of urban public transport lines, in coexistence with the new tram line. Enabling bus lanes.
- Consolidation of a secure network of bike lanes supplemented with bicycle hire service.
- Setting up a pedestrian network that minimizes pedestrian coexistence with motorized private vehicles. Creating pedestrian islands.
- Changes in the regulation of surface parking (called *OTA*) and reorganization of global parking supply and management.
- Reducing the environmental impact of pollution and noise in the streets.
- Increasing the quality and liveability of public space: accessibility, pedestrian permeability, presence of vegetation, acoustic and thermal comfort, air quality, and road and citizen safety.

Following subsections describe, for each transportation sub-system, current and planned configuration and state of mobility patterns.

4.2.2 Private motorized vehicle sub-system

The private vehicle primary sub-system is currently in a process of being completely transformed by the implementation of the 'superblock' strategy pursued by the SM&PSP. The initial and final scenarios marked by the Plan, represented in Figure 43, are characterized by a totally distinct distribution of public space: from 38.6% in 2009, the global pedestrian share is expected to reach the value of 65% in 2020 by the effect of the SM&PSP and other planning tools (Agencia de Ecología Urbana de Barcelona 2010).

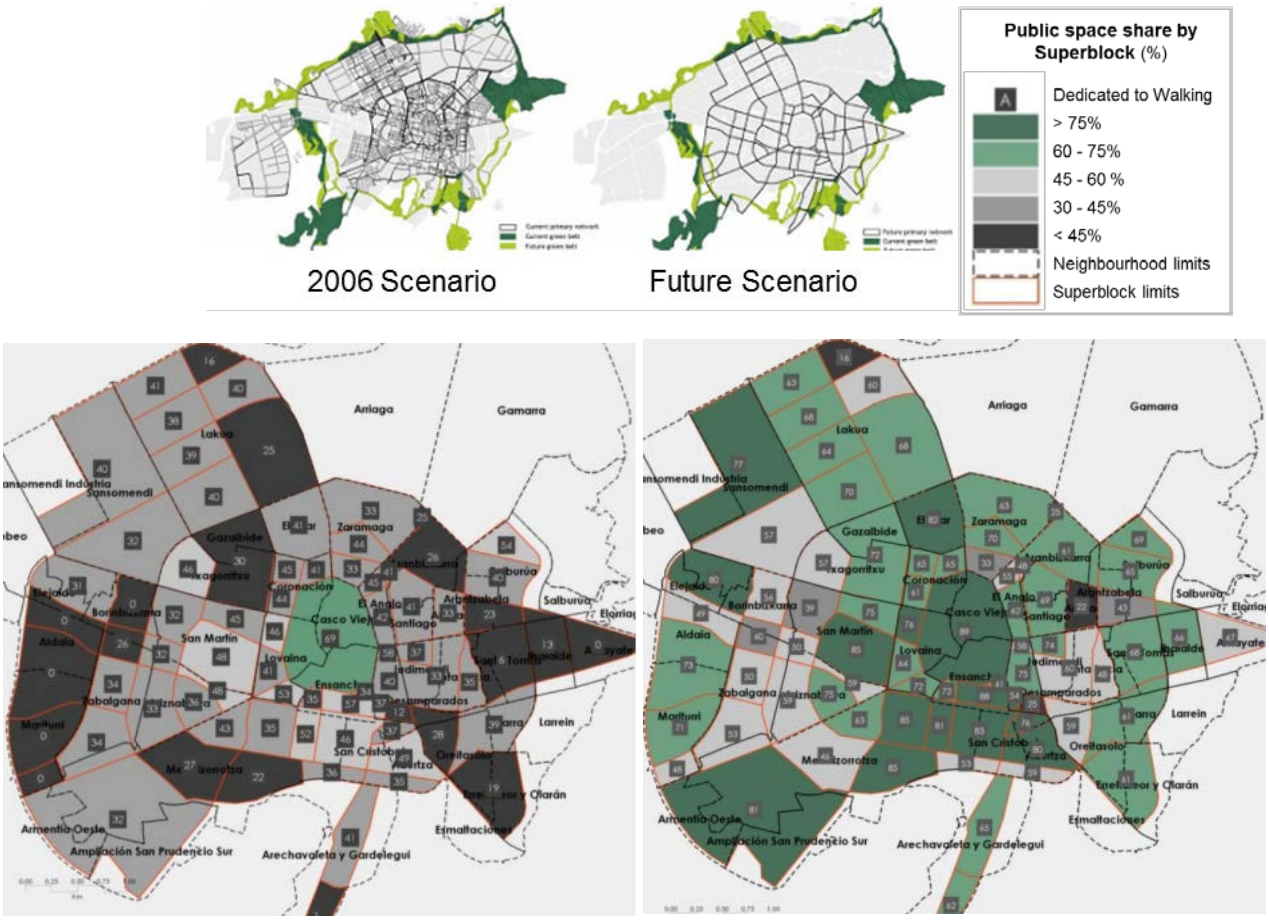


Figure 43. The private vehicle primary network, before and after the implementation of SM&PSP (City of Vitoria-Gasteiz 2007)

The superblock development strategy is currently under a continuous expansion and evaluation process, which includes monitoring the performance of each planning stage. In 2013, the planned superblock development scheme has been implemented through the completion of those units which are inside Ringway 2 (see Figure 44). For 2020, the Plan expects to extend the model in every urban fabric of the city, with the exception of the industrial ones.

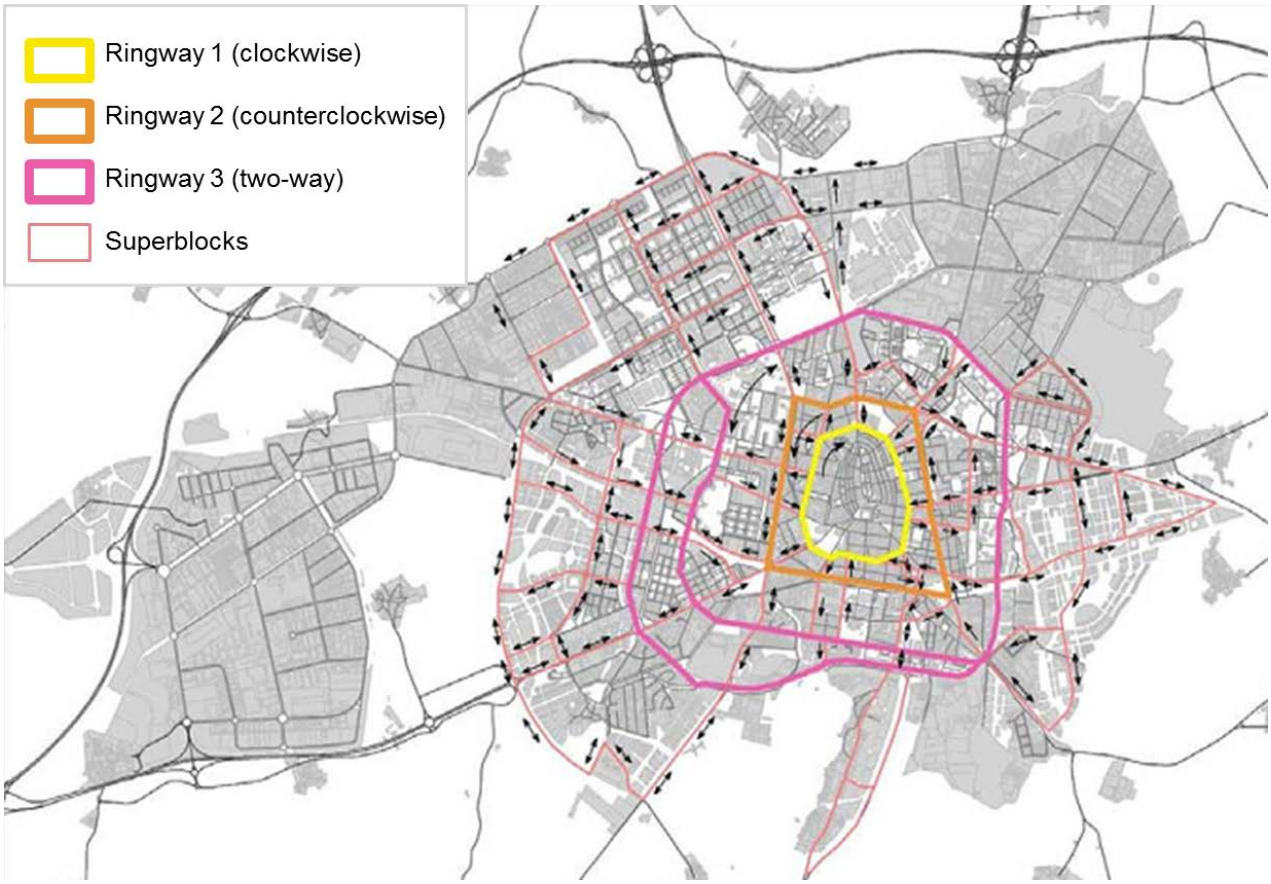


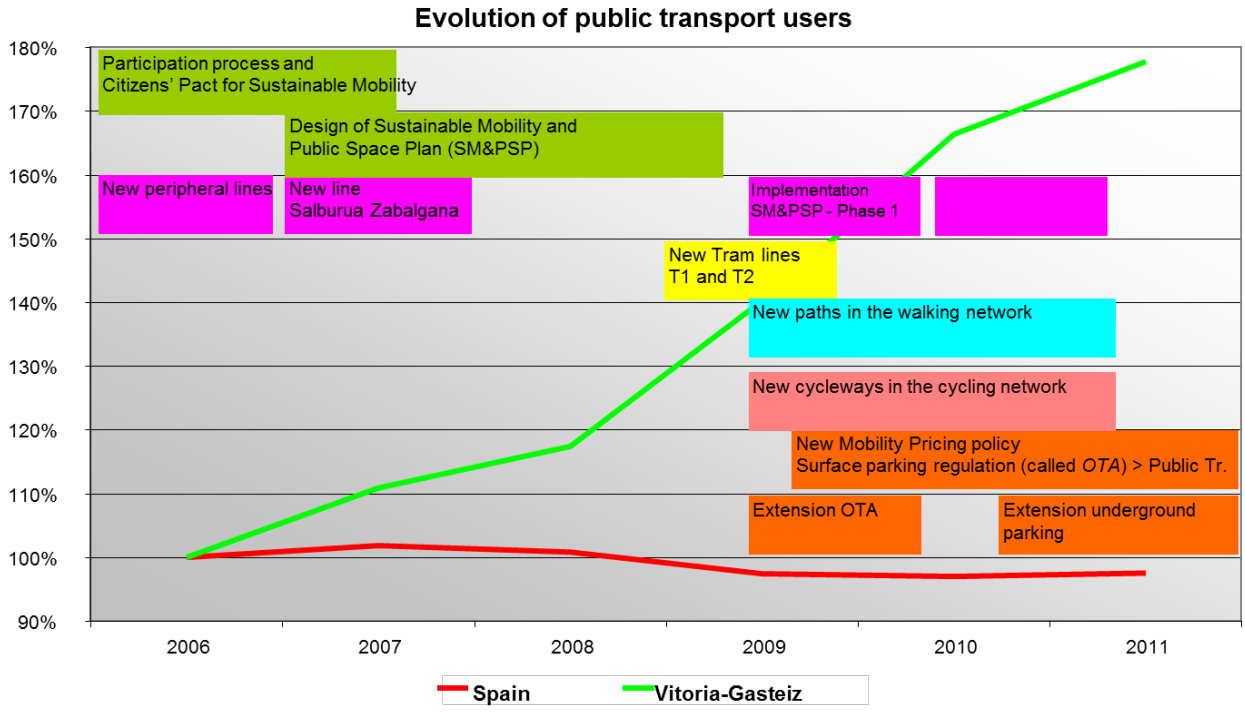
Figure 44. Implementation stages of the superblock model (City of Vitoria-Gasteiz 2007)

Besides the implementation of the superblock model, the private vehicle network is also in a process of a) reducing the standard lane wide (passing from the current average size of more than 3 m to 2.5 m); b) establishing shorter traffic light cycle lengths; and c) transferring underground the infrastructural barrier of the current railway in order to create an underground high capacity road and, at the same time, a high capacity transit and cycling corridors on the liberated surface (City of Vitoria-Gasteiz 2007; Agencia de Ecología Urbana de Barcelona 2010).

Also with regard to parking, current situation is being heavily transformed by the planning tools in force. Public space dedicated to car parking in the interior of implemented superblocks is gradually being reduced and rationalized in order to liberate space for cycling, pedestrian and public transport infrastructure. Parking spots on street are substituted by off-street parking (mostly underground), changing the distribution between the two forms from 38%-62% in 2009 to 13%-87% in 2020 (Agencia de Ecología Urbana de Barcelona 2010). Also a new on-street parking regulation has been introduced, with increased parking fares and the design of new Park & Ride facilities.

4.2.3 Public transport sub-system

Vitoria-Gasteiz's public transport system consists of a network composed by 9 bus lines and two tram lines. The bus network has been recently (2009) restructured to optimise journey flows, times and frequencies and to integrate with an also recent (2008) new tram service, conceived as a key part of the city's intermodal transport policy. Both changes have been among the first implemented actions of the SM&PSP, both aimed at raising public transport modal share. The 20-30 minute frequencies of the previous network dropped to 10 minutes frequencies of the fewer straighter routes, resulting in an improved commercial speed of 12.73 km/h (previously was 10.77 km/h) and a decrease of average travel time from 31 minutes in 2006 to 22 minutes in 2011 (City of Vitoria-Gasteiz 2011; City of Vitoria-Gasteiz 2012b). Population accessibility to the system also increased, permitting 96% of city's residents to live within 300 m of an hourly (or more frequent) public transport service (City of Vitoria-Gasteiz 2010).



	Previous network	New network
Frequency	20'	10'
Schedule speed	10.77 Km/h	12.73 Km/h
Travel time		Up to 10' savings
Average fuel consumption per bus	56.6 l/100 Km	53.0 l/100 Km
CO2 emissions savings due to reduced consumption		- 421.5 Tons/year
Transfers		+ 261,96 %
Public transport users		+ 45 %
Modal Split	7,9 %	8.3 %

Figure 45. Vitoria-Gasteiz public urban transport passengers, evolution 2006-2011 (City of Vitoria-Gasteiz 2010)

The change in both services was supported by a broad range of supporting measures, including bus lanes, queue jumpers, traffic-light priorities, new platforms, and the new on-street parking regulation mentioned above. Together with the launching of the new tram service, an integrated fare and payment card for the entire public transport was implemented. These measures all together got the result that passenger numbers rocketed, with a continuous increase of passengers in the entire system (see Figure 45).

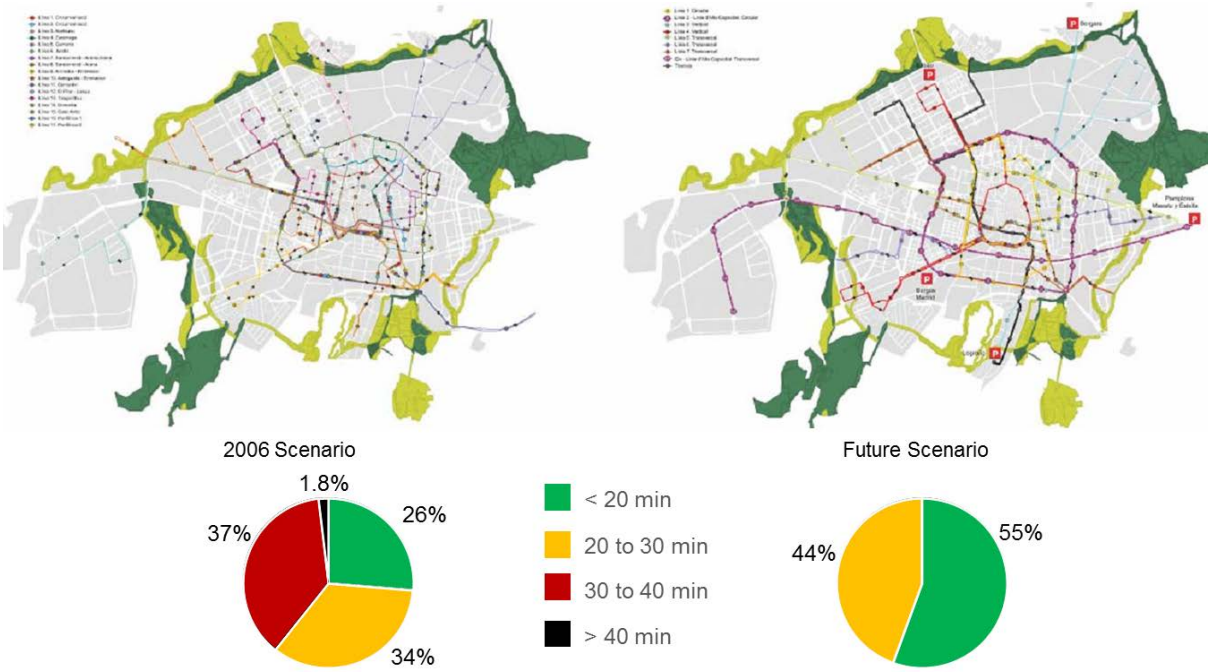


Figure 46. The public transport network and global network accessibility (% of population), current and planned (City of Vitoria-Gasteiz 2010)

However, all these improvements are still far to produce a relevant effects on the global modal share. In fact, public transport share in 2011 was estimated at 8.3% of all trips, few decimal points above the 2006's figure. This is partly due to the land use transformations mentioned above. The change in the city scale brought as a result of latest residential developments in the east and west sectors produced a strong increase[7] in the total number of trips generated in Vitoria-Gasteiz, from almost 600,000 daily trips in 2006 to more than 800,000 trips in 2011 (City of Vitoria-Gasteiz 2006; City of Vitoria-Gasteiz 2011).

Other planning initiatives for the public transport system are geared at tackling the great dysfunction within the urban model: the geographical segregation of industrial activity, especially of the large industrial estates, which, solely in the case of journeys to and from work, make private vehicles the dominant mode of transport. The new design of the public transport network, with new lines and shuttle services to the industrial estates, the bicycle infrastructures which are under construction,

[7] The increase is partly due to changes in the survey data collection. In 2006 the Mobility Survey was realized in December when trips per person are lower than in late spring, the period of realization of the 2011's survey.

which connect these to the residential areas, and the project to implement a high-capacity public transport route (BRT or Tram) which resolves the connection between the Jundiz industrial business park and the city centre and the new areas of expansion to the east and west of the city, are some of the measures designed to resolve the negative effect of their being placed outside the city (City of Vitoria-Gasteiz 2010).

4.2.4 Walking sub-system

As mentioned above, in Vitoria-Gasteiz walking is considered a primary form of transportation, well suited to address mobility needs and a key element of an alternative form of organizing the local transportation system. The city was in facts one of the first Spanish cities in creating pedestrian zones and in considering comfort and safety of walking trips in its planning principles. The city already counts with over 25% of the public space reserved for pedestrian access only, there are 33 km of pedestrian pathways inside the urban area and 91 km across the Green Belt (City of Vitoria-Gasteiz 2010, p.15). The percentage however decreases to 9% if quality criterions are applied, i.e. considering only pedestrian only streets and boulevards and sidewalks wider than 5 m). The city centre has a vast pedestrian area extended to all the medieval town and many access streets.

The planning initiatives started in 2006 supported urban paths network -and more generally pedestrian mobility- with pedestrian priority and enhanced quality performance in the superblocks interior streets. The SM&PSP explicitly aims at ensuring that all the communications nodes, installations and public spaces come within the reach of citizens who travel on foot in order to guarantee a satisfactory level of accessibility to services and day-to-day activities and consequently, to reduce the dependence of the population on motor-driven mobility.

In order to get the objectives, a specific Pedestrian Mobility Master Plan is currently under development which take actions to form a network of urban paths, covering most of the residential city and reaching the Green Belt. The network consists of several main axes which currently co-exist with motorized traffic in 45% of their extension. The final aim is to reduce this percentage to 10%, leaving 90% of the urban walking path with pedestrian priority (see Figure 47).

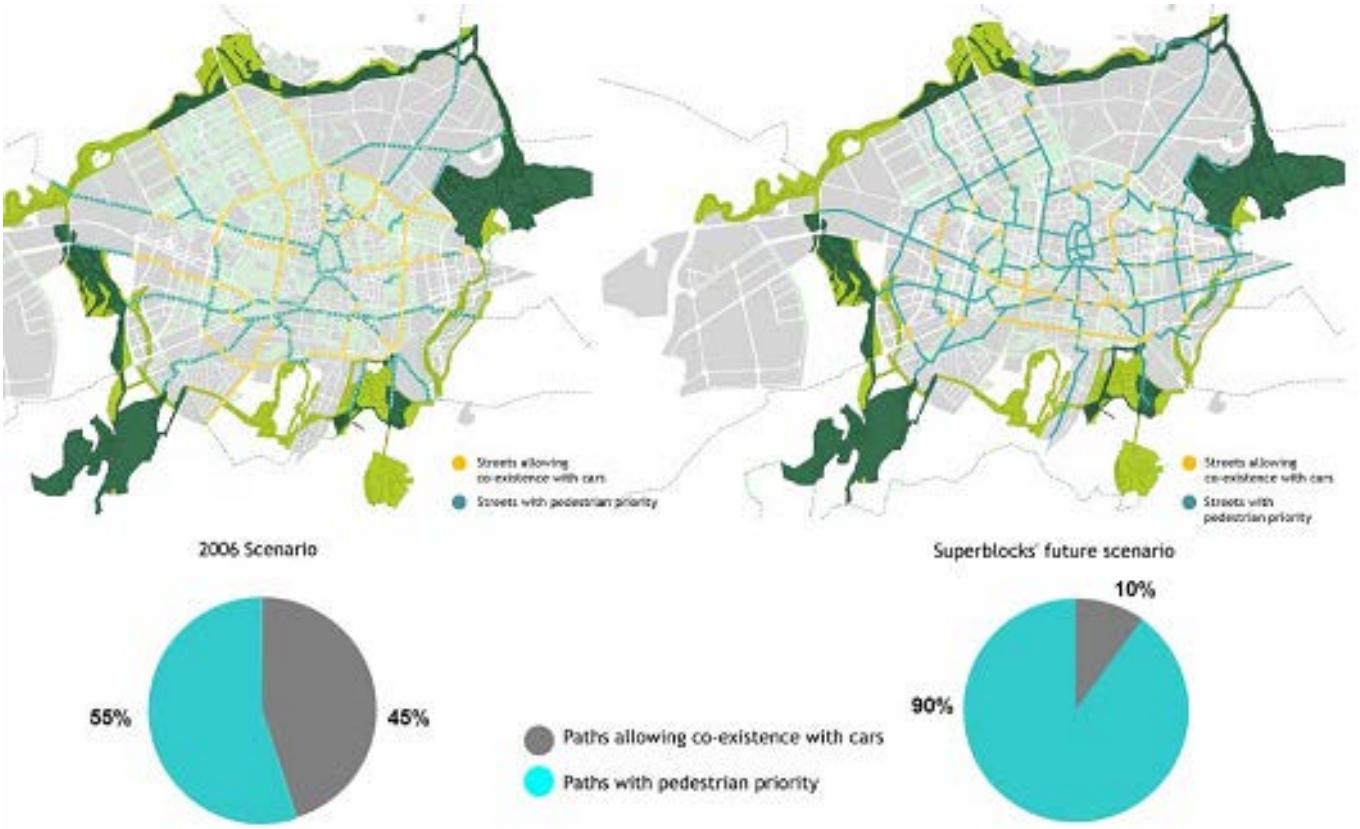


Figure 47. The walking path network of Vitoria-Gasteiz, current and planned (City of Vitoria-Gasteiz 2010)

The network does not respond exclusively to mobility needs, since it allows for 'stay' needs (rest, play, waiting at the school, social life of the neighbourhood, etc.) and activity needs (window shopping, leisure walking, sport circuits, cultural events, etc.).

The changes to be made in the route taken by the railway is, in the aims of the SM&PSP, an opportunity to improve the quality of this network. "This will be placed underground, freeing up the land occupied by the current railway and permitting the configuration of a high quality pedestrian walkway crossing from east to west connecting with the Green Belt" (City of Vitoria-Gasteiz 2010, p.42).

4.2.5 Cycling sub-system

Bicycle use is increasing steadily in Vitoria-Gasteiz since the turn of the century and it counts for almost 7% of the modal split (see Section 4.3 for a detailed description of cycling demand). This rapidly changing scenario is one of the main reasons which motivates the choice of Vitoria-Gasteiz as a case study for this thesis.

The bicycle network counts in 2012 with 115 km of urban bicycle infrastructures and a further 91 km of cycle and pedestrian paths across the Green Belt. The length of designated cycle lanes in relation to the total number of inhabitants in the city has increased from 0.05 m/inhabitant in 2002 to 0.47

m/inhabitant in 2012. In addition, the Bicycle Mobility Master Plan proposes the creation of another 47 km of tracks in order to achieve the total length of 162 km of network in 2015 (102 km of primary network and 60 km of secondary network). With such a network, the 86.8% of the population will have access to the network at a distance less than 250 m. The configuration of current and planned networks is depicted in Figure 48. As it can be noted by the map, the extension of the network steadily increases with new connections each year.

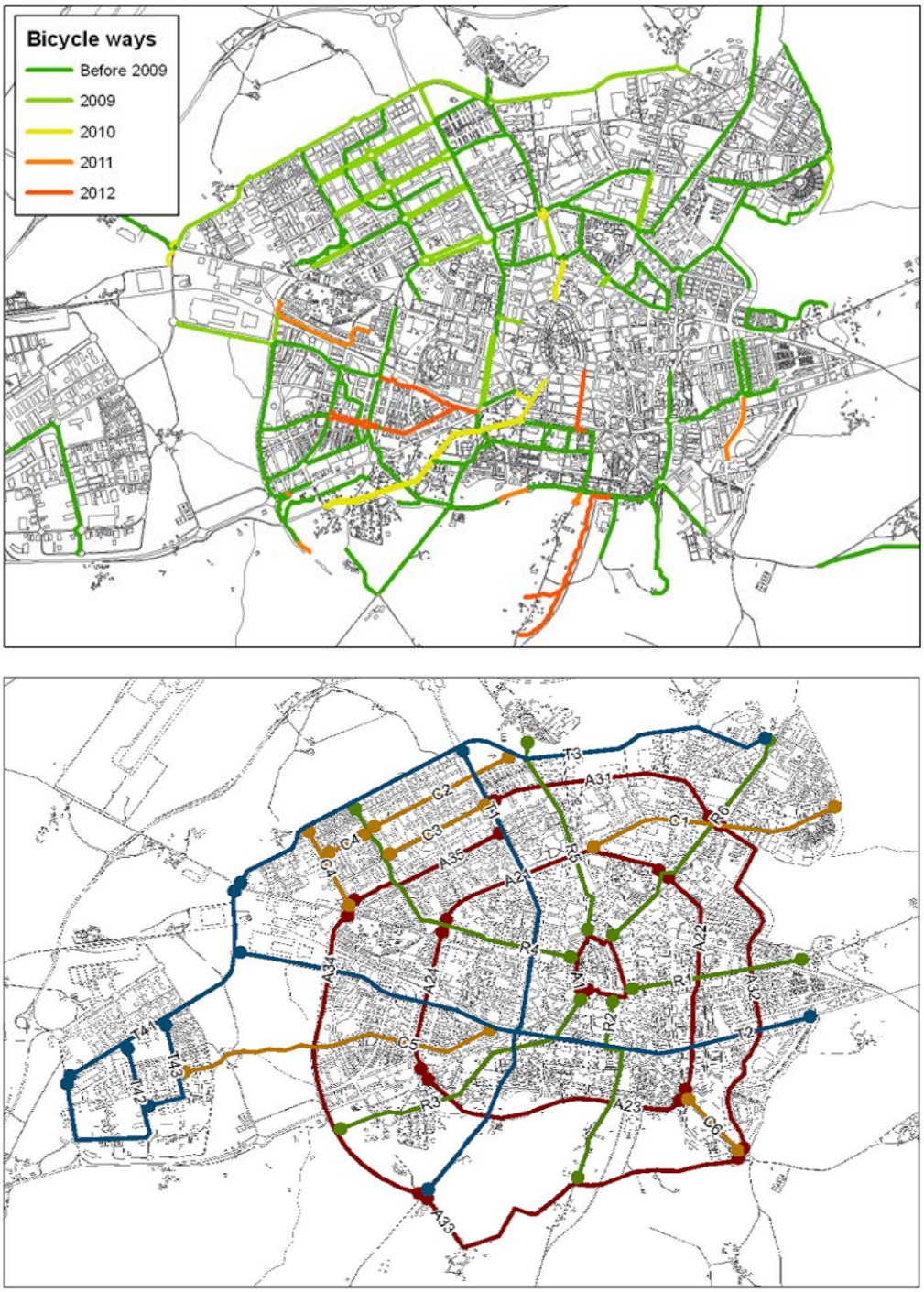


Figure 48. The cycling network of Vitoria-Gasteiz, current and planned by 2015 (City of Vitoria-Gasteiz 2009)

Virtually 50% the population resides in areas with an average access time by bicycle to the rest of the city of less than 10 minutes and virtually the whole of the population at less than 15 minutes. Even the recent urban developments are within cycling distance from the city centre (3 km, which is equivalent to 12 minutes by bike and 40 minutes on foot). Moreover, in the current network, "a third of the city's installations are located at less than one minute from the cycling network, 50% between 1 and 3 minutes and 17% between 3 and 5 minutes" (City of Vitoria-Gasteiz 2010, p.18).

The available bicycle infrastructure currently includes 457 bicycle parks with almost 5,000 parking places, 85% of them located on-street and the rest in closed facilities. Supply of bicycle parking places should reach the final figure of 8,588 in 2015 (see Figure 49), which means that 98% of population will live to a distance less than 100 m from a bicycle parking (Agencia de Ecología Urbana de Barcelona 2010, p.341).

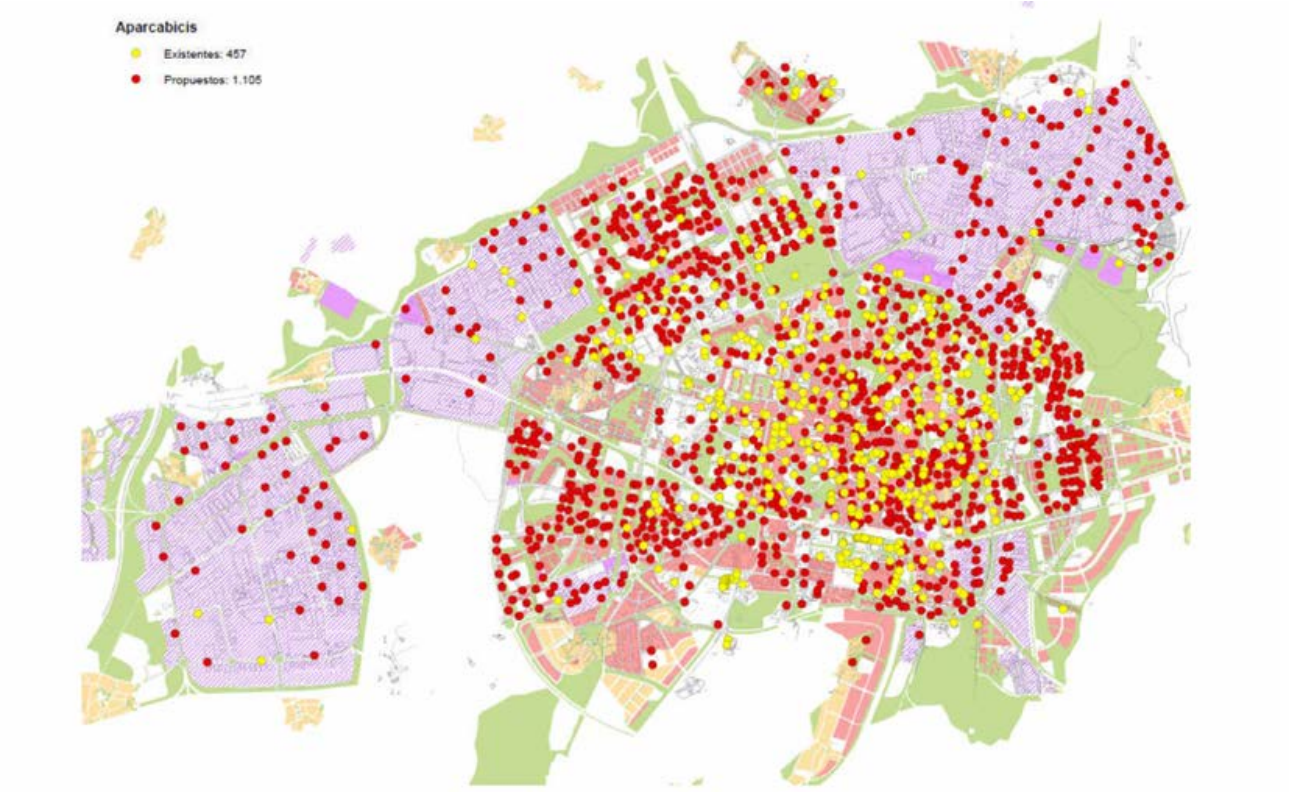


Figure 49. Bicycle parks in Vitoria-Gasteiz, current (yellow) and planned by 2015 (red) (City of Vitoria-Gasteiz 2010)

In order to increase the use of bicycles, Vitoria-Gasteiz implemented in 2004 one of the first public-bike system in Europe. The scheme has been working until 2012 with 19 pick-up points throughout the city placed in civic centres, leisure centres and shopping malls, offering a total of 457 bicycles free of charge. The service also focused on the provision of transport for people with disabilities, such as tandems for the sight impaired or tricycles for people with reduced mobility. Registered users of this service amounted to more than 67,000 in 2011, and there were more than 157,000 loans, approximately 440 loans per day.

Coherently with the radical transformations declared by planning documents and the rest of environmental policies, Vitoria-Gasteiz is hence actively promoting the use of bicycles and is currently engaged in implementing the Bicycle Master Plan to improve cycling in the city. And that specific plan, a development of the SM&PSP, plays a leading role improving bicycle-related policies. Besides the provision of specific flow and parking infrastructure, the Bicycle Master Plan, approved in 2009, proposes also:

- To develop the old public-bike system toward a fourth generation system, fully integrated with the public transport network, and to increase the number of lending points to a total of 35, placing these at no more than 5 minutes walking from anywhere in the city[8].
- To invest about 900 thousand Euros in bike promotion until 2015.
- A modification of the Bicycle Mobility Bylaw, approved in 2013.

Other measures implemented are a bicycle route planner, the bicycle registration system and a pilot public-bike-bus modal exchange scheme in one of the main industrial estates.

With an investment of nearly 22 million Euros, the Bicycle Mobility Master Plan aims to develop an effective strategy to promote bicycle use and, according to the Charter of Brussels signed by Vitoria-Gasteiz on May 2010, seeks to reach 15% of the modal split in 2020.

[8] The implementation of public-bike system upgrade has been postponed several times since 2012 due to financial hardship of public entities. Actually is still a pending measure. More information on the system can be found at the City Council's web page on cycling issues (http://www.vitoria-gasteiz.org/ and following the path: Thematic fields > Mobility and transport > Bicycles)

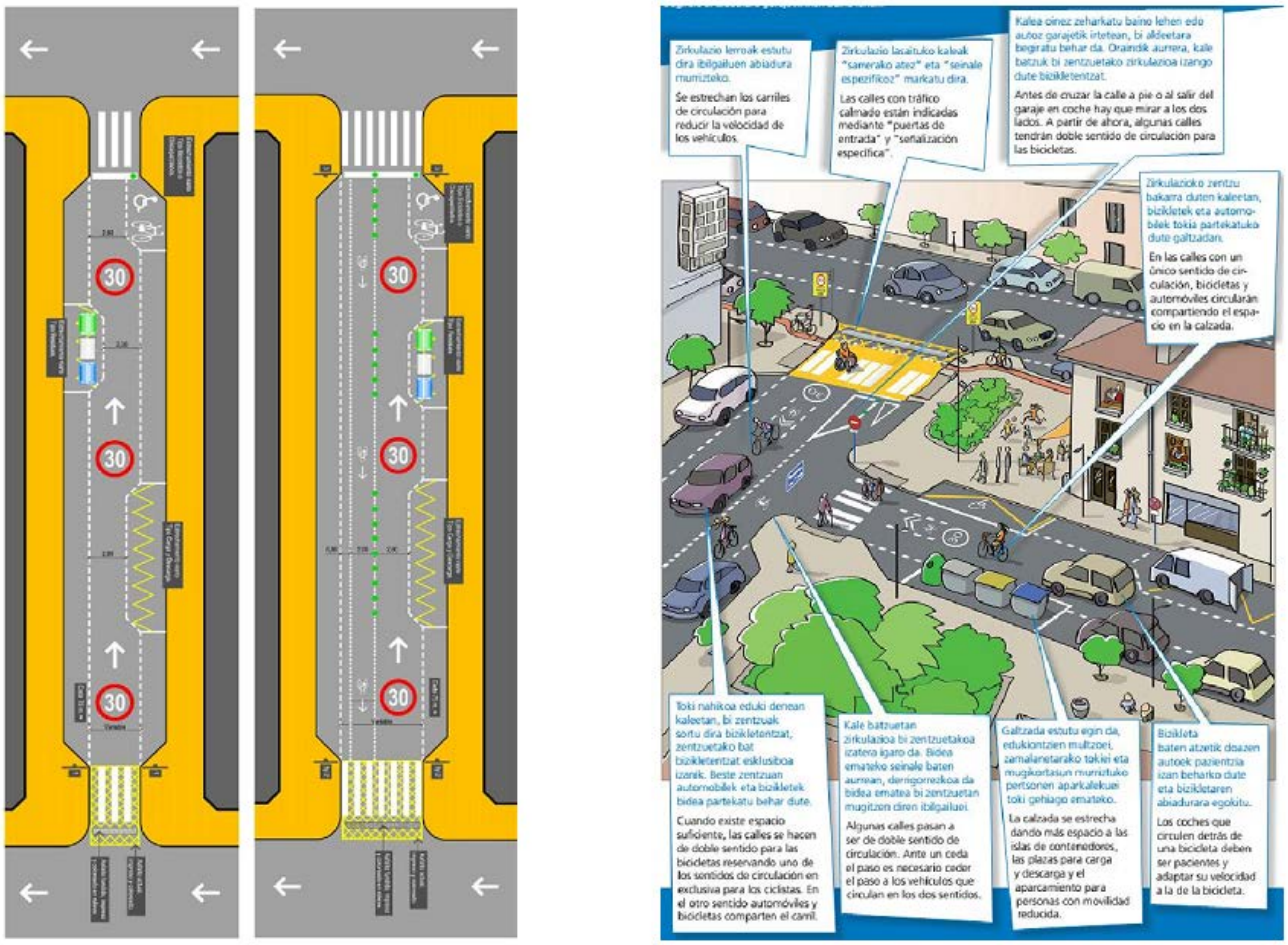


Figure 50. Design of superblock interior streets and sample of information campaign launched to explaining major changes in streets affected (City of Vitoria-Gasteiz 2013)

Nevertheless, much of the strategy to achieve the ambitious goal marked by City Council and backed by participative processes is placed on the more systemic actions planned by the SM&PSP, that is to reduce the traffic dominants (flows, speeds, parking and privileges) in most of the city's streets in order to ensure a safe coexistence between cyclists and motorized vehicles. Main measures in this sense are:

- Traffic calming elements to reduce the speed of movement and to give more trust to cyclists and pedestrians to take the road.
- Vertical and horizontal signage to inform the preference of cyclists and pedestrians over cars.
- Restriction to 30 km/h maximum speed within the superblock unit. In many streets maximum speed is further reduced to 20 and 10 km/h.
- Elimination of parking spaces in defined areas.
- Change in traffic systems to prevent through traffic.
- Creating bike lanes running in opposite direction to traffic.
- Narrowing of the road wide to slow down traffic.
- Creating parking spaces for residents in defined streets.

The actions, planned by the Superblock Master Plan[9], have been implemented in Winter 2012-2013 in a vast area around the medieval town, comprising 47 streets in the interior of Ringway 2 (see Figure 44). The implementation have been accompanied by a population-wide campaign by the sending of a letter to each household explaining major changes to city landscape, rules and practices produced by the measures. Figure 50 shows a sample of such campaign along with the design of superblock interior streets.

4.3 Cycling in Vitoria-Gasteiz

In the context described above, the practise of cycling as a mode of transport –especially for commuting– is still considered as an issue by the vast majority of citizens of Vitoria-Gasteiz. The image of utilitarian cycling as being 'difficult', 'risky' and 'strange' prevents many people from commuting by bicycle and, as it is hypothesised by this thesis, it even prevents them from considering the option as a possibility. The fact that the cycling modal share accounts for almost the 7% of all trips and that both policies and the institutional environment are pursuing –constantly and coherently– the improving of conditions for cycling does not tell enough about the tangible and the perceived reality of cycling in Vitoria-Gasteiz.

This section, following the general conceptual framework depicted in Figure 18 (p. 61), presents a collection of descriptive analyses on how cycling is *practised* and how it is *viewed* by the city's inhabitants. The description is carried out making use of previous studies (secondary sources) as well as some results from the same methodological tools put in place by present research which will be described in the following Chapter 5.

4.3.1 How cycling is practised

Although Vitoria-Gasteiz displays the highest ratio of bicycle usage among Spanish cities, the figures on how cycling is practised there return a configuration that is typical of many 'low-cycling contexts' as they were defined in Chapter 1. One of the main indicators is the unequal proportions of men and women cycling. While in places where cycling is more 'normalised' the participation of both gender tends to be even, in countries with low cycling rates, men are likely to cycle more than women (Heinen et al. 2010; Garrard et al. 2012; Garrard et al. 2008; Dill & Voros 2007). This is the case of Spain, where overall, only 36% are women among cycling users (Fundación Eca Bureau Veritas 2011). In Vitoria-Gasteiz the rate is higher (43%) but it is far to be even.

[9] The Superblock Master Plan is another specific spinoff of the SM&PSP, currently under development.

Table 8 shows the gender distribution as long as other socio-demographic characteristics of cycling users and non-users in Vitoria-Gasteiz. Women are the majority among non-users (61%) with similar percentages whether they have access or not to a bicycle. The source of data is the most recent Household Mobility Survey (City of Vitoria-Gasteiz 2011), which for the first time estimates that rate, as well as other data on characteristics of cycling use. Previous estimations (Torres Elizburu 2003b) placed the women participation into cycling at 28% in 2003, therefore a huge increase has occurred in less than a decade, which tells about the progress Vitoria-Gasteiz is making toward cycling 'normalisation'.

Unfortunately, the cited Household Mobility Survey does not have any data on the capability of people to ride a bicycle. In fact, it is expected that such data would be another indicator of being in a low-cycling context. Nationally, among people who declare to not knowing how to ride a bicycle (which are the 12% of population in Spain), the 86% are women. In Vitoria-Gasteiz data on this aspect can only be taken from the survey employed by present research[10] which refers on a subset of the whole population, namely the population of people between 16 and 64 years old who travel daily to the workplace or to their study centre (*commuters*). According to such data, only 5% of the commuter population in Vitoria-Gasteiz declare to not knowing how to ride a bicycle and, among them, the 95% are women evenly distributed among age groups (see Table 30 in Annex 3).

[10] Methods and procedures for this survey will be described in the following Section 5.

	Population (≥ 6 years)	*Users by frequency*				*Non-users*		
		Daily or almost every day (more than 3 uses per week)	Weekly or almost every week (more than 3 uses per month)	Occasional (more than 3 uses per year)	Total of users	They do have a bike available but they use it less than 3 times per year	They do not have a bike available	Total of non-users
Vitoria-Gasteiz [% of rows]	*N = 213.277*	23.9	23.8	52.3	48.3	30.0	70.0	51.7
Gender [% of columns]								
Male	47.4	62.7	61.8	51.7	56.7	39.6	38.3	38.7
Female	52.6	37.3	38.2	48.3	43.3	60.4	61.7	61.3
Age group [%of columns]								
6-15 years	8.8	6.1	24.1	16.6	15.9	1.1	2.5	2.1
16-24 years	10.3	27.7	11.7	11.2	15.2	8.8	4.3	5.7
25-34 years	12.5	18.9	15.2	15.2	16.1	12.3	7.8	9.2
35-44 years	18.3	23.1	21.9	23.5	23.0	18.7	11.9	14.0
45-54 years	16.6	15.0	15.0	18.4	16.8	23.3	13.6	16.5
55-64 years	14.2	6.3	9.4	10.1	9.0	17.9	19.5	19.0
> 64 years	19.3	2.9	2.8	5.0	4.0	17.8	40.3	33.5
Study level [%of columns]								
Low	42.2	27.6	41.7	36.3	35.5	37.4	53.2	48.5
Medium	36.0	45.7	36.2	39.8	40.3	38.3	29.1	31.9
High	21.8	26.8	22.1	23.9	24.2	24.3	17.6	19.6
Income level [%of columns]								
Less than 1000€/month	8.4	3.3	2.4	4.3	3.6	5.8	15.8	12.8
1000 - 2000€/month	29.3	27.6	29.2	26.5	27.4	29.2	31.8	31.0
2000 - 3000€/month	17.7	16.5	26.1	22.5	21.9	16.9	12.4	13.7
More than 3000€/month	10.4	11.8	12.2	14.6	13.4	11.9	5.9	7.7
No answer	34.2	40.7	30.2	32.2	33.7	36.1	34.1	34.7

Table 8. Socio-demographic characteristics of cycling users and non-users in Vitoria-Gasteiz by cycling frequency (author's own elaboration based on City of Vitoria-Gasteiz 2011)

Table 8 shows also that the people who are considered 'cycling users', namely those who cycle at least 3 times in a year, are almost a half of the whole city's population (48%). More than half of them, therefore almost a quarter of the population, have only an occasional use (23.3% = 52.3% x 48.3%). The other quarter declares to ride either daily or weekly.

The age profile of cycling users is another peculiar indicator common to many low-cycling contexts. Cycling tends to be associated to younger people, especially for higher cycling frequencies (almost half of daily users are between 16 and 34 years old).

Data for level of education show that cycling users of Vitoria-Gasteiz are slightly more educated than the average population and they also have a slight higher household income (see Table 8). The latter indicator contrasts with the typical income profile of low-cycling contexts, confirming that in Vitoria-Gasteiz a slow change toward cycling 'normalisation' is occurring. In fact, in countries where cycling is more usual people who cycle is more likely to be in higher income brackets.

Considering the same socio-demographic characteristics by purpose of cycling trips also other peculiar characteristics of low-cycling contexts can be found (see Table 9). Cycling for transport purposes as opposed to other non-utilitarian purposes results to be a further sign of 'normalisation' of cycling. In countries with low cycling rates, people who are less likely to cycle for transport are found to be older, female, less educated, and in higher income ranges (Winters et al. 2007; Moudon et al. 2005). Table 9 shows that that is the case for Vitoria-Gasteiz population for *gender*, *age* and *education* but for *income* the association is not clear, since rates are similar between transport and non-transport purposes.

	Users by trip purpose						
	Transport			*Other purposes*			
	Work / study	To make arrangements and shopping	Total of users for transport	Leisure	Sport / Fitness	Other uses	Total of users for other purposes
Vitoria-Gasteiz [% of rows]	20.8	4.2	25.1	58.0	13.1	3.9	74.9
Gender [% of columns]							
Male	58.4	62.0	59.0	52.6	73.9	49.1	56.0
Female	41.6	38.0	41.0	47.4	26.1	50.9	44.0
Age group [%of columns]							
6-15 years	4.4	4.6	4.4	23.2	7.9	9.7	19.7
16-24 years	27.8	23.2	27.0	9.7	16.7	19.3	11.3
25-34 years	21.7	22.6	21.8	13.0	17.9	22.0	14.2
35-44 years	26.8	25.1	26.5	21.5	23.5	18.2	21.8
45-54 years	15.4	14.4	15.3	17.4	16.3	18.5	17.3
55-64 years	3.5	7.7	4.2	10.4	11.0	10.7	10.6
> 64 years	0.5	2.4	0.8	4.9	6.7	1.7	5.1
Study level [%of columns]							
Low	20.7	23.1	21.1	42.4	33.6	31.1	40.3
Medium	48.3	41.3	47.1	36.1	45.3	50.7	38.1
High	31.0	35.6	31.8	21.5	21.1	18.2	21.6
Income level [%of columns]							
Less than 1000€/month	3.8	2.2	3.5	3.8	2.9	1.6	3.6
1000 - 2000€/month	26.0	29.1	26.6	27.6	28.1	30.3	27.7
2000 - 3000€/month	19.2	17.6	19.0	23.7	22.3	12.7	22.9
More than 3000€/month	13.8	18.8	14.7	12.0	14.7	20.6	12.9
No answer	37.2	32.3	36.3	32.8	32.0	34.7	32.9

Table 9. Socio-demographic characteristics of cycling users and non-users in Vitoria-Gasteiz by purpose of cycling trips (author's own elaboration based on City of Vitoria-Gasteiz 2011)

As mentioned above, the fact that in Vitoria-Gasteiz the modal split for cycling is steadily increasing for more than a decade is the most outstanding sign of the rapidly changing scenario of the practice of cycling in that city and it is one of the main reasons motivating the choice of Vitoria-Gasteiz as a case study for this thesis. From the turn of the century cycling share of total trips has constantly risen from 1.4% in 2001, to 3.3% in 2006, to 6.9% in 2011 (see Figure 38 in previous section). Last mobility survey estimated an average cycling demand of about 56,000 daily trips[11] (City of Vitoria-Gasteiz 2011) out of the more than 800,000 trips realized every day for all purposes and by all modes.

[11] In 2006 estimated daily bicycle trips were 18,000, then more than a threefold increase, but (as mentioned in previous Note 7, p.107) the circumstances of that survey should be considered in order to properly assess the huge increase. In fact, in 2006 the Mobility Survey was realized in December when the cycling use is much lower than in late spring, the period of realization of the 2011's survey.

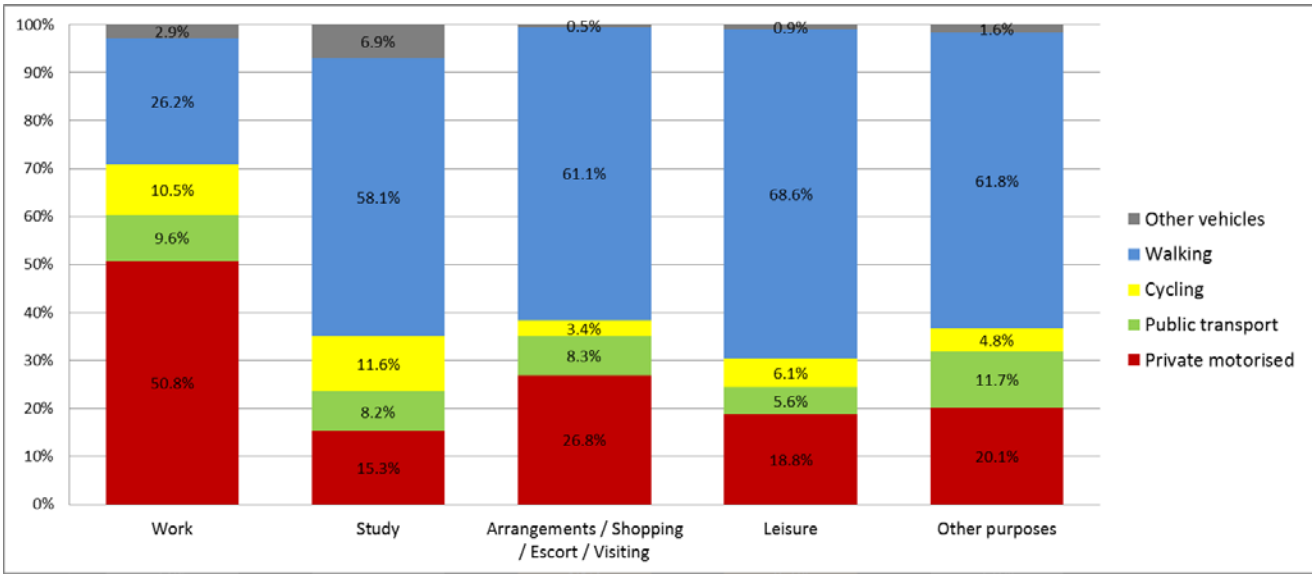


Figure 51. Modal split by purpose of trips (author's own elaboration based on City of Vitoria-Gasteiz 2011)

The bicycle is especially used for commuting trips, i.e. travelling to the workplace, to the study centre or realising errands and/or work-related trips. The resulting rate for these kind of trips is 10.9% (about 33,000 daily trips), meaning that one out of 10 commuting trips is carried out by bicycle. Especially in the inner parts of the city, namely the central and medium fabrics (see Section 4.1.2), the rate rises between 12% and 14%. Figure 51 and Figure 52 show distribution of these rates across several purposes and modes. Statistics refers to all the trips realised during a working day, then they do not match with frequencies and purposes people declared about their *customary* use of bicycles showed in Table 8 and Table 9, although they are close for the *daily* frequency and the *commuting* purpose.

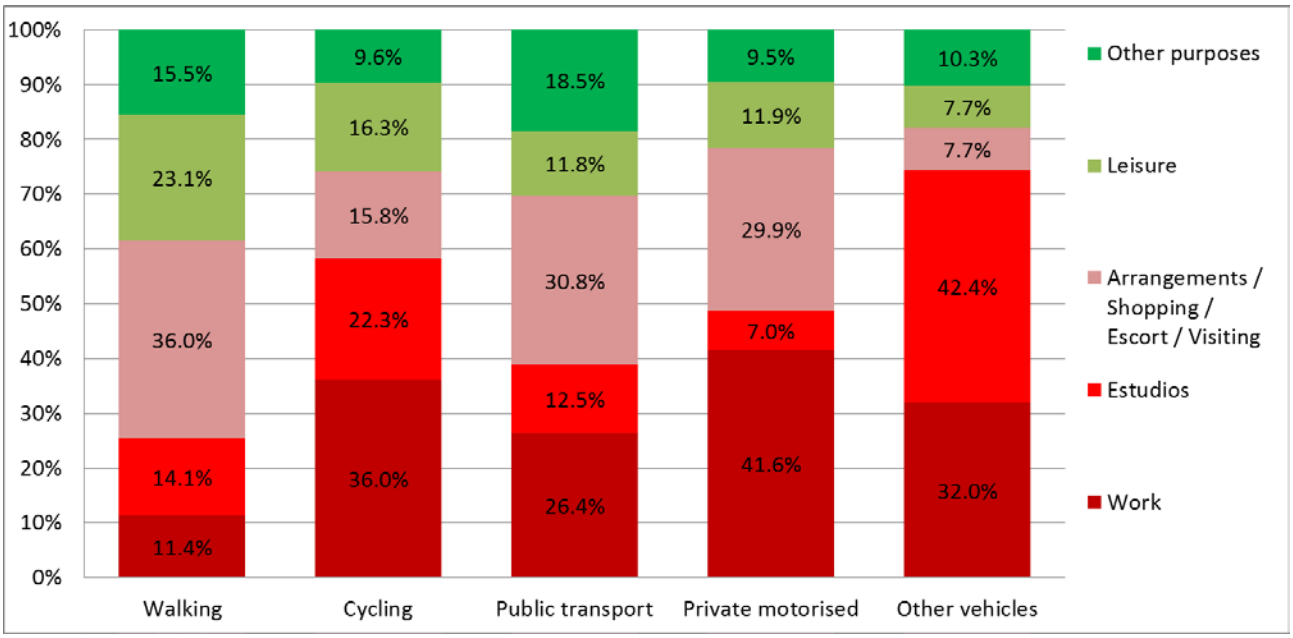


Figure 52. Purpose of trip by mode (author's own elaboration based on City of Vitoria-Gasteiz 2011)

Access to bicycle is quite generalised in Vitoria-Gasteiz. People who declare to have a direct or indirect access to a bicycle are 64% of the population, 57% among women, and 70% among men.

Older people above 55 years old have a lower rate of access (35%). An interesting data about vehicle accessibility is the fact that among people who declare a daily use of bicycles for commuting, 88% have access to a car (author's own elaboration based on City of Vitoria-Gasteiz 2011).

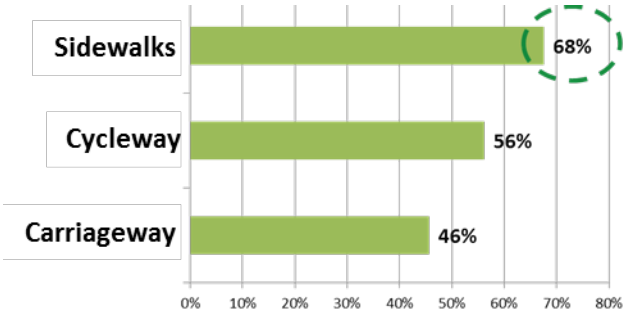


Figure 53. Type of infrastructure used for each cycling trip (author's own elaboration based on City of Vitoria-Gasteiz 2011)

In the last mobility survey, people who cycled were also asked to indicate what type of infrastructure do they used for each of their declared cycling trip. A data that stands out is the use of sidewalks to ride the bicycle: 68% of their trips occur on sidewalks, 56% on a cycleway[12], and 46% on the carriageway (see Figure 53).

Description given so far provide a synthetic outlook of how cycling is practised in Vitoria-Gasteiz. While some of the data presented confirm the interpretation of being in a low-cycling context, others contradict this understanding, showing signs of progression towards higher levels of cycling 'normalisation'. To unveil the interpretation which is closest to reality we turn in the next section, exploring in more details how the practice of cycling is viewed by the city's inhabitants.

4.3.2 How cycling is viewed

Besides considering how cycling is practised, it is important to analyse how it is viewed by people, taking into consideration aspects related to the image of cycling and of cyclists, the meanings and values associated to that practice and the perception of the skills and knowledge required to be practised (Aldred & Jungnickel 2014).

To begin this analysis, it can be useful to explore the images of cycling along the course of recent urban history. In fact, cycling in Vitoria-Gasteiz has a long tradition if compared to many other Spanish cities. During the 1950s the bicycle was a common mode of transport, so common that the city proudly exhibited one of the few cycleways existing in Spain at that time. Figure 54 shows such

[12] The cycleways in Vitoria-Gasteiz are commonly intended as the '*bidegorri*', a Basque word for 'red strip', which indicates the dedicated infrastructure for the exclusive circulation of bicycles, regardless if it is provided on the carriageway surface or on the pavement/sidewalk surface.

dedicated cycling infrastructure connecting the core of the city to the industrial sites of Gamarra (Sanz Alduán 1997).

From left to right:

- 1964: Cycleway connecting the core of the city to the industrial site of Gamarra
- 1957: Iriondo bicycle factory
- 1955: Cyclists in Portal de Villareal
- 1959: Celebration of "Day of Pedal" in Dato Street

Figure 54. Historical images of cycling in Vitoria-Gasteiz. Source: ARQUÉ. Municipal Archives of Vitoria-Gasteiz

The rest of images presented in Figure 54 exhibit a city where cycling was part of the urban scape, with people cycling for commuting, factories producing bicycles for the national market, and events organised to celebrate the practice of cycling.

Also during the 1980s, after the motorization rush filled up the city's streets and the urban scape with automobiles flowing and standing, the tradition of being a leading city with respect to cycling has continued. In 1982 the Council of Vitoria-Gasteiz signed a document on cycling network planning for 80 Km which was the first of such efforts in Spain, enabling the building of many sections of the current network cycleways (Sanz Alduán 2006). The particular type of infrastructure had even an own specific name in Euskera that since then has entered in the common language also in Spanish: the '*bidegorris*' which means 'red strip' for the colour of the surface painting.

Since that efforts though, such emphasis on the building of a certain type of cycling infrastructure had enduring effects on how cycling was viewed by city's inhabitants. In fact, according to a diagnosis of cycling mobility realised in 2003, from the beginnings, *bidegorris* were mainly built in two types of areas: a) green parks and b) unbuilt areas (Torres Elizburu 2003b). They were also built 'in stretches', not connecting newer sections with older ones and with many of these stretches terminating before intersections because of their difficult integration with the rest of traffic infrastructure (Torres Elizburu 2003b). In doing so, two effects were produced in how cycling was viewed by both users and non-users:

a) Due to their location, the specific infrastructure favoured certain types of usages – those mainly related to leisure and sport purposes – instead of those linked to transport purposes. As a consequence, cycling was mainly perceived as a recreational or an exercise practice instead of a utilitarian one, because its utility to get to places of activities was low. The conclusions of the cited diagnosis document reported: "Currently the bike is perceived as a sporty appeal and its consideration as a means of transport has been lost, to the point to be considered as a 'delayed' or a menial tool" (Torres Elizburu 2003a, p.3.4.2).
b) Due to their design and consequent functioning in the traffic regulation system, the specific infrastructure reinforced the image of cycling as a dangerous practice, since the lack of continuous dedicated infrastructure forces users to share the space with motor vehicles just in the places where the user feels himself weaker and more vulnerable, namely busy intersections. Cited report states: "Cycling is seen by the user as a risky means of transport. This perception forces current users to boost warning and predicting mechanisms and significantly inhibits the potential users, which will not dare to take this mode due to the hostile environment created by the dominance of the car in the urban system" (Torres Elizburu 2003a, p.3.3).

The passages in the text cited were based on the first example of psychosocial data gathered in Vitoria-Gasteiz on the practice and the perception of cycling. The report exhibited results of a survey carried out among 128 cycling users, collecting quantitative data on the conditions of their usage as well as their assessment of problems involving their practice. According to the diagnosis' author, the survey does not meet scientific rigor but it is "an initial orienting pool allowing to see some patterns and perceptions of cycling in the city" (Torres Elizburu 2003b, p.200).

The survey asked for the preferred infrastructure habitually used to ride. For the 63% of the sample, the *bidegorris* is the first preferred option, although its shortage in many situations forces users to choose other options, according to the following order: pedestrian areas, sidewalks and, at last, the carriageway.

The survey also asked the user to give a relative rank of importance to a list of 9 typical problems facing their cycling practice, accepting for suggestions of further problems not considered in the list. The problems included were:

- Road safety issues caused by the intensity of motorized traffic

- Conflicts with pedestrians and drivers
- Shortage and/or lack of functionality of the existing network of *bidegorris*
- Adverse weather conditions in the city (rain, cold ...)
- Lack of proper place to store the bicycle at home
- Shortage of bike parking on the streets
- High risk of theft when the bicycle is left in the street
- Lack of habit
- Lack of prestige / social recognition of the bike as means of transportation

Feeling unsafe because of motorized traffic was the main problem faced by respondents in their usage of bicycles: it was indicated as the first problem by the 38% of the sample. Next was the shortage of dedicated cycling infrastructures along their habitual routes (33%). The two problems are considered linked together and their prevalence confined other problems to the background. The survey also allowed to detect the main design and functionality problems derived from the usage of the *bidegorris*, namely their bad connectivity and their 'invasion' by pedestrians.

In spite of its limitations, the main contribution of such survey and corresponding report to the analysis of perceptions of cycling in Vitoria-Gasteiz lies in being the first attempt to verify the match of each factor which in the literature is considered influential for cycling (see Section 2.2.1) with the perception of it by real users of that city. Although the sample is not representative and respondents were limited to current users, the analytical effort is useful for the disentangling of this dissertation because it constitutes a basis on which our empirical research can start (see Chapter 5).

Factors influencing cycling in Vitoria-Gasteiz and their perception were analysed by Torres Elizburu (2003b) according to a framework selected by the report's author. The list of factors and general aspects considered is showed in Table 10. For many of such factors, our research will gather structured psychosocial data according to the specific theoretical framework built in previous chapters. In many cases, factors considered by such first analysis overlaps with elements considered in our research so that they can be matched in Chapter 6.

	Importance given by current users in Vitoria-Gasteiz	*Importance given by Torres Elizburu (2003b)*
Influencing factors		
Distance		-
Hilliness		-
Weather conditions	•	
Bicycle availability		-
Parking at home availability	•	
Parking at destination availability	•••	
Perceived theft risk	••	
Perceived accident risk	•••••	
Conflicts with other users for space	••	
Capacity to carry objects	•	
Exposition to pollution and noise		••
Influencing conditions		
from urban model (density and compactness vs. sprawl)		-
from transport model (car dominance and modal split)		••••
from infrastructure design (availability and performance of cycleways)		••••
from traffic management (mode space assignment)		•••
from social and cultural environment (image of cycling, stereotypes, attitudes, etc.)		•••••

Table 10. List of factors and conditions influencing cycling in Vitoria-Gasteiz and their perception (author's interpretation based on Torres Elizburu 2003b)

Distinction between influencing *factors* vs. *conditions* is not clearly defined in the document, either theoretically or methodologically, but it gives a first outlook of the elements taken into account for cycling consideration in Vitoria-Gasteiz, on how such elements are viewed by current users (in 2003) or on how they influence cycling according to the interpretation made by the author of the diagnosis. Such diagnosis has subsequently informed much of the planning practice carried out by municipal administration to foster cycling mobility thereafter. The both cited Sustainable Mobility and Public Space Plan (City of Vitoria-Gasteiz 2007) and the Bicycle Mobility Master Plan (City of Vitoria-Gasteiz 2009) take in facts their context analysis from that document, influencing therefore also the corresponding measures proposed by the plans and subsequently carried out.

For the specific scope of this thesis it is interesting to note that, from the beginning, the analysis of how cycling were viewed by users is characterised by the observation of distinct importance given to specific factors according to the experience level of each user. Like in other context where the perceptions of users were analysed, also in Vitoria-Gasteiz was soon noted how aspects like i.e. the perception of (and the relative importance given to) the weather adverse conditions were lower for those users who cycle more and for utility reasons, and conversely it were higher for occasional users. Hence, insights similar to those resulting from the analysis carried out in Madrid (see Section 3.3) are noticeable also in Vitoria-Gasteiz.

From left to right:

- New housing development in Salburúa is an example of the recent change in city scale (Image source: ACXT)
- Example of infrastructure favouring cycling in a commercial street (Image source: City of Vitoria-Gasteiz)
- The public-bike system in service from 2004 to 2012 had more than 67,000 users in 2011, providing approximately 440 loans per day (Image source: DNA)

Figure 55. How cycling is viewed in Vitoria-Gasteiz has recently changed because of three factors, according to Sanz Alduán (2006)

Other three aspects that mark the way cycling is viewed in Vitoria-Gasteiz are those highlighted by the diagnosis of the whole system of urban mobility realised by Sanz Alduán (2006). He noted how in recent years, the combination of several factors changed substantially the consideration of cycling in the city and generate strong expectations that the bicycle may be 'normalised' as a means of everyday urban travel. These factors refer to: a) the recent change in city scale (see Section 4.1.2), which goes beyond the range of the pedestrian mode but remains on the bicycle one; b) the increase in cycling infrastructure (cycleways, urban paths and trails, cycle parking) either dedicated, as the time of the diagnosis, or shared as it is happening more recently (see Section 4.2.5); and c) the emergence of a 'critical mass' of users, which has the effect of limiting and transforming the feeling of isolation and the neglected images associated to former cyclists (Sanz Alduán 2006, p.90). The latter factor has been largely influenced by the public-bike system implemented in 2004 (see Section 4.2.5). According to Sanz Alduán, the greatest value of such system may have been precisely the increase of the presence of cyclists in the urban landscape and, with it, confidence and respect toward cycling mode increased (2006).

5 Empirical research carried out in Vitoria-Gasteiz

This section presents an overview of the research approach applied in Vitoria-Gasteiz. The research consisted of a combination of face-to-face in-depth interviews, recruitment face-to-face short interviews and telephone interviews developed in the framework of the project called TRANSBICI (Travel behaviour analysis for modelling the potential use of bicycle: transition towards a cycling city), a three-year research project financed by the Spanish Ministry of Science National Plan I+D+i. Research materials can be found in Annex 2. Key points of TRANSBICI survey in Vitoria-Gasteiz are:

- large and representative survey
- city in transition, survey catches the particular timing
- different situation with rest of Spanish cities

In order to test the empirical validity of the theoretical model proposed in previous sections, we applied the framework to a study of individuals in Vitoria-Gasteiz as part of the TRANSBICI project.

The objectives of the TRANSBICI project are: 1) To identify and measure factors influencing cycling mode choice, including cultural, social, spatial, urban, economic, and subjective aspects. 2) To develop a new model for travel demand analysis, adapted to include cycling trips in urban areas with low cycling use, in order to implement effective strategies to increase cycling modal share. 3) To develop a GIS model of optimal bikeways networks design and a GIS model of optimal location for bike-sharing stations.

As a result, a set of new research findings are expected: a) A definition of the structure of a new transport demand model that considers bicycle options in urban areas. b) The identification of psychosocial factors influencing the use of bicycles in urban contexts. c) New methodological developments to combine transport quantitative data (traffic counts, trip time and cost) with other data coming from research in urban structure (accessibility, network density, reliability, etc.) and in social-psychology (individual perceptions of cost & benefits, safety, health, environmental friendly behaviour, etc.). d) A definition of transport strategies to develop friendly cities for cyclists and pedestrians.

The current study uses cross sectional data obtained in spring of 2012 to test the relative contribution of this thesis's theoretical model, particularly to test the constructs of cycling consideration and cycling familiarity and the relationship between them.

The main source of data for this study is a telephone survey to a panel of 736 commuters of Vitoria-Gasteiz conducted between April 2012 and May 2012. The survey has been designed as a longitudinal survey, to be repeated to the same baseline participants after a year, in May 2013, and after two years, in May 2014[13].

Previous to the telephone survey, two other research methods were conducted: a qualitative research of face-to-face in-depth interviews and a series of recruitment face-to-face short interviews. Aims and methodology used in the qualitative research is explained in the next section, while subsequent sections are dedicated to the quantitative methods.

5.1 A preparatory qualitative study: face-to-face in-depth interviews

5.1.1 Design and procedure

A main aim of the qualitative research was to explore beliefs and perceptions toward cycling as a mode of transport in people who travel to their work-place or study-place at least weekly. The research is designed to give insights useful to build measures of the socio-psychological constructs to be used in the subsequent quantitative survey. Previous literature on these kind of measures (e.g. de Geus et al. 2008; Handy et al. 2010; Heinen et al. 2011) are results of research conducted in other socio-cultural contexts, where cycling is more 'normalised' than in Spanish cities. As remarked in previous sections, beliefs and perceptions toward cycling are different from place to place and they vary across different cultural settings, then exploring and understanding what is shared and what is specific had been considered essential for the development of this thesis.

5.1.2 Participants

A total of 21 in-depth face-to-face interviews were undertaken with residents of Madrid and Vitoria-Gasteiz so that insights could be gained from two different cities in the Spanish context. In each city

[13] Initial survey design contemplated three waves separated by a time-lapse of six months (Spring 2012, Autumn 2012 and Spring 2013), but a delay in the implementation of important measures affecting the transportation and public space systems lead to change the time-lapse between each wave to 12-month periods.

the target was to recruit regular cyclists for commuting purposes, non-cyclists who commute with other modes and persons from cycling advocacy groups. The sample was recruited from municipal sources and databases, asking people whom accepted to take part in the research by been interviewed face-to-face for a duration of approximately 30 minutes. Table 11 provides information on the sample recruited and the type of participants.

Interviewee's profile	*Madrid*	*Vitoria-Gasteiz*
Commuter (by bicycle)	2	4
Commuter (by car)	3	2
Commuter (by public transport)	3	-
Commuter (by walking)	1	3
Cycling advocacy group member	2	1

Table 11. Type of participants to the face-to-face interviews realized in Vitoria-Gasteiz and Madrid.

The rationale for sampling was to collect a set of beliefs and perceptions around cycling as a mode of transport among distinct types of people, in order to confirm or discard those factors indicated by international literature as influencing for cycling intention and cycling behaviour. Consequently, they are not statistically representative of cities residents and therefore cannot be generalised to the corresponding cities' populations.

5.1.3 Interviews

Interviews were realized at places negotiated between interviewee and the researcher from the TRANSBICI project, generally at a public venue suggested by the participant. Interviews were recorded during the whole duration (about 30 minutes) in order to allow posterior transcription and analysis of items. At the end of interviews, a purchasing check of the amount of 20€ was given to participant in order to thank his/her cooperation.

Technique used to perform the face-to-face interviews was the *focused semi-structured interview* (Bernard 2000). This type of interview is called *focused* because it is focalized on experiences, attitudes or beliefs about particular situations or behaviours, in this case the use of bicycle for commuting purposes. Moreover, the interview is *semi-structured*, since although there is a pattern of interview guide, there is also scope for reshaping and deepening in some areas of interest according to the interviewee's answers. In fact, although mainly aimed to test existing theories about factors influencing cycling, the discussion was also meant to be open and not leave out issues which may be of importance to individual participants.

Before starting the interview, the participants were asked to fill a short questionnaire asking for:

- habitual mode of transport used to realize a series of common activities (commuting for work or study, shopping, taking children to school, travelling for leisure purposes, visiting friends);

- frequency of use for several modes of transport (including bicycle) during the last year;
- gender and age;
- eventual affiliation to environmental group, cycling advocacy group, institutional position, or transport related position.

Based on answers to the previous questionnaire, the interview followed a prepared topic guide including the following main areas:

- Travel behaviour over the last year (cycling and other modes);
- General experiences of cycling in Vitoria-Gasteiz or Madrid;
- Detailed discussion of reasons for cycling or for not cycling;
- Awareness of cycling infrastructure and other measures in the own city.

Script used for the interviews is shown in Annex 1.

5.1.4 Content analysis

All interviews were transcribed word-for-word with pseudonyms assigned to each participant. Analysis guidelines were followed (Smith & Osborn 2003) to ensure that a thorough analysis was carried out whilst paying attention to the original aims of the investigation. Throughout the transcription and analysis process a research journal was kept to document the researcher's ideas about tentative relationships and emerging themes within and between data sets. The cyclists and non-cyclist groups were initially analysed separately to facilitate a more idiographic and nuanced analysis. Emerging themes from the initial notes were written in the right hand margin allowing for theoretical connections whilst still grounded in the specifics of the accounts. The transcripts were then re-read, with a more critical focus. Through carrying out this process some small changes were made to the existing interpretations. The transcripts were then analysed entailed clustering of the emerging themes into overarching items across all the interviews.

5.1.5 Insights for the quantitative research

The results of analysis have allowed defining beliefs that are central to the respondents as well as how they are expressed verbally, and assessing the functional, symbolic and affective meanings associated with cycling. Rich information was also obtained on perceived control beliefs toward this mode of transport.

Twenty-three themes emerged from the interviews. Within the themes, commonalities and differences between the Madrid and Vitoria-Gasteiz participants were highlighted. These themes encompassed beneficial, challenging and facilitating aspects of cycle commuting behaviour. In Box 2, the categories extracted from the data analysis are shown. In the case of the factor *Attitude toward*

the Behavior, three sub-categories were created to identify both the nature of the beliefs (instrumental, symbolic) and the affective aspects associated with the bicycle. In line with the theoretical works of Dittmar (1992) and Ennis and Zanna (2000; 1993), this classification has been applied in research of ecological behavior in general and of urban mobility in particular. Gatersleben and Steg (2012) indicate that these behaviors are not only explained by beliefs associated with instrumental factors (such as cost or time spent), but they can also be predicted (even more precisely) by beliefs associated with symbolic (expression of identity, status or group membership) and affective motivations (pleasure, anger, relaxation).

Box 2. Categories employed for the analysis.

Attitude toward the behaviour

- Instrumental beliefs
  - Versatility, flexibility
  - Reliability: predictability of trip time
  - Safety: risk of accidents
  - Safety: interaction with drivers and pedestrians
  - Safety: risk of bicycle theft
  - Economy
  - Health
  - Exposure to climatology
  - Comfort
- Symbolic beliefs
  - Benefits for the environment
  - Expression of values and status
- Associated affective aspects
  - Fear
  - Anxiety
  - Arousal
  - Pleasure

Social norm

- Descriptive norm
- Subjective norm
- Prototypes of cyclists

Perceived control of behaviour

- Availability of bike paths
- Car speed reduction and car restrictions
- Availability of bike hire services
- Availability of parking places
- Hilliness of the city

The analysis of categories emerged from the interviews allowed reviewing the set of factors built through the literature review in Section 2.2 on types of influences on cycle commuting behaviour, in order to confirm their consideration in the present study or, reversely, to discard any of them.

The results obtained from this preparatory qualitative study are presented and discussed in a co-authored submitted paper (Lois et al. n.d.). Insights from those results were used to design the questionnaires of the main quantitative study described in the next section.

5.2 The main quantitative study: cross-sectional telephone survey to commuters

5.2.1 Design and procedure

Since the focus of the study is placed on uses and perceptions related to the commuting trip of city residents, survey sample was gathered at workplaces and schools. Explicit aim of the study was to reach a certain grade of representativeness of real commuting population, so quotas have been set by gender, by age group and by spatial distribution of jobs and study places throughout the city. For each of the six districts of Vitoria-Gasteiz, the target was to recruit a number of participants proportional to the share of workers and students commuting to that district, which was a known data provided by municipal sources (City of Vitoria-Gasteiz 2011). Workplaces and schools were first selected based on those data, establishing quotas of potential participants by sector of activity (for workers) and by type of school/university (for students). Figure 56 provides a map of the 452 selected locations were survey participants have been recruited. The global sampling error for the selection of the sample was ±3.6% at $p < 0.05$, ranging from 5.2% to 5.7% for each of the district sampled.

5.2.2 Participants

Participants were recruited approaching workers and students at the doorsteps of selected workplaces and schools by trained interviewers working for a market analysis company[14]. Previously, an e-mail had been sent to employers and school directors, informing them about the study and asking them to inform their constituencies about the possible recruitment of participants at their doorsteps. During the recruitment phase, few socio-demographic and travel questions were asked

[14] The market analysis company (QUOR s.l.) is a specialised firm dedicated to surveys and was contracted by the TRANSBICI project to carry out the surveys designed by the author of this thesis.

by the interviewers (2 minutes duration), followed by the permission to be contacted by telephone in the subsequent days in order to perform the first telephone interview.

Persons who agreed to take part in the panel were stimulated to participate by financial rewards assigned by lot. Number and financial amount of the prizes was set to increasing values in each wave, in order to further stimulate participants to complete interviews until the end of the study. Three prizes of the amount of 100€ were raffled after the first wave in 2012, five prizes of the amount of 120€ were raffled after the second wave in 2013, ten prizes of the amount of 150€ were raffled after the third wave in 2014.

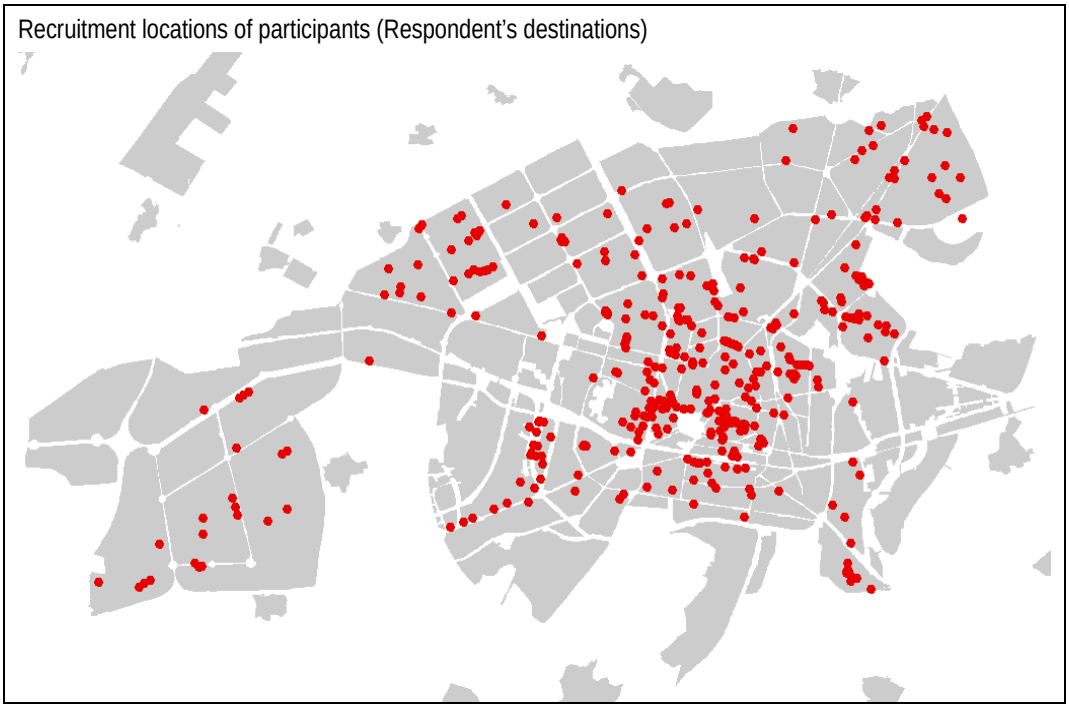


Figure 56. Recruitment locations of participants corresponding to respondent's destinations

Potential participants were also given some welcome materials. These included a thank-you letter signed by City Councillor for Mobility and Public Space and a little reminder card (see Annex 2). The card contained a memo note of the scheduled phone calls and a 0 to 6 graphical scale in order to easily associate the questionnaire's Likert scale values to their meanings once the person was called for the interview. Participants were recommended to hold the card during the whole duration of the study, also because the card would serve to withdraw the financial award in case of being lot-winning.

A total of 934 individuals were approached during the 3-weeks long recruitment campaign, but only 736 of them composed the final sample in order to guarantee the representativeness targeted. Ages range from 16 to 64 and each participant share the condition to commute to their workplace or school at least once a week. Resulting sample features socio-demographic and mobility characteristics are close to the ones revealed by the most recent Household Mobility Survey realized in 2011. Table 12 provides some descriptive statistics of the sample and its comparison with the corresponding population of commuters.

Variable	*Category*	*Population of commuters (n=84,999) (*)* *%*	*Study sample (N = 736)* *%*	*N*
Gender	Female	51.2	53.1	391
	Male	48.8	46.9	345
Age group	16-24 years	17.0	20.4	150
	25-34 years	18.7	27.2	200
	35-44 years	28.1	27.9	205
	45-54 years	24.8	17.5	129
	55-64 years	11.4	7.1	52
End of commute trip	District 1	19.7	19.6	144
	District 2	22.8	25.4	187
	District 3	8.1	11.4	84
	District 4	11.0	10.7	79
	District 5	21.5	18.3	135
	District 6	16.9	14.5	107
Activity (**)	Students (older than 16 years)	16.8	18.5	136
	General Education System	*9.8*	*11.1*	*82*
	Higher Education (University level)	*6.6*	*8.2*	*60*
	Workers	79.9	80.6	593
	Primary sector	*0.5*	*0.4*	*3*
	Industry and energy	*21.4*	*21.9*	*161*
	Construction	*7.3*	*4.2*	*31*
	Services	*54.5*	*54.2*	*399*
	Both (work and study)	3.3	1.0	7
Commute mode (***)	Walking	37.7	27.2	200
	Cycling	10.9	11.8	87
	Public transport	9.0	17.1	126
	Car (and other private motorized modes)	42.5	43.9	323

Notes: (*) data on population of commuters are taken from Household Mobility Survey 2011 (City of Vitoria-Gasteiz 2011); data consider only categories included in survey design with an estimated n=84,999 individuals (**) data on sub-category of activity by sector (for workers) and by type of education (for students) come from Statistical Yearbook 2011 (City of Vitoria-Gasteiz 2012a) (***) Sample characteristics on commute mode is a result of respondent's answers, not a survey design input.

Table 12. Descriptive statistics of the survey sample and comparison with population of commuters in Vitoria-Gasteiz

Telephone calls were conducted during 3 weeks, from April 27th to May 18th 2012. The duration of the telephone calls was on average 13 minutes. Research materials, including telephone recordings, are available at the Transyt research centre, which is the responsible for the TRANSBICI Project.

5.2.3 Survey questionnaire

A questionnaire (see Annex 2) was adapted from measures used in previous studies (Crawford et al. 2001; van Bekkum 2011). It consisted of a total of 106 variables divided in four parts: (i) socio-demographic and mode availability data; (ii) time/spatial characterization of commute trips; (iii) past

and current cycling use (for commute and other purposes); (iv) psychosocial questions about commute cycling with items based on the qualitative phase.

Among **socio-demographic and mode availability** data, also the ability to cycle was asked in the same line as the ability to drive (holding a car driving license) and the ability to ride a motorcycle (holding a motorcycle driving license).

Time/spatial characterization of commute trips. Current commuting behaviour, as well as many socio-demographic data, were information asked during the recruiting phase, at the doorsteps of selected workplaces and schools, consequently they were not asked again during the telephone call. A description of the commute trip included asking for the origin location (the destination as well as the habitual mode used were known), the number of weekdays when the commute trip was usually performed, time of starting and ending of the trip, whether it was direct from home to final destination or if other activities were performed along the way, and the type of commute schedule (whether interrupted by a long lunch break, uninterrupted of without a fixed schedule).

Questions about commute cycling were initiated by a modified version of the 'stage of change' scale (see Table 13). This qualitative variable was based on the TTM model of Prochaska (2008) and the works of Bamberg (2007; 2011). The participants in this study indicated the statement with which they agreed the most. Each statement corresponded to one of the stages of the model: "I have never thought to commute by bicycle" (stage of *pre-contemplation*), "I have never commuted by bicycle, but sometimes I consider it" (*contemplation*) and "Sometimes I have commuted by bicycle, and I am seriously thinking about doing it more regularly" (*preparing for action*). People in the *action/maintenance* stage (current cyclists) were further categorised based on the pilot work realised: seasonal cyclists as well as people who cycled regularly but subjected to constraints created by household and family responsibilities (relatives) could not be categorised within the stages of change model. Consequently, two extra stages was added to the scale stating "I regularly commute by bike, but only in good weather" and "I often commute by bike, although it depends on specific circumstances (health, day-schedule, family commitments, etc.)" to accommodate those who were only cycling to work for part of the year or part of their daily schedules. People in the *relapse* stage ere also included. The 'stage of change' scale was also used to assess behavioural intentions used for the TPB's model.

Noteworthy is the fact that the percentage of regular commute cyclists resulting from Table 13 are very close to the modal share of cycling in Vitoria-Gasteiz, i.e. 10.9% for commute trip purposes as seen in Figure 51 (City of Vitoria-Gasteiz 2011). Although the two surveys were asking for different things ('mode used regularly' in our survey vs. 'the modes used for specific trips made during a specific day' in the 2011 Households Mobility Survey) the resulting percentages are comparable, highlighting the statistical representativeness of our instrument.

Table 13. Current cycle commuting behaviour was measured using a 'stage of change' scale

	Which of the following statements best describes you? (stage of change)	*Frequency*	*%*
1	*I've never thought to commute by bike*	*236*	*32.1*
2	*I've never commuted by bike, but sometimes I consider it*	*156*	*21.2*
3	*Sometimes I've commuted by bike, and I think seriously about doing it more regularly*	*114*	*15.5*
4	*Sometimes I've commuted by bike, but I don't think seriously about doing it more regularly*	*89*	*12.1*
5	*I used to commute by bike, but I no longer do it*	*52*	*7.1*
6	*I regularly commute by bike, all year round*	*47*	*6.4*
7	*I regularly commute by bike, but only in good weather*	*24*	*3.3*
8	*I often commute by bike, although it depends on specific circumstances (health, day-schedule, family commitments, etc.)*	*18*	*2.4*
	Total	*736*	*100.0*

Characteristics of other cycling practices. The frequency of bicycle usage when performing some other type of activities besides going to work or to the study centre was recorded as well. Activities elicited were: 1) leisure (going for a ride, tourism, going out), 2) practicing sports, and 3) doing errands, going to the doctor, shopping, visiting relatives. These frequencies were recorded with a scale with four ordinal categories: 0 (*Never*), 1 (*Occasionally*), 2 (*Almost always*), and 3 (*Always*). These questions were only completed by the people who had a bicycle and knew how to ride it.

Psychosocial questions about commute cycling. A full range of questions according to the TPB's model and other psychosocial aspects were asked in the TRANSBICI survey questionnaire, although only some of them were used for the current research on mode familiarity. They were preceded by the warning: "From now on all questions will refer to your regular trip to place of work/study". They were assessed in the following way (see complete questionnaire in Annex 2).

*Attitude toward the commute cycling behaviour***.** Taking as reference the theoretical framework proposed by Fishbein and Ajzen (2005), different components of this evaluative concept were taken into account:

a) Beliefs about the attributes associated with bicycle commuting. After the sentence "Considering the possibility of using the bicycle to travel to your place of work or study" (for non-cyclists) or "Thinking about your usual travel to their place of work / study" (for cyclists), "please indicate to what extent would you agree or disagree with the following statements:", this attitude component included 20 items rated on a Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), such as "I (would be)/(am) free because I (would)/(do) not depend on any other transport mode" or "I (would) save money compared to other transport modes";

b) The importance conveyed by the person to each one of these attributes regarding commuting. Introduced by the question "… and, to what extent each of the following statements is important to you in your commuting trip?", this component included 20 items appraising the importance of the attributes reflected in the beliefs, in a Likert format ranging from 1 (*not at*

all important) to 7 (*extremely important*), such as "parking easily" or "contaminating the environment less"; and

c) The global measure of attitude toward the specific behaviour of using a bicycle for the commuting trip is obtained, from this theoretical perspective, as the product of the assessment of the beliefs by the importance given by the person to each belief as in expression (1) seen in Section 2.1.1 (p. 19).

Subjective norm. To populate this variable, the recommendations of Fishbein and Ajzen (2005) were followed as well. The interviewees first responded to the question, "Imagine that you decide to commute to your workplace/study centre by bicycle"/ "Regarding your decision to travel by bicycle to your place of work / study"… "To what extent (would)/(do) the following groups of people agree? (my family, my friends, my co-workers or classmates)" on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Subsequently they appraised the personal importance conferred to the opinion of each one of those groups on a scale ranging from 1 (*not at all important*) to 7 (*extremely important*). In the same fashion as for attitudes measures, the items appraising approval of the interviewees' behaviour by their social environment is obtained as the product of the assessment of both indicators.

Self-efficacy. On a scale ranging from 1 (*not at all capable*) to 7 (*totally capable*), the interviewees appraised the degree to which they (would be)/(are) capable of performing different tasks (if)/(when) they cycled to their workplace or study centre, such as "Riding the bicycle in car traffic" or "Fixing a flat tire on a bicycle wheel".

Social identity. A multi-item scale for this construct has been adopted following Murtagh et al (2012). The interviewees rated their degree of agreement on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*) with the statements "I identify myself as a cyclist", "I envisage myself as a cyclist", and "I think I have something in common with cyclists" (Lois et al. 2015).

5.2.4 Statistical analyses

The statistical analyses were carried out using the software package SPSS Statistics 20 (IBM, 2011). Firstly, descriptive statistics were provided using percentages to make available an overview of each measure of cycling familiarity in relation to gender, age, study level and distance. For the inferential statistics, the independent variables were cycling familiarity (four levels; see Section 5.3.2), gender and study level (as an indicator linked to income). The dependent variables were the 20 measures of attitude toward cycling and more specifically 4 synthetic measures of cycling consideration (see Section 5.3.1).

One-way ANOVAs were carried out to analyse whether measures of cycling consideration significantly differed between levels of cycling familiarity (see Section 5.3). In the case of significant results, post hoc tests were used to identify differences in measures of cycling consideration between

individual levels. Post hoc Scheffe tests were used for data that conformed to homogeneity of variance tests and Games-Howell tests were used in instances where the data violated the assumptions of homogeneity of variance (Field 2009). Independent t-tests were used to determine whether there were any significant differences in measures of cycling consideration between men and women. Effect sizes have also been reported alongside significance values, as they provide complementary information about the magnitude of reported differences (Field, 2009). Cohen's *d* tests have been used to measure effect sizes for t-tests and partial eta squared calculations have been used to measure effect sizes for ANOVAs.

5.2.5 Descriptive results

Table 14 provides some descriptive statistics for some of the socio-economic factors considered, such as household size and situation, educational level and car availability for the commute trip.

Table 14. Descriptive statistics of the survey sample for socio-economic factors

Variable			*Sample (N = 736)*
Household size		*Mean*	2.96
		Std. Dev.	1.1
		Median	3
			%
Household situation	Father/Mother		45.0
	With children <12 years		26.5
	Son/Daughter		22.0
	Spouse or couple without children (or children outside home)		18.9
	Without family ties (i.e. living alone, shared flat)		13.5
	Other family ties		0.7
Education level	None		0.4
	Middle School		21.6
	High School		21.6
	Vocational Training		31.5
	University		24.9
Car availability for commute trip	Owner/driver		57.7
	Passenger		14.3
	User not owner		13.0
	Don't have		14.7
Bicycle availability for commute trip	Yes		73.0
	No		22.0
	(Do not know how to ride a bike)		5.0

5.3 Measures of cycling consideration and mode familiarity

This section, following the general conceptual framework depicted in Figure 18 (see Chapter 3), presents the measurement building of each of the two constructs under analysis: cycling consideration and mode familiarity. Measures obtained are subsequently used to carry out the exploration on the hypothesised associations between the two constructs at stake, pursuing the scopes of Objective 2 (see Chapter 6).

5.3.1 Cycling consideration

The construct of how cycling is considered is, according to the methodological definition given in Section 3.2.2, based on the *beliefs* people hold toward the practice of cycling. In this sense, the research carried out in this dissertation profits by the measures included in the questionnaire developed for the TRANSBICI project. The survey performed in Vitoria-Gasteiz has been designed under the theoretical framework of the theory of planned behaviour (TPB; Ajzen 1991, see Section 2.1) also because its methodological definitions allow for more extensive investigations which, making use of the same measures, may develop new insights from the same constructs. In this section, a factor analysis is performed on a selection of variables from the TRANSBICI survey in order to explore the underlying dimensions of cycling consideration.

Data source

The same components of the evaluative concept of *attitude* may be used to build the evaluative concept of cycling consideration and its underlying dimensions since the way how the construct of cycling consideration has been conceptualised makes it very similar to the construct of attitude in the TPB, and consequently, in that fashion may be operationalized.

The global measure of attitude toward cycling can been obtained, in the TRANSBICI survey, through the data collected by the two components of *belief* and *importance* for each of the 20 items associated with bicycle commuting. Those components have been identified with the preparatory qualitative study described in Section 5.1 and their description has been presented in details in previous Section 5.2. The set of items obtained in this way to measure attitudes may be taken as a satisfactory base to measure the dimensions of the cycling consideration construct, since it contains measures of how cycling is *viewed* individually, as discussed in Section 3.2.2.

In order to identify the underlying factors for cycling consideration an Exploratory Factor Analysis (EFA) is carried out on the set of variables obtained by the product between the raw score of beliefs and importance collected in the TRANSBICI survey. Exploratory factor analysis (EFA) is a statistical procedure that can be used to reduce a larger number of variables to a smaller set of factors in order to evaluate the presence of ‘unobserved’ or ‘latent’ variables which underlie the observed measures.

Each factor built through this analysis is comprised of variables that are most highly correlated with each other, and least correlated with variables in other factors (Field 2009).

For each respondent i and for each of the 20 items collected j, the resulting measure of the commute cycling attitudinal component $CC_{i,j}$ is the result of the strength of each belief ($b_{i,j}$) weighted by the evaluation ($e_{i,j}$) of the importance given to it by respondent, as shown in the following expression:

$$CC_{i,j} = (b_{i,j} - 4) \cdot e_{i,j} \qquad (2)$$

The expression recalls the method used by the TPB to measure attitude toward a particular behaviour (see expression (1) in Section 2.1.1) but it has been modified since the new construct of cycling consideration is not the linear aggregation of the total set of accessible behavioural beliefs linking the behaviour as in the TPB (Ajzen 1991), but a combination of several underlying dimensions that need to be explored through the EFA carried out in this section.

The expression (2) introduces also an additional change. The scale of beliefs has been transformed to allow for the semantic differential type scale ranging from -3 to +3. In fact, the original raw scores (ranging from 1=*strongly disagree* to 7=*strongly agree*) multiplied by the raw scores of importance (ranging from 1=*not at all important* to 7=*extremely important*) produced a range of possible products (ranging from 1 to 49) which does not respond to the 'true' semantic level of the psychological construct of the attitudinal component. Consider, for example, the following situations.

a) Assume $b_{1,1}$=1 to be the answer of respondent 1 expressing a belief that cycling would *not* allow him/her to travel quickly (item 1 of the questionnaire). If the same respondent attaches to her travelling quickly to the workplace or study centre a very high value of importance ($e_{1,1}$=7), the resulting product would be ($CC_{1,1}$=1*7=7), which means *a low* assessment score, *but not the lowest* as the respondent's 'true' assessment would be in comparison with all the possible answers. Actually, such an assessment would result *higher* than the one of a second respondent who, for example, still considering the possibility of her commuting by cycle not quick at all ($b_{2,1}$=1), does not attach any importance to the speed of her commute ($e_{2,1}$=1, then $CC_{2,1}$=1). The first respondent has the 'truly' worst consideration of potential cycling for commuting but it is not reflected by the resulting product.
b) Assume now $b_{3,1}$=7 to be the answer of respondent 3 expressing a belief that cycling would allow him/her to travel quickly, but at the same time she attaches to it a very low value of importance ($e_{1,1}$=1), maybe because she is careless toward speed. The resulting product would be ($CC_{3,1}$=7*1=7), that means she has the same *low* assessment score than respondent 1, while actually she is 'truly' considering cycling *better* than respondent 1.

Item 1 (travel quickly) refers to an outcome of the inquired behaviour that has an almost universal *positive* valence (at least in the commute travelling domain). Let us consider item 7 ("*I would have a*

high risk of having an accident") which has conversely an almost universal *negative* valence[15]. In order to be aggregated with other items and concur to form a coherent dimension, the row scores for this (and for all the items that holds a negative valence) have to be inverted, that means that respondents who assess cycle commuting as highly risky would score 1 (inverted from the raw score 7) and, vice versa, respondents who assess cycle commuting as not risky at all would score 7. By doing so, the semantic of belief scores for this negative items would concord with those of positive items, so they can be weighted by the corresponding score of importance which remains in the original form. Consider now other two hypothetic situations, referring this time to item 7.

c) Respondent 1 in this case expresses a belief that cycling would be highly risky ($b_{1,7}$=1) and attaches to the minimisation of the risk of having an accident a very high importance ($e_{1,7}$=7). The resulting product, as in previous case a), would be ($CC_{1,7}$=1*7=7), so again *a low* assessment score *but not the lowest*. Such an assessment would actually result *higher* than the one of a second respondent who, for example, still considering the commute by cycle very risky ($b_{2,7}$=1), does not attach any importance to the minimisation of risk ($e_{2,7}$=1, then $CC_{2,7}$=1). The second respondent in this case, although believing cycling as risky, hold a potential higher consideration for cycling than the first one but the 'true' situation is not reflected by the resulting product.

d) The same occurs for the corresponding situation described for case b).

The disadvantages derived from the transformation discussed above lie on the fact that products involving the middle-point category of a response scale ($b_{i,j} = 4$) are all reduced to 0 independently from the value of $e_{i,j}$, altering in this way the 'true' assessment given by respondent. In this case however, the 'true' assessment is related more to the behavioural belief than to the importance attached to it, therefore the drawbacks of this approach are mitigated by its benefits.

Resulting range for the product scores is consequently a semantic differential type scale ranging from -21 to +21. For permitting comparison throughout the sample with other measures, such transformed products are standardized to the usual scale ranging from 1 to 7 by the use of Percent of Maximum Possible (POMP) transformation method (Cohen et al. 1999 cited in Fischer & Milfont 2010) which allow to express scores in terms of the maximum possible score, successively shifted to the range 1 to 7. The resulting expression for the cycling consideration component of a respondent *i* assessing aspect *j* ($CC'_{i,j}$) is the following:

$$CC'_{i,j} = 6 \cdot (CC_{i,j} - m)/(M - m) + 1 \qquad (3)$$

where m and M are the constants representing the minimum (-21) and the maximum (+21) values for the product $CC_{i,j}$. Table 15 summarises descriptive statistics of the resulting variables.

[15] The items expressing a negative valence are labelled with a pound sign (#) in their variable names, see Table 15 for details.

Table 15. Descriptive statistics for variables expressing the cycling consideration component for each of the aspects considered

	Variable	*Description* ("Commute cycling ...")	*Mean*	*Median*	*SD*
1	CC_QUICK	... allows you to **travel quickly**	4.97	5.0	1.50
2	CC_TIMEREL	... allows you to **rely on travel times** that are stable and known in advance	5.31	5.7	1.46
3	CC_SELFSUFF	... allows you to **be self-sufficient** because of not depending on any other mode of transport	5.31	5.7	1.58
4	CC_MONEYSAV	... allows you to **save money** compared to other modes of transport	5.87	6.1	1.31
5	CC_FITNESS	... allows you to be **physically active**	5.68	5.7	1.12
6	CC_PARK	... allows you to **park easily**	5.91	6.6	1.25
7	CC_POLLOUT	... allows you to **pollute less** the environment	6.18	6.6	1.10
8	CC_APPRCLOTHES	... allows you to **wear appropriate clothing** for my activities	4.65	4.7	1.54
9	CC_GOODIMAGE	... allows you to cause a **good impression** on others	4.62	4.6	1.19
10	CC_ENJOY	... allows you to **enjoy** during the trip	4.47	4.3	1.25
11	CC_RELAX	... allows you to **relax** during the trip	4.38	4.4	1.38
12	CC_#PEOPLETR	... makes it difficult to **transport people**	4.83	4.9	1.53
13	CC_#OBJECTTR	... makes it difficult to **transport objects**	4.55	4.6	1.52
14	CC_#ACCRISK	... implies a high **risk of accidents**	4.55	4.7	1.37
15	CC_#THEFTRISK	... implies a high risk of having your **vehicle stolen or damaged**	4.75	4.9	1.63
16	CC_#POLLIN	... makes you to **breathe polluted air**	4.46	4.6	1.42
17	CC_#PEDNUISANCE	... causes **nuisances to pedestrians**	3.73	4.0	1.49
18	CC_#WEATHERRISK	... makes you to **depend a lot on the weather**	5.65	5.7	1.30
19	CC_#STRESS	... makes you to **arrive stressed** to your destination	3.60	3.4	1.66
20	CC_#SWEAT	... makes you to **arrive sweaty** to your destination	4.95	4.9	1.48

Data Analysis

The 20 variables resulting from the procedure descripted above and expressing the cycling consideration component for each of the aspects considered were analysed with the statistical techniques of EFA in order to search for underlying factors for the construct of cycling consideration. All the measures conducted to evaluate test reliability and sampling adequacy allowed us to proceed with the application of the factor analysis.

Principal Axis Factoring (PAF) extraction method was performed through the software SPSS 20 (IBM, 2011). The advantage of PAF is of entailing no distributional assumptions, most appropriate in this case of not-normally distributed data (Costello & Osborne 2005). In fact, for all such measures as well as the raw scores, $0.14 < D(736) < 0.35$, $p < .01$ the K-S test for normality gives a significantly non-normal result.

To identify the underlying cycling consideration dimensions using exploratory factor analysis, successive PAFs suggested eliminating 4 out of the original set of 20 variables. The variables "... makes it difficult to transport people", "... makes it difficult to transport objects", "... implies a high risk of having your vehicle stolen or damaged" and "... makes you to breathe polluted air" are excluded from the analysis based on low communality (<0.3), leaving 16 variable to test for underlying constructs.

The Kaiser–Meyer–Olkin measure verified a good sampling adequacy for the analysis, KMO = .82, and all KMO values for individual items were > .73, which is well above the acceptable limit of .5 (Field 2009). Bartlett's test of sphericity $\chi^2(120) = 2711.6$, $p < .001$, indicated that correlations between items were sufficiently large for PAF.

The number of factors was obtained through the scree test, jointly used with the Kaiser criterion of computing the eigenvalues for the correlation matrix, to avoid eventual distortions in the results (Fabrigar et al. 1999; Costello & Osborne 2005). Four components had eigenvalues over Kaiser's criterion of 1 and in combination explained 39.7% of the variance. The scree plot was slightly ambiguous and showed inflexions that would justify retaining both 2 and 4 factors. Given the large sample size, and the convergence of the scree plot and Kaiser's criterion on four components, this is the number of components that were retained in the final analysis.

Subsequently, factors are rotated to obtain a simple interpretation and the oblique rotation has been chosen as it permits correlation among factors. In case the factors structure involves orthogonal factors, a successful oblique rotation provides estimations of the correlations among factors that are close to zero and produces a solution quite similar to that obtained by a successful orthogonal rotation (Costello & Osborne 2005). The Direct Oblimin oblique rotation method was chosen.

Table 16 shows the factor loadings after rotation, where the loadings having a score higher than ±0.3, on the 16 variables considered, are highlighted for each factor. The items that cluster on the same factors suggest that factor 1 represents the cycling consideration on the commute cycling being '*Green & Smart*', factor 2 on its being '*Difficult & Unsafe*', factor 3 on being '*Pleasant & Suited*' and factor 4 on being '*Efficient*'.

Table 16. Summary of exploratory factor analysis results for the cycling consideration construct (N= 736)

Item	*Rotated Factor Loadings*			
	Factor 1	Factor 2	Factor 3	Factor 4
	Green & Smart	*Difficult & Unsafe*	*Pleasant & Suited*	*Efficient*
CC_POLLOUT	.78	-.03	-.08	.02
CC_FITNESS	.65	.09	.16	-.03
CC_MONEYSAV	.62	-.03	-.05	.12
CC_PARK	.44	-.01	.11	-.02
CC_#SWEAT	-.01	.59	.10	-.22
CC_#STRESS	-.07	.57	-.09	-.16
CC_#ACCRISK	.06	.53	-.06	.03
CC_#PEDNUISANCE	-.10	.47	-.02	.15
CC_#WEATHERRISK	.18	.41	.02	-.09
CC_ENJOY	-.08	.01	.86	-.07
CC_RELAX	.07	-.09	.59	.08
CC_GOODIMAGE	.10	.04	.39	.11
CC_APPRCLOTHES	.07	-.13	.31	.23
CC_QUICK	-.04	-.05	.11	.69
CC_TIMEREL	.04	-.05	.05	.61
CC_SELFSUFF	.24	.05	.05	.46
Eigenvalues	3.98	2.24	1.21	1.20
% of variance	21.36	10.22	4.45	3.71
α	.73	.66	.69	.68

The first factor is named '*Green & Smart*' (G&S) because, on the one hand, it refers to some unequivocal characters of cycling, those recognised without much debate. The fact that cycling has less (or almost null) impacts on the environment and that allows people to be physically active is almost undoubtable and our data support it. On the other hand, the name 'smart' refers to other characters of cycling that are becoming to be increasingly valued by people by effect of increasing costs of transport ("allows you to save money compared to other modes of transport") and by effect of increasing shortage of parking space devoted to parking in city centres.

The second factor is labelled '*Difficult & Unsafe*' (D&U) since the variables with high scores on it are those most frequently mentioned as barriers to cycling. The *difficulties* implied by effect of the physical effort required to copy with distances, slopes, wind, heat, etc. and the sense of *unsafety* it generates by feeling at risk of accidents and getting stressed by traffic. This factor also includes the nuisances that cycling may cause to pedestrians since in Vitoria-Gasteiz cycling is very common to be practiced on sidewalks precisely for the difficulties and the sense of unsafety perceived by users (see Section 4.3).

The third factor is labelled '*Pleasant & Suited*' (P&S) because presents high loadings on the characters of cycling that are increasingly discovered by new users and that are getting 'popular', in many cases

'fashionable'. The feeling of 'good life' cycling exhibits is reflected by expressions of identity and symbolic labelling (Lois et al. 2015).

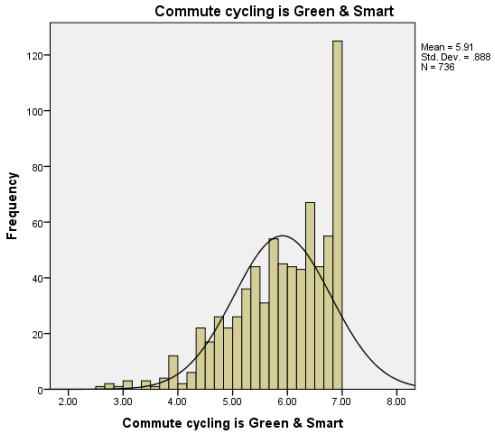
The fourth factor, '*Efficient*' (E), concerns some intrinsic benefits of cycling as in G&S, but dissimilarly from that, in this case such positive characters are not universally recognised. It is suggested that they are becoming evident by effect of increasing inefficiencies of other urban modes of transport (car driving and public transport services) and the increasing unpredictability of travel times generated by traffic congestion. In this sense, the efficiency of cycling is assessed in relation to the situational conditions of the urban transport system, not in an absolute sense.

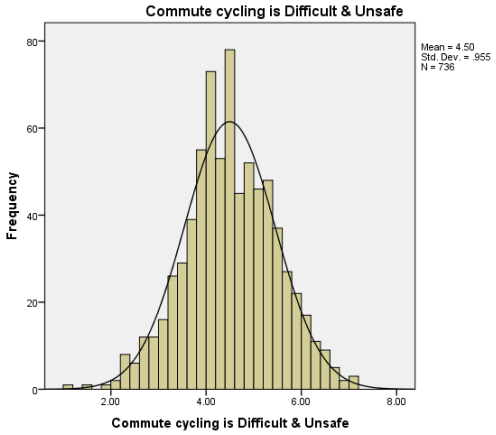
To validate this first exploratory step, the factor analysis was carried out on the whole sample and on two different random subsamples (half of the total sample). It has been interesting to observe that a strong stability of the factor selection was referred to the same four factors for the 16 variable set. In each case, the same sets of variables constitute the identified factors, adding solidity to the analysis (Morales Vallejo 2012). Lastly, a reliability analysis is conducted. All the subscales obtained for the cycling consideration construct had acceptable reliabilities, exhibiting all Cronbach's $\alpha > .66$ (see Table 16).

The identification of the four factors allowed computing a composite score for each individual on each particular factor identified. This procedure consents to compare and segment individuals according to their level of agreement with their relative spacing or standing on the (latent) factor, then it is useful to perform a further analysis on the relationship with cycling familiarity measures. The score for each individual was computed following the non-refined method of summing the raw scores corresponding to all items loading on a factor (DiStefano et al. 2009). Resulting scores have been averaged to retain the same scale metric of items and allowing for comparisons across factors since there are differing numbers of items per factor. This method was preferred over refined ones (e.g. regression, Bartlett or Anderson-Rubin) because the scales used to collect the original data were "untested and exploratory, with little or no evidence of reliability or validity" (Hair et al. 2010, p.140) and to preserve the variation in the original data. Table 17 shows descriptive statistics and frequencies for the resulting score variables.

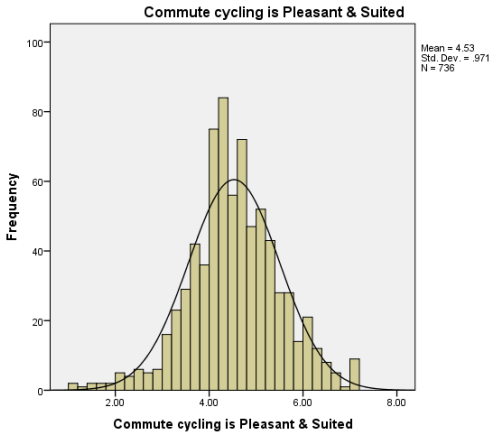
Table 17. Descriptive statistics and frequencies of resulting scores for the four factors obtained for cycling consideration

	Factor 1 Green & Smart	*Factor 2* Difficult & Unsafe	*Factor 3* Pleasant & Suited	*Factor 4* Efficient
Mean	5.91	4.50	4.53	5.20
Median	6.04	4.46	4.50	5.38
Std. Deviation	*0.89*	*0.96*	*0.97*	*1.18*
Variance	*0.79*	*0.91*	*0.94*	*1.40*
Skewness (z)	-.806 (-8.95)	-.081 (-0.90)	-.161 (-1.79)	-.847 (-9.40)
Kurtosis (z)	.342 (1.90)	.035 (0.19)	.775 (4.31)	.837 (4.65)
Frequencies	*Factor 1* - Green & Smart		*Factor 2* - Difficult & Unsafe	

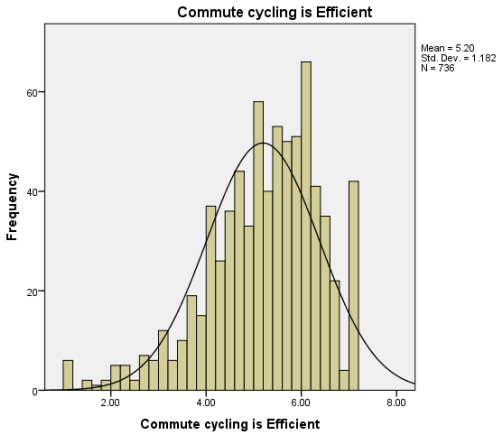




Factor 3 - Pleasant & Suited



Factor 4 – Efficient



The score for all the factors are discrete variables which may be treated as continuous ones. Two of them are close to the normal distribution (D&U, P&S) while other two show a negatively skewed distribution (G&S, E). This frequency distributions reveal that the consideration of cycling as being *green and smart* and its *efficiency* as a mode of transport for commuting is mainly recognised within the sample, while *its pleasant and suited* character as well as the main drawbacks of its use (the *difficulties* implied *and* the sense of *unsafety* it generates) present a symmetric dispersion around the mean.

Globally, the three positive factors obtain average scores way above the median point of 4, especially for G&S and for E, which altogether would indicate a global positive consideration of cycling commuting. In facts, the items included in the D&U factor (barriers to cycling) are deemed as counterparts within composite variables such as attitude and decisional balance and, being their assessment on average above the median, a simple mathematical combination would result in a positive composite score. Nonetheless, previous studies reported that perceived barriers seemed to have a greater influence on the decision to cycle to work than perceived benefits (Shannon et al. 2006; van Bekkum 2011), so their weight in the composite variable should be amplified. In this thesis though, a definition of those weights cannot be carried out, and the four indicators of cycling consideration are maintained separated for the performing of further analyses. The main aim of this thesis is in fact understanding the relationship between wide measures of cycling consideration and the hypothesised construct of cycling familiarity. The four measures identified with EFA relate directly to how cycling is *viewed* individually, considering the aspects of that practice elicited in the people interviewed, then they may be used for the proposed exploratory analysis.

5.3.2 Cycling familiarity

Following the methodological definition of cycling familiarity given in Section 3.2.2, the measure of the hypothesised construct of cycling familiarity should be based on data relating to how cycling is *practised* individually, focusing on the specific behaviour of using a bicycle for commuting or other utilitarian purposes, such as shopping, making arrangements, going to the doctor, visiting, etc. For the sake of that, a factor analysis is carried out on a selection of variables in the TRANSBICI survey relating to the construct at stake. Measures obtained are subsequently used to segment the sample based on levels of cycling familiarity and allowing the subsequent exploration of the assumed associations with the measures of cycling consideration discussed in next Chapter 6.

Data source

Theoretically, the elements to be considered for the measure of cycling familiarity are: the cycling frequency for commuting; the individual history of cycling for commuting; and the cycling frequency for other utilitarian purposes (see Section 3.2.2). Still, a statistical analysis on a wider set of elements is needed to build valid and reliable measures for cycling familiarity.

Out of the above mentioned 106 variables of the TRANSBICI survey (see Section 5.2), 14 are selected based on their ability to describe each respondent in relation to her stated *intensity* of cycling use (for any purposes) and for her stated level of *acquaintance* with the particularities of those practices, in line with the methodological definition of cycling familiarity given in Section 3.2.2. As realised for the previous measures of cycling consideration, on such selected set of variables exploratory factor analysis (EFA) is carried out to identify the underlying factors.

Table 18 shows groups and characteristics of selected variables. The first group of variables regards the respondent's frequency of cycling for non-commuting trips, expressed on a self-reported 4-steps scalar score ranging from 'Never' to 'Always'[16]. The second group regards the respondent's cycle commuting characteristics. Since frequencies for the commuting purpose have not been gathered in the TRANSBICI questionnaire, this information has been extracted from the 'Stage of change' variable. Such variable contains two interrelated elements: 'current intention' to commute by bicycle and 'past attempts' to commute or, even 'past behaviour' commuting by bicycle (see Section 5.2.3). The latter element contains therefore information of how frequent the use of a bicycle for commuting uses has been in the past, with the same scale as in variables regarding the frequency of cycling for non-commuting trips, although in this case that frequency cannot be related to a specific period of time but it is considered along the entire respondent life cycle. This second group also includes the individual history of cycling for commuting (only for the respondents who currently declared to commute regularly), expressed in number of years the practice of cycle commuting has occurred[17]. Lastly, in order to account for the *acquaintance* with the practice of cycling, a third group of variables are included regarding the perceived self-efficacy of cycling for commuting trips. These variables are ranked on a Likert scale ranging from 1 to 7 (from '*Not able*' to '*Totally able*'), according to the TPB extended model followed by the TRANSBICI survey and built on qualitative items surged from focused interviews. All data can be treated as discrete quantitative data, so that the use of multivariate data analysis is allowed.

[16] The data has been coded in relative terms instead of the more usual quantitative rate by time-periods because non-commuting activities are dependent on real user's frequency of performing the specific non-commuting group of activities, which is an unknown data. I.e. if the user does perform a sport activity by bicycle, her stated cycling frequency will be independent on how frequently she performs sport.

[17] The data has been quantitatively coded from respondent own words.

Group	*Variable name*	*Description of variables*	*Type and range of values*
1. Variables regarding the frequency of cycling for non-commuting trips:			
	IH_SHOPPFREQ@	How often have you ridden a bicycle in the last year to make arrangements, go to the doctor, shopping, visits…?	Ordinal ranging from 0 to 3 (Never < Occasionally < Almost always < Always)
	IH_LEISUREFREQ@	How often have you ridden a bicycle in the last year for leisure?	
	IH_SPORTFREQ@	How often have you ridden a bicycle in the last year to practise sport?	
2. Variables regarding frequency and history of cycling for commuting trips:			
	IH_COMMUTEFREQ@	Commuting frequency by bicycle. Calculated variable taking the following values based on IH_STAGE: - 0 if IH_STAGE = 1 or 2 - 1 if IH_STAGE = 3, 4 or 5 - 2 if IH_STAGE = 7 or 8 - 3 if IH_STAGE = 6	Ordinal ranging from 0 to 3 (Never < Occasionally < Almost always < Always)
	IH_HISTORYYEARS	Nº of years commuting by bicycle	Scale; >= 0
3. Variables regarding the perceived self-efficacy for cycling for commuting trips, defined by the statement "How much would / do you consider yourself able to perform the following tasks?"			
	PBCA_RIDEINTRAFFIC	To ride your bicycle in car traffic	Likert scale (interval) on respondent's perceived ability to perform the specific task, ranging from 1 (Not able) to 7 (Totally able)
	PBCA_SAFEPARK (*)	To park your bicycle safely for avoiding thefts	
	PBCA_TUNINGUP (*)	To make frequent bicycle tune-ups in order to keep it in a good state	
	PBCA_FLATTIREFIX	To fix a flat tire on a bicycle wheel	
	PBCA_SAFETYELEM (*)	To use elements of personal safety	
	PBCA_MANEUVERS	To manoeuvre a bicycle safely	
	PBCA_GOUPHILL	To go uphill and overcome slopes by bicycle	
	PBCA_ROUTEPLANNING (*)	To plan the route of a trip	
	PBCA_ROADSIGNALS (*)	To interpret road signs and traffic regulations	
	(*) variable subsequently excluded from EFA.		

Table 18. Variables selected from TRANSBICI survey for EFA to build the measures of cycling familiarity.

The analysis is limited to those who declare ability to access to cycling mode for commuting trips, i.e. they express 'Ability to cycle' (95% of respondents) and 'Bicycle availability' (73%). The sample of 736 units was consequently reduced to 537, since 37 persons declared they do not know how to cycle and 162 persons declared they do not have access to a bicycle. Their given answers on cycling frequency and self-efficacy were either missing or, where present, they were biasing the analysis.

Data Analysis

The selected variables from the TRANSBICI survey were analysed with the statistical techniques of Exploratory Factor Analysis (EFA) in order to search for underlying factors. All the measures conducted to evaluate test reliability and sampling adequacy allowed us to proceed with the application of the factor analysis.

Principal Axis Factoring (PAF) extraction method was performed through the software SPSS 20 (IBM, 2011). The advantage of PAF is of entailing no distributional assumptions, most appropriate in this case of not-normally distributed data (Costello & Osborne 2005). In fact, the Shapiro–Wilk normality test was applied and showed that data are not-normally distributed ($W<\alpha$).

To identify the underlying cycling familiarity dimensions using exploratory factor analysis, successive PAF suggested eliminating 5 out of the original set of 14 variables. The variables "Ability to park the bicycle safely for avoiding thefts", "Ability to make frequent bicycle tune-ups in order to keep it in a good state", "Ability to use elements of personal safety", "Ability to plan the route of a trip" and "Ability to interpret road signs and traffic regulations" are excluded from the analysis based on low communality (<0.3), leaving 9 characteristics to test for underlying constructs.

The Kaiser–Meyer–Olkin measure verified a good sampling adequacy for the analysis, KMO = .78, and all KMO values for individual items were > .7, which is well above the acceptable limit of .5 (Field 2009). Bartlett's test of sphericity $\chi^2(36) = 1430.3$, $p < .001$, indicated that correlations between items were sufficiently large for PAF.

The number of factors was obtained through the scree test, jointly used with the Kaiser criterion of computing the eigenvalues for the correlation matrix, to avoid eventual distortions in the results (Fabrigar et al. 1999; Costello & Osborne 2005). Three components had eigenvalues over Kaiser's criterion of 1 and in combination explained 53.4% of the variance. The scree plot was slightly ambiguous and showed inflexions that would justify retaining both 2 and 3 factors. Given the large sample size, and the convergence of the scree plot and Kaiser's criterion on three components, this is the number of components that were retained in the final analysis.

Subsequently, factors are rotated to obtain a simple interpretation and the oblique rotation has been chosen as it permits correlation among factors. In case the factors structure involves orthogonal factors, a successful oblique rotation provides estimations of the correlations among factors that are close to zero and produces a solution quite similar to that obtained by a successful orthogonal rotation (Costello & Osborne 2005). The oblique rotation method Promax was preferred, assuming a certain degree of correlation among factors and allowing for an easier computational process with respect to Direct Oblimin since a large data set is computed (Field 2009).

Table 19 shows the factor loadings after rotation, where the loadings having a score higher than ±0.3, on the 9 variables considered, are highlighted for each factor. The items that cluster on the same factors suggest that factor 1 represents a '*practical ability for commuting use*', factor 2 a '*familiarity with commuting use*', and factor 3 a '*familiarity with non-commuting use*'.

Table 19. Summary of exploratory factor analysis results for the cycling familiarity construct (N= 537)

	Rotated Factor Loadings		
	Factor 1	Factor 2	Factor 3
Item	*Practically able for commuting use*	*Familiar to commuting use*	*Familiar to non-commuting use*
PBCA_GOUPHILL	.70	.07	-.01
PBCA_RIDEINTRAFFIC	.68	-.01	-.01
PBCA_MANEUVERS	.66	.00	-.04
PBCA_FLATTIREFIX	.65	-.06	.10
IH_COMMUTEFREQ@	.00	.87	-.03
IH_HISTORYYEARS	.00	.72	-.10
IH_SHOPPFREQ@	.02	.54	.22
IH_LEISUREFREQ@	-.08	.02	.95
IH_SPORTFREQ@	.13	-.06	.62
Eigenvalues	3.34	1.67	1.08
% of variance	32.2	13.3	7.9
α	.75	.64	.74

The first factor is named '*Practically able for commuting use*' because it refers to some of the specific skills required for cycling in an everyday settings, expressed by judgments regarding the respondent's perceived ability to perform a specific task: that is the ability to go uphill and overcome slopes, to ride bicycle in car traffic, to manoeuvre the bicycle safely or to fix a flat tire on a bicycle wheel. Similar loadings among the four variables are computed, indicating a similar contribution to factor definition.

The second factor is the one that most interests us for the subsequent analysis to be performed in order to explore the association between cycling familiarity and cycling consideration. It is labelled '*Familiar with commuting use*' because presents high loadings on the three different elements initially hypothesised to be related to the familiarity for commuting by bicycle: the cycling frequency for commuting; the individual history of cycling for commuting; and the cycling frequency for other utilitarian purposes like is shopping, making arrangements, going to the doctor, visiting, etc. The result gives support to the methodological construction pursuit so far, although it is just a first step.

The third factor is labelled '*Familiar with non-commuting use*' since the variables with high scores on it are leisure frequency and sport frequency. The fact this set of two variables displays very low loadings on the other two factors, and particularly on the '*Familiar with commuting use*' factor, lead us to support the hypothesis of two distinct underlying dimensions for the cycling familiarity construct. Cycling familiarity, as a measure of the real and the perceived relative intensity of use of a bicycle, may be differently formed for utilitarian or non-utilitarian purposes. The process of gaining a certain level of acquaintance with the mode is then, as hypothesised, assumed to be related to the amount of time, the intensity and the regularity an individual spends in using a bicycle, but it is distinctly formed for the two distinct categories of purposes: the utilitarian and the non-utilitarian purposes.

To validate this first exploratory step, the factor analysis was carried out on the whole sample and on two different random subsamples (half of the total sample). It has been interesting to observe that a strong stability of the factor selection was referred to the same three factors for the 9 variable set. In each case, the same sets of variables constitute the identified factors, adding solidity to the analysis (Morales Vallejo 2012).

Lastly, a reliability analysis is conducted. The '*practical ability for commuting use*', '*familiarity with commuting use*' and '*familiarity with non-commuting use*' subscales of the familiarity construct all had acceptable reliabilities, all with Cronbach's α >.64 (see Table 19).

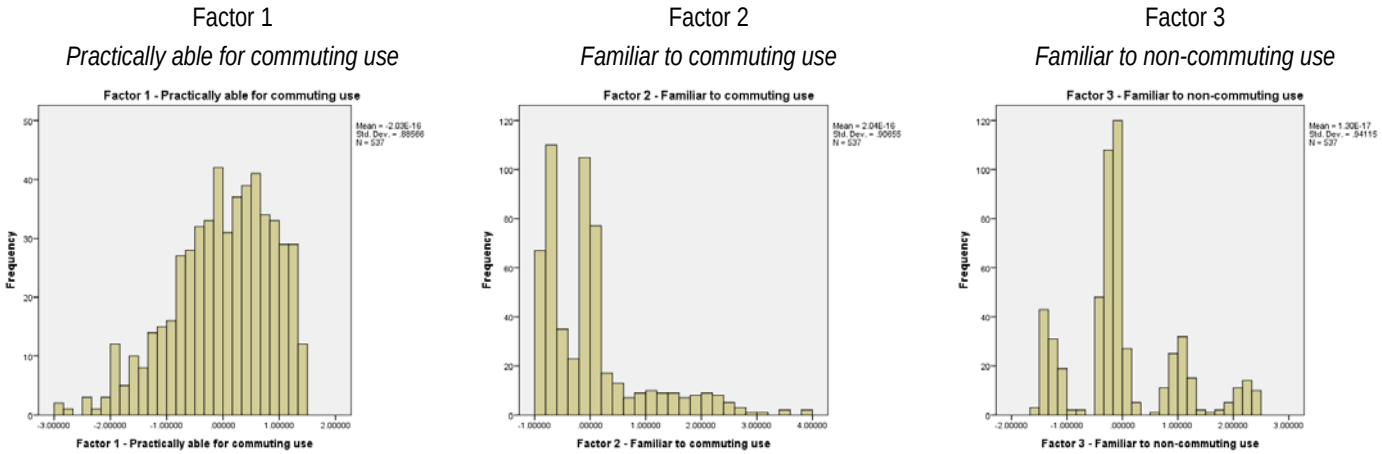


Figure 57. Frequencies of resulting scores for the three factors obtained for cycling familiarity

The identification of the three factors allowed to compute a composite score for each individual on the particular factor identified. This consents to segment the sample based on score's values and then to allow for the successive analyses on the association between cycling familiarity and cycling consideration. The score for each individual was calculated as the factorial score following the regression method. This technique for producing factor scores ensures that the resulting scores have a mean of 0 and a variance equal to the squared multiple correlation between the estimated factor scores and the true factor values (Field 2009). Figure 57 shows frequencies for the resulting variables containing a score for each individual.

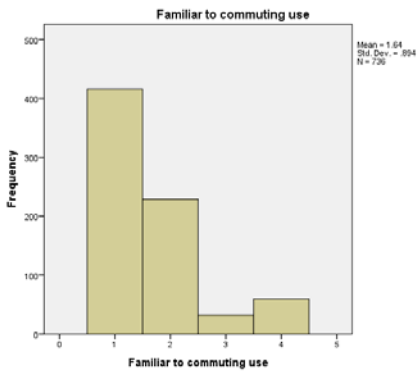
The measure for the first factor is a continuous variable with a negatively skewed distribution, while the other two variables clearly show a discrete character originated from the set of the original variables that compose the factors. It is therefore convenient to perform a binning of the score values in order to identify clear levels of cycling familiarity which can only be measured on an ordinal level. The binning procedure returns for both variables 4 levels (similarly to the frequencies in the original variables that compose the factors) which are labelled as follows: 1 - Not familiar; 2 - Barely familiar; 3 - Moderately familiar; 4 - Fully familiar.

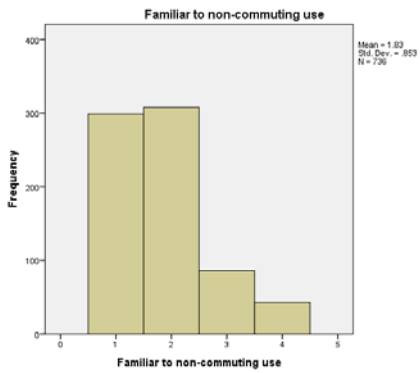
The new variables containing the binned measures define each respondent by her level of cycling familiarity, distinctly for commuting and non-commuting use. The lowest level of cycling familiarity (1=not familiar) has been assigned to those respondents who were excluded from the previous EFA, either because they do not know how to cycle or because they do not have access to a bicycle, since by definition their intensity, regularity and level of acquaintance in using a bicycle is low. Table 20 gives the descriptive statistics for the new variables obtained from the factor analysis as measures of cycling familiarity for the whole sample.

Table 20. Descriptive statistics for variables obtained from the factor analysis as measures of cycling familiarity (N= 736).

	Factor 2		*Factor 3*	
	Familiar to commuting use		*Familiar to non-commuting use*	
Mean	1.64		1.83	
Median	1.00		2.00	
Mode	1		2	
Std. Deviation	.894		.853	
Variance	.800		.728	
Values	*Frequency*	*%*	*Frequency*	*%*
1 - Not familiar	416	56.5	299	40.6
2 - Barely familiar	229	31.1	308	41.8
3 - Moderately familiar	32	4.3	86	11.7
4 - Fully familiar	59	8.0	43	5.8
Total	736	100.0	736	100.0

Frequencies





The analysis carried out with EFA has allowed to identify three measures of the wide construct of cycling familiarity hypothesised in this thesis. Two of them relate directly to how cycling is *practised* individually, either for utilitarian or non-utilitarian purposes. A third one, '*practical ability for commuting use*' is indirectly related to cycling familiarity, as it reflects the skills an individual has gained through the life course which potentially enable him/her to cycle for commuting but they may be frozen since they may have been not practised recently. So we can refer to this measure as a potential familiarity with the general act of urban cycling.

6 Analysis of results

6.1 Mode familiarity as a segmentation criteria

The two measures of mode familiarity as defined in the previous section are now analysed in relation to a set of socio-economic variables (gender, age, level of education, and distance) in order to verify their ability to segment the sample gathered and to allow further analysis on the assumed associations. Firstly, the measures for familiarity to non-commuting use are analysed, then those for familiarity to commuting use. In both cases, Pearson's chi-square tests were conducted to explore the relationship between each pair of categorical variables.

In terms of *cycling familiarity to non-commuting use* there were 41% not familiar, 42% barely familiar, 12% moderately familiar, and 6% fully familiar (see Figure 58). The measure refers to the non-commuting components of cycling familiarity, then we can say that 60% of the commuting population of Vitoria-Gasteiz has at least a minimum level of familiarity with cycling for leisure and sport purposes.

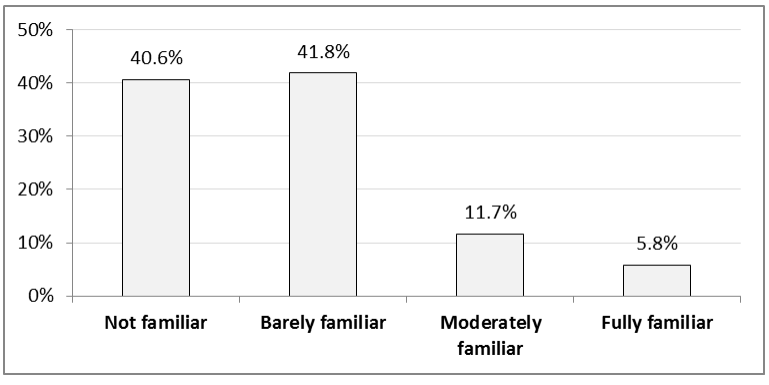


Figure 58. Sample segmentation by cycling familiarity to non-commuting use (N=736)

Table 21 shows gender, age, level of education, and distance variables in relation to cycling familiarity to non-commuting use. A chi-square analysis revealed a significant association between gender and cycling familiarity to non-commuting use (χ^2 (3) = 48.3, p<.001). This association reflects the tendency

for females to be less familiar with cycling than men (i.e. less likely to be fully familiar with the practice of cycling), supporting what has been discussed in Section 4.3.1 in relation to this as one of the characteristics of a 'low cycling context'.

Table 21. Demographic variables by level of familiarity to non-commuting use (N=736)

	Familiarity to non-commuting use									
	Not familiar		Barely familiar		Moderately familiar		Fully familiar		Total	
	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)
Total	40.6%	(299)	41.8%	(308)	11.7%	(86)	5.8%	(43)	100.0%	(736)
Gender										
Female	26.1%	(192)	22.1%	(163)	3.5%	(26)	1.4%	(10)	53.1%	(391)
Male	14.5%	(107)	19.7%	(145)	8.2%	(60)	4.5%	(33)	46.9%	(345)
Age										
16-24 years	5.3%	(39)	8.2%	(60)	3.9%	(29)	3.0%	(22)	20.4%	(150)
25-34 years	11.1%	(82)	12.4%	(91)	2.7%	(20)	1.0%	(7)	27.2%	(200)
35-44 years	11.1%	(82)	13.0%	(96)	2.9%	(21)	0.8%	(6)	27.9%	(205)
45-54 years	9.1%	(67)	6.3%	(46)	1.5%	(11)	0.7%	(5)	17.5%	(129)
55-64 years	3.9%	(29)	2.0%	(15)	0.7%	(5)	0.4%	(3)	7.1%	(52)
Study level										
Low	9.4%	(69)	7.2%	(53)	3.3%	(24)	2.2%	(16)	22.0%	(162)
Medium	21.5%	(158)	23.2%	(171)	6.0%	(44)	2.4%	(18)	53.1%	(391)
High	9.8%	(72)	11.4%	(84)	2.4%	(18)	1.2%	(9)	24.9%	(183)
Distance										
<= 1.5 Km	11.0%	(81)	9.8%	(72)	3.4%	(25)	1.8%	(13)	26.0%	(191)
1.5 - 5 Km	23.1%	(170)	24.6%	(181)	6.8%	(50)	3.5%	(26)	58.0%	(427)
5 - 10 Km	5.3%	(39)	4.8%	(35)	0.7%	(5)	0.1%	(1)	10.9%	(80)
> 10 Km	1.2%	(9)	2.7%	(20)	0.8%	(6)	0.4%	(3)	5.2%	(38)

A significant association is also found between cycling familiarity to non-commuting use and age (χ^2 (12) = 55.5, p<.001). Young people result more likely to be fully familiar with the practice of non-commute cycling than older people. This bias is especially evident in the first age group: while people between 16 and 24 years old represent 20% of the commuting population gathered in the sample, they are the majority of the fully familiar segment (51%) and over a third of the moderately familiar one (34%).

There was a relatively even spread of participants across study levels: 22% of a low level, 53% of a medium level (which comprises professional training which in Vitoria-Gasteiz has a high rate), and 25% of a high level. At each end of the cycling familiarity spectrum, differences between level of education were not evident (χ^2 (12) = 18.1, p>.05), then no association is found between cycling familiarity to non-commuting use and study level.

The great majority of the sample (84%) lived within a five kilometres radius from the worksite or the study centre which confirms the compact character of the city. In terms of cycling familiarity to non-

commuting use, no association is found between this measures and commute distance, being the Pearson Chi-Square test not significant (χ^2 (9) = 12.5, p>0.05).

A graphical representation of the relations between gender, age, level of education, and distance variables with the cycling familiarity to non-commuting use measure is shown in Figure 59.

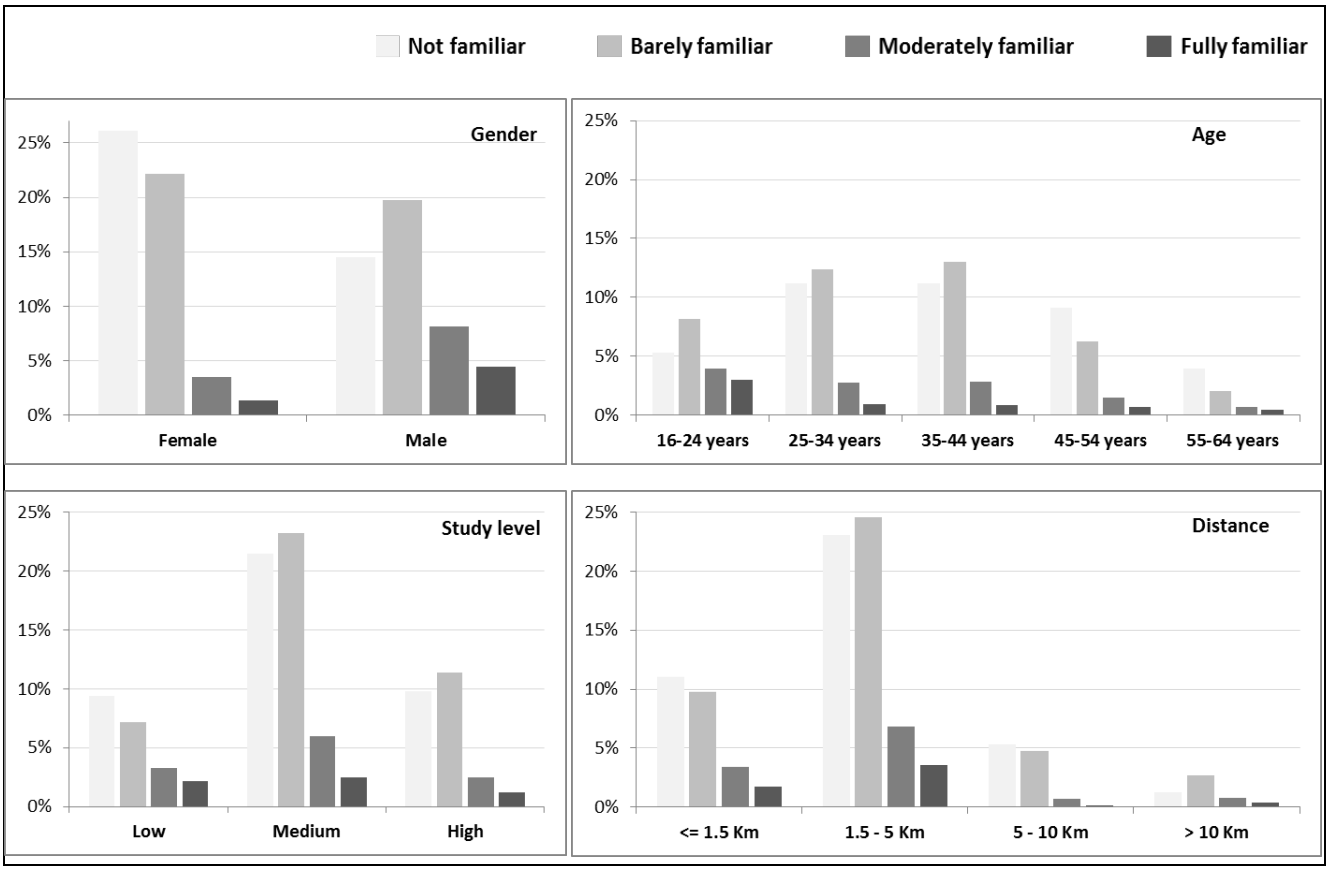


Figure 59. Demographic characteristics by level of familiarity to non-commuting use (N=736)

More interesting for the scopes of this thesis is the measure of *cycling familiarity to commuting use*. In terms of this measure, there were 56% not familiar, 31% barely familiar, 4% moderately familiar, and 8% fully familiar (see Figure 60). The measure refers to the commuting and utilitarian components of cycling familiarity, then we can say that in this case the share of the commuting population of Vitoria-Gasteiz which has at least a minimum level of familiarity with cycling commuting purposes stands almost 20 points below the same measure for non-commuting purposes (43%).

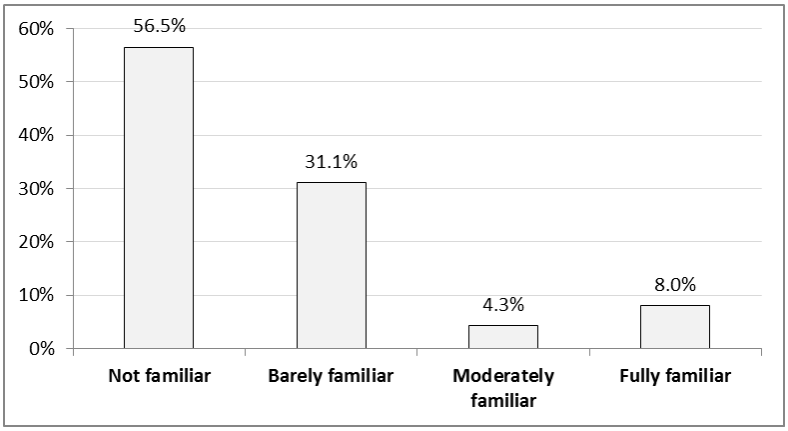


Figure 60. Sample segmentation by cycling familiarity to commuting use (N=736)

Similarly as seen above, Table 22 shows gender, age, level of education, and distance variables in relation to cycling familiarity to commuting use. A chi-square analysis revealed a significant association between gender and cycling familiarity to commuting use (χ^2 (3) = 35.5, p<.001). This association reflects the tendency for females to be less familiar with cycling than men (i.e. less likely to be fully familiar with the practice of cycling), supporting what has been discussed in Section 4.3.1 in relation to this as one of the characteristics of a 'low cycling context'.

Table 22. Demographic variables by level of familiarity to commuting use (N=736)

	Familiarity to commuting use									
	Not familiar		Barely familiar		Moderately familiar		Fully familiar		Total	
	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)
Total	56.5%	(416)	31.1%	(229)	4.3%	(32)	8.0%	(59)	100.0%	(736)
Gender										
Female	34.0%	(250)	15.6%	(115)	1.9%	(14)	1.6%	(12)	53.1%	(391)
Male	22.6%	(166)	15.5%	(114)	2.4%	(18)	6.4%	(47)	46.9%	(345)
Age										
16-24 years	9.4%	(69)	5.6%	(41)	1.2%	(9)	4.2%	(31)	20.4%	(150)
25-34 years	14.0%	(103)	10.3%	(76)	1.5%	(11)	1.4%	(10)	27.2%	(200)
35-44 years	16.8%	(124)	8.7%	(64)	1.0%	(7)	1.4%	(10)	27.9%	(205)
45-54 years	11.1%	(82)	4.8%	(35)	0.7%	(5)	1.0%	(7)	17.5%	(129)
55-64 years	5.2%	(38)	1.8%	(13)	0.0%	(0)	0.1%	(1)	7.1%	(52)
Study level										
Low	12.5%	(92)	6.4%	(47)	0.8%	(6)	2.3%	(17)	22.0%	(162)
Medium	31.3%	(230)	15.9%	(117)	2.2%	(16)	3.8%	(28)	53.1%	(391)
High	12.8%	(94)	8.8%	(65)	1.4%	(10)	1.9%	(14)	24.9%	(183)
Distance										
<= 1.5 Km	15.6%	(115)	6.9%	(51)	1.0%	(7)	2.4%	(18)	26.0%	(191)
1.5 - 5 Km	28.5%	(210)	20.8%	(153)	3.3%	(24)	5.4%	(40)	58.0%	(427)
5 - 10 Km	7.7%	(57)	2.9%	(21)	0.1%	(1)	0.1%	(1)	10.9%	(80)
> 10 Km	4.6%	(34)	0.5%	(4)	0.0%	(0)	0.0%	(0)	5.2%	(38)

A significant association is also found between cycling familiarity to commuting use and age (χ^2 (12) = 55.6, p<.001). Young people result more likely to be fully familiar with the practice of commute cycling than older people. This bias is especially evident in the first age group: while people between 16 and 24 years old represent 20% of the commuting population gathered in the sample, they are

the majority of the fully familiar segment (53%) and almost a third of the moderately familiar one (28%).

Also in this case, no association is found between cycling familiarity to commuting use and study level (χ^2 (12) = 8.3, p>.05), indicating that cycling familiarity seems a character not linked to this socio-economic aspect.

Opposite to what results above for non-commuting use, in terms of cycling familiarity to commuting use a significant association is found between this measures and commute distance (χ^2 (9) = 39.2, p<.001). This result is indicating that such measure of familiarity is influenced by distance since those who live further away are less likely to be fully familiar with the practice of commute cycling than those who have a shorter commute distance.

A graphical representation of the relations between gender, age, level of education, and distance variables with the cycling familiarity to commuting use measure is shown in Figure 61.

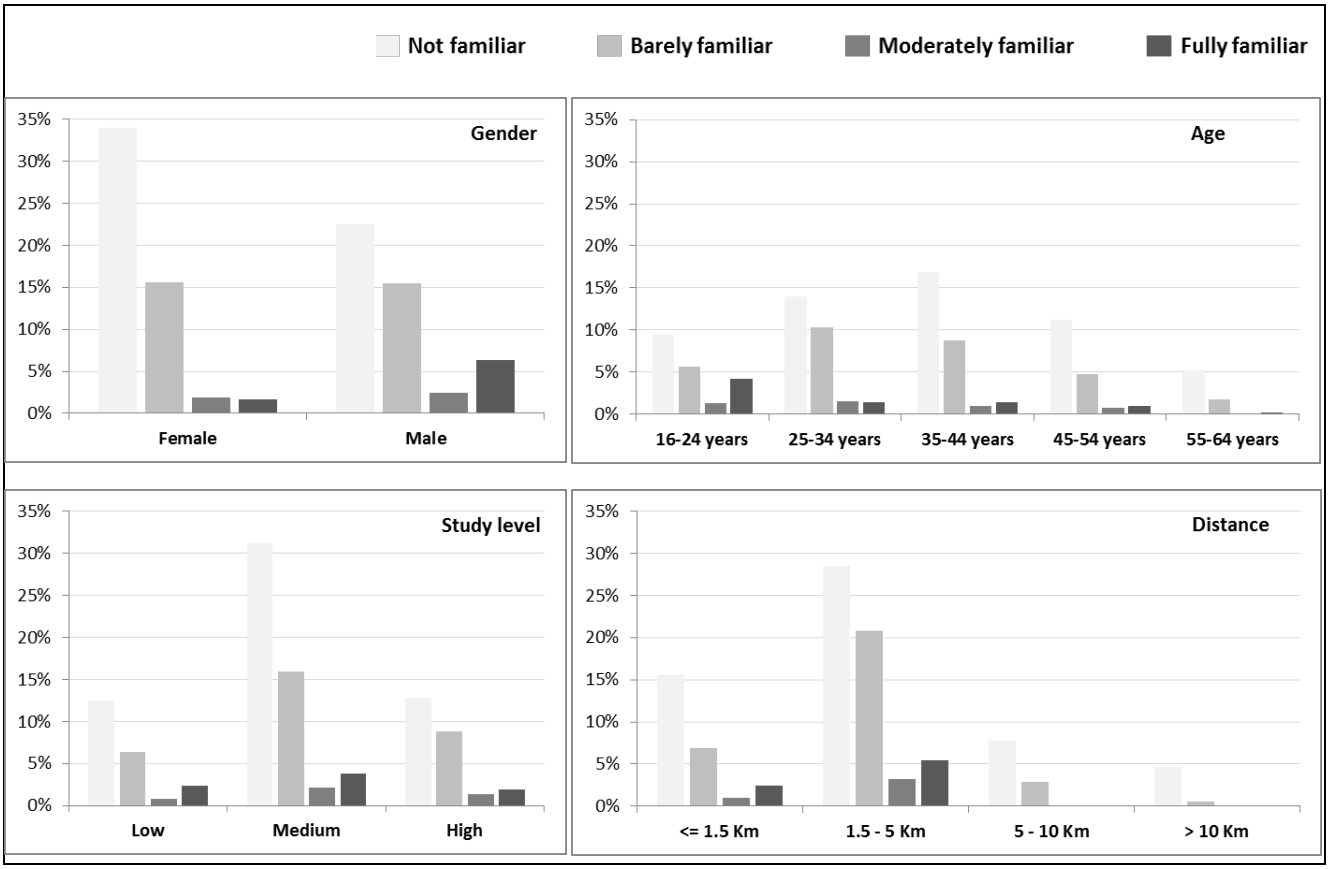


Figure 61. Demographic characteristics by level of familiarity to commuting use (N=736)

The cycling familiarity construct defined and measured until now allows to assign to each participant a specific level of a measure which results useful to better understanding the underlying elements of how cycling is practised in a definite context. This measure is then useful as a segmentation criteria which allows the exploration of the relationship between the same measure and that of cycling

consideration, in search of the hypothesised associations, pursuing what have been set as Objective 2. Those results are discussed in next section.

6.2 The association between mode familiarity and cycling consideration

With the aim of exploring the possible downstream relationships that the hypothesised construct of cycling familiarity may have in shaping or informing what has been called as 'mode consideration' – and specifically, 'cycling consideration'–, **Research Objective 2** was defined as the exploration of the association between the two measures set in Section 5.3. Such exploration is carried out by looking for: **2.a)** the differences in cycling consideration indicators according to levels of cycling familiarity; and **2.b)** the possible measure of such association. The following two sections describe the results of each of these two related analytical effort.

6.2.1 Differences in cycling consideration indicators according to levels of cycling familiarity

Looking at each measure of cycling familiarity separately, it is possible to discern if there are differences in cycling consideration indicators according to levels of cycling familiarity (Objective 2.a). Firstly, the measures for *Familiarity to non-commuting use* were analysed, and then those for *Familiarity to commuting use*. In both cases, one-way between-groups analyses of variance (ANOVA) were conducted to explore the impact of cycling familiarity levels on measures of consideration of cycling, as delineated in Section 5.3.1 ('*Green & Smart*', '*Difficult & Unsafe*', '*Pleasant & Suited*', and '*Efficient*'). Subjects were divided into four groups according to their level of cycling familiarity, as measured in Section 5.3.2 and in the previous descriptive analysis ('*Not familiar*', '*Barely familiar*', '*Moderately familiar*', '*Fully familiar*').

Table 23 shows differences in cycling consideration measures according to levels of cycling familiarity to non-commuting use. At the significance level of 95% ($p < 0.05$) differences are statistically significant for all the 4 measures between the second and the third level of cycling familiarity (*Barely* vs. *Moderately familiar*). Differences also exists between the first and the second level of cycling familiarity (*Not* vs. *Barely familiar*) for 3 out of the 4 measures. If, in order to protect against Type I errors, significance level is set at 99% ($p < 0.01$), differences still exist at the first shift for *P&S* and *E* measures and at the second shift for *D&U* and *P&S* measures. In such cases, post hoc Scheffe test confirm that significant differences on how people consider cycling exists among certain levels of cycling familiarity to non-commuting use.

Table 23. ANOVA for differences in cycling consideration indicators according to levels of cycling familiarity to non-commuting use (N=736)

Factor	*Group*	*N*	*Mean*	*Std. Deviation*	*Std. Error*	*Post hoc contrast*	*Difference of means*	*Std. Error*	*F = t²*	*df*	*Sig. (1-tailed)*
Green & Smart G&S	Not familiar	299	5.8238	.92996	.05378	Not vs. Barely familiar	-.1010	.07186	1.977	732.0	.080
	Barely familiar	308	5.9249	.85484	.04871	*Barely vs. Moderately familiar*	*-.1964**	*.10795*	*3.310*	*732.0*	*.035*
	Moderately fam.	86	6.1213	.84932	.09158	Moderately vs. Fully familiar	.1495	.16531	.818	732.0	.183
	Fully familiar	43	5.9718	.84611	.12903						
	Total	736	5.9095	.88812	.03274						
Difficult & Unsafe D&U	Not familiar	299	4.6742	.93876	.05429	*Not vs. Barely familiar*	*.1525**	*.07532*	*4.102*	*732*	*.022*
	Barely familiar	308	4.5216	.91011	.05186	***Barely vs. Moderately familiar***	***.4273*****	***.11314***	***14.260***	***732***	***.000***
	Moderately fam.	86	4.0944	.94373	.10176	Moderately vs. Fully familiar	.2306	.17327	1.771	732	.092
	Fully familiar	43	3.8638	.94320	.14384						
	Total	736	4.4952	.95528	.03521						
Pleasant & Suited P&S	Not familiar	299	4.3316	1.02664	.05937	*Not vs. Barely familiar*	*-.2122***	*.07687*	*7.624*	*732*	*.003*
	Barely familiar	308	4.5438	.88612	.05049	*Barely vs. Moderately familiar*	*-.3760***	*.11547*	*10.604*	*732*	*.001*
	Moderately fam.	86	4.9199	.88755	.09571	Moderately vs. Fully familiar	-.1275	.17684	.520	732	.236
	Fully familiar	43	5.0473	.90087	.13738						
	Total	736	4.5310	.97073	.03578						
Efficient E (§)	Not familiar	299	4.9825	1.23261	.07128	*Not vs. Barely familiar*	*-.2709***	*.09556*	*8.038*	*595.3*	*.002*
	Barely familiar	308	5.2534	1.11680	.06364	*Barely vs. Moderately familiar*	*-.2942**	*.13827*	*4.528*	*134.1*	*.018*
	Moderately fam.	86	5.5476	1.13836	.12275	Moderately vs. Fully familiar	-.0072	.20633	.001	87.6	.486
	Fully familiar	43	5.5548	1.08747	.16584						
	Total	736	5.1953	1.18166	.04356						

Note: df = degrees of freedom, F = ANOVA score, Post hoc = Scheffe or Games-Howell test with a significance value set at significance level of * = $p < 0.05$ or ** = $p < 0.01$,
§ = Levene's test for homogeneity of variance has been violated ($p < 0.05$) so the Brown-Forsythe test (adjusted F and residual degrees of freedom) has been used instead.

Since the hypothesised effect of cycling familiarity on cycling consideration is directional, all test conducted are one-tailed. For a visual interpretation of results, the differences for levels of cycling familiarity to non-commuting use are showed in Figure 62. According to the analysis, except the consideration of cycling as Green & Smart (attitudes on those benefits are fairly shared throughout the sample with a statistical significant difference on the second shift), differences constantly exist for the other three measures of cycling consideration at $p < 0.05$. Both for the first shift, between '*Not familiar*' and '*Barely familiar*', and for the second shift, between '*Barely familiar*' and '*Moderately familiar*', people with those different level of cycling familiarity differently assess cycling characteristics, i.e. they consider cycling in a different way according to their level of cycling familiarity to non-commuting use. No differences were found between the third and the forth level of cycling familiarity to non-commuting use.

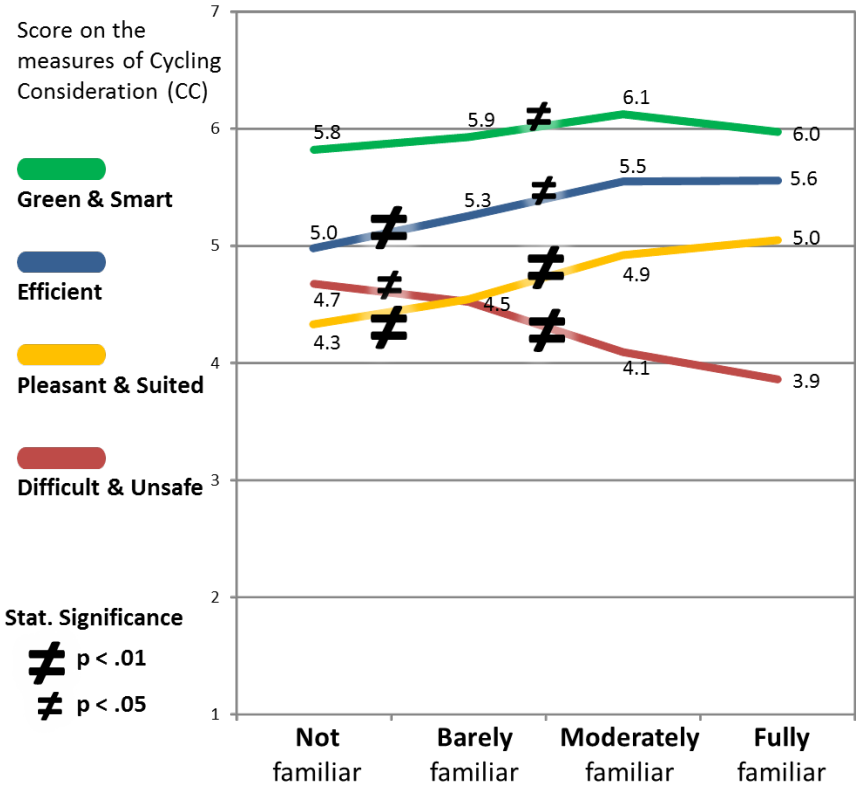


Figure 62. Differences in cycling consideration indicators according to levels of cycling familiarity to non-commuting use

The analysis would suggest reducing the stages of cycling familiarity to only three levels, being no differences between the third and the fourth level. Nevertheless, the presence of four levels is justified by the analysis of the measures for Familiarity to commuting use, showed as follows.

ANOVA measures for Familiarity to commuting use are exhibited in Table 24 and group means as well as significant differences are graphically showed in Figure 63. In this case the differences across the several levels of cycling familiarity are found more pronounced than those found above.

At the significance level of 95% ($p < 0.05$), statistically significant differences were always found between the first and the second level of cycling familiarity (first shift) for all of the 4 measures of cycling consideration. At this significance level, also between the second and the third level (second shift) differences exists for all the measures. Between the third and the fourth level (third shift) they exists for the measure of '*Difficult & Unsafe*'. The latter result indicates that attitudes on weakness of cycling are NOT shared throughout the sample and that for the specificity of the commuting use different forms of familiarity may be hypothesised.

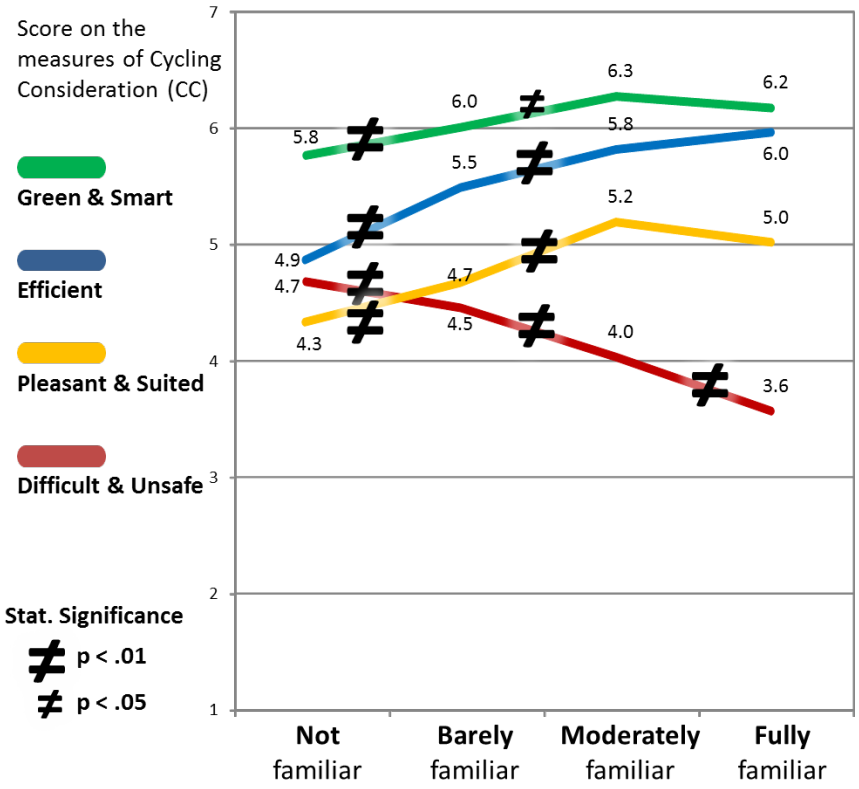


Figure 63. Differences in cycling consideration indicators according to levels of cycling familiarity to commuting use

Respondents who were defined as *not familiar* to the practical uses of cycling rate all the four cycling consideration measures taken into account (G&S, E, P&S, D&U) distinctly than those who have been identified as *barely familiar*, indicating a threshold between inherently distinct stages of cycling familiarity. People belonging to the category of *barely familiar* have only a little level of familiarity more than those who have been identified as *not familiar*, for example by stating their use of a bicycle for shopping or for doing some errands, even if that use has been declared as occurring 'sometimes' instead of 'never' stated by the first group. Using a bicycle sometimes for such practical purposes, as opposed as not using it at all, is then associated to significant higher scores in the three positive factors (G&S, E, P&S), while it is associated to significant lower scores in the cycling consideration measure associated with the negative characteristics of cycling commuting (D&U).

Table 24. ANOVA for differences in cycling consideration indicators according to levels of cycling familiarity to commuting use (N=736)

Factor	*Group*	*N*	*Mean*	*Std. Deviation*	*Std. Error*	*Post hoc contrast*	*Difference of means*	*Std. Error*	*F = t²*	*df*	*Sig. (1-tailed)*
Green & Smart G&S (§)	Not familiar	416	5.7798	.94983	.04657	*Not vs. Barely familiar*	*-.2408 ***	*.07034*	*11.718*	*541.5*	*.000*
	Barely familiar	229	6.0206	.79780	.05272	*Barely vs. Moderately familiar*	*-.2674 **	*.11390*	*5.510*	*49.7*	*.011*
	Moderately fam.	32	6.2879	.57114	.10096	Moderately vs. Fully familiar	.1003	.13889	.521	77.9	.236
	Fully familiar	59	6.1877	.73263	.09538						
	Total	736	5.9095	.88812	.03274						
Difficult & Unsafe D&U	Not familiar	416	4.6845	.93061	.04563	*Not vs. Barely familiar*	*.2280 ***	*.07433*	*9.412*	*732*	*.001*
	Barely familiar	229	4.4565	.87337	.05771	*Barely vs. Moderately familiar*	*.4271 ***	*.17048*	*6.275*	*732*	*.006*
	Moderately fam.	32	4.0295	.76643	.13549	*Moderately vs. Fully familiar*	*.4663 ***	*.19831*	*5.528*	*732*	*.009*
	Fully familiar	59	3.5632	.88817	.11563						
	Total	736	4.4952	.95528	.03521						
Pleasant & Suited P&S	Not familiar	416	4.3323	.99401	.04874	*Not vs. Barely familiar*	*-.3403 ***	*.07714*	*19.464*	*732*	*.000*
	Barely familiar	229	4.6726	.87363	.05773	*Barely vs. Moderately familiar*	*-.5238 ***	*.17692*	*8.765*	*732*	*.002*
	Moderately fam.	32	5.1964	.82719	.14623	Moderately vs. Fully familiar	.1758	.20581	.730	732	.197
	Fully familiar	59	5.0206	.80951	.10539						
	Total	736	4.5310	.97073	.03578						
Efficient E (§)	Not familiar	416	4.8690	1.28623	.06306	*Not vs. Barely familiar*	*-.6292 ***	*.08687*	*52.457*	*605.9*	*.000*
	Barely familiar	229	5.4982	.90413	.05975	*Barely vs. Moderately familiar*	*-.3291 ***	*.12952*	*6.458*	*49.5*	*.007*
	Moderately fam.	32	5.8274	.65008	.11492	Moderately vs. Fully familiar	-.1500	.14431	1.081	65.4	.151
	Fully familiar	59	5.9774	.67043	.08728						
	Total	736	5.1953	1.18166	.04356						

Note: df = degrees of freedom, F = ANOVA score, Post hoc = Scheffe or Games-Howell test with a significance value set at significance level of * = p < 0.05 or ** = p < 0.01,
§ = Levene's test for homogeneity of variance has been violated (p < 0.05) so the Brown-Forsythe test (adjusted F and residual degrees of freedom) has been used instead.

Also in this case, in order to protect against Type I errors, significance level may be raised at 99% ($p < 0.01$). Doing so, statistical significant differences still exist between the first and the second level of cycling familiarity to commuting use for all the 4 measures, and between the second and the third level for 3 out of 4 measures, excluding *G&S*. Post hoc Scheffe or Games-Howell tests demonstrated that consistently people at the lower levels of cycling familiarity consider lower the positive aspects of cycling and conversely they exhibit higher concerns towards negative characteristics than those individuals more familiar in cycle commuting. And the presence of a statistical significant difference also at this level of significance between the third and the fourth level (third shift) for the measure of '*Difficult & Unsafe*' confirms that beliefs on weakness of cycling are NOT shared throughout the sample and that four distinct levels of familiarity may be hypothesised for the specificity of the commuting use.

6.2.2 A measure of the association between measures of cycling consideration and cycling familiarity

In order to estimate the extent of the association between the four measures of cycling consideration and the two measures of cycling familiarity (Objective 2.b), for each pair of relations a Spearman's rank correlation test was carried out. The reason of choosing a nonparametric test for assessing the statistical dependence between the variables is because the data (especially for the cycling familiarity measures) have violated parametric assumptions such as non-normally distribution. Still, the test is appropriate for both continuous and discrete variables, including ordinal variables as the cycling familiarity measures are. Table 25 provide the ρ (rho) value for each relations.

Table 25. Spearman's rank correlation coefficients (ρ) for each pair of relations between measures of cycling consideration and cycling familiarity (N=736)

	Green & Smart	*Difficult & Unsafe*	*Pleasant & Suited*	*Efficient*
Familiar to non-commuting use	.08*	-.22**	.22**	.17**
Familiar to commuting use	.16**	-.32**	.26**	.33**

* = Correlation is significant at the 0.05 level (1-tailed)
** = Correlation is significant at the 0.01 level (1-tailed)
ρ > .3 highlighted in bold

There were significant relationships between the two measures of cycling familiarity and all the scores obtained for the cycling consideration measure. To protect against Type I errors, significance level has been set at 99% ($p < 0.01$) and, since the hypothesis of familiarity influencing consideration is directional, a one-tailed test was selected. At this significance level, 7 out of the 8 relationships

results significant, although following Cohen's criteria (Cohen 1988) for 5 of them the size effect of the relationship is only small.

A medium effect was found for the association between familiarity to commuting use and the consideration of cycling as being '*Difficult & Unsafe*' (ρ = -.32, p <.001) and '*Efficient*' (ρ = .33, p <.001). We cannot say much for interpreting the effect size of these results because of the explorative character of this research, then with no references in the context of the research literature.

A possible way to interpret the results is through the using of Odds Ratios as an alternative measure of the effect size for the association between cycling familiarity and cycling consideration. For doing so, respondents were classified with a dichotomous variable according to their level of cycling consideration for all the four factors taken into account. Those who displayed a score above the sample mean on all the factors (below the mean for '*Difficult & Unsafe*', being its meaning inverted) were classified as '*Considering cycling for commuting*' (C), otherwise they were classified as '*Not considering cycling for commuting*' (N). A similar dichotomisation was carried out on the cycling familiarity to commuting use measure, giving to respondents who were considered as '*Moderately*' or '*Fully familiar*' a value of '*Higher levels of cycling familiarity*' (HF), while to the '*Not*' or '*Barely familiar*' a value of '*Lower levels of cycling familiarity*' (LF). A contingency table for the two variables is showed in Table 26.

Table 26. Number of respondents according to their cycling familiarity for commuting use and cycling consideration status

		Cycling consideration status		Total
		N (not considering cycling for commuting)	C (considering cycling for commuting)	
Cycling familiarity status	LF (lower levels of cycling familiarity)	568	77	645
	HF (higher levels of cycling familiarity)	53	38	91
Total		621	115	736

There was a significant association between the cycling familiarity status and whether or not respondents would consider cycling for commuting, χ^2 (1) = 53.8, p <.001. This seems to represent the fact that, based on the odds ratio, the odds of considering cycling were .19 for people having lower levels of cycling familiarity. Saying it in other ways, the odds of considering cycling if people displayed lower levels of cycling familiarity were 5.29 times lower than if they had higher levels. The result seems to indicate that higher levels of cycling consideration have a low probability to be associated with lower levels of familiarity, and the same seems to occur for the opposite: the likelihood of the association between lower levels of cycling consideration and higher levels of familiarity present the same value of OR = .19.

These results give a hint for answering Research Question 2 formulated in Chapter 3 (see Section 3.1.1). The assumed hypotheses are that being familiar to commuting use affects the way a person consider the difficulties and the fear associated with urban cycling (it lowers their perceptions) and also the way a person consider the efficient character of a bicycle as a mode for commuting (it rises its perception). Establishing a global threshold of cycling consideration on the entire set of factors taken into account, the association seems occurring as well, having the odds ratio for the opposite situation a low likelihood, more than 5 times lower than the one hypothesised.

Nevertheless, having measured the strength of these associations does not give any indication of the direction of causality between the two measures. Such measures do not resolve the question on whether is the fact that people positively consider cycling the reason for them to cycle or is the fact that they do cycle the reason for them to positively consider cycling. A third-variable, either measured or unmeasured, may affect the results or, even if it is not the case, no indication can be obtained from the analysis about which variable causes the other to change. So, although it is intuitively appealing to conclude that an increase in cycling familiarity causes people to have more positives beliefs and attitudes toward cycling, there is no statistical reason why this relation had the assumed direction.

6.3 Additional elements for the measuring of the cycling familiarity construct and the extension of the proposed conceptual framework

With the aim of extending the proposed conceptual framework for the understanding of the cycling consideration problem, **Research Objective 1** also anticipates the exploration of the role that higher than individual ecological layers may have on the measurement of cycling familiarity, hypothesising which may be the elements for its measurement. This section describe the results of applying the proposed conceptual framework to the case study of Vitoria-Gasteiz.

As declared in Chapter 3, questions on the origin and consequently the building of the cycling familiarity construct from higher ecological layers are not addressed by this thesis at an *empirical level*, because of methodological limitations which forced to restrict the scope of current investigation (see Section 3.2.3, page 69). However, insights on the constitutive elements of mode familiarity may be generated at a *heuristic level* from the application of the conceptual framework proposed. The heuristic results of such a work may constitute a preliminary step to develop a path of future research, including empirical studies, geared at providing further answers to the questions posed by this thesis. That advancement will be discussed in Section 7.4.

Based on the recent research developments discussed in Section 2.1.3, in Chapter 3 the construct of cycling familiarity was defined at the individual, social and physical level. Its measurement was consequently assumed to include components measured at those three distinct ecological layers, comprising:

- measures of how cycling is practised individually
- measures of how cycling is practised around the individual
- measures of how cycling is fostered by elements of the physical environment

Figure 64 schematically illustrates the contribution each layer, synthesising the linkages already outlined in Figure 22, Figure 23 and Figure 24 showed in Chapter 3.

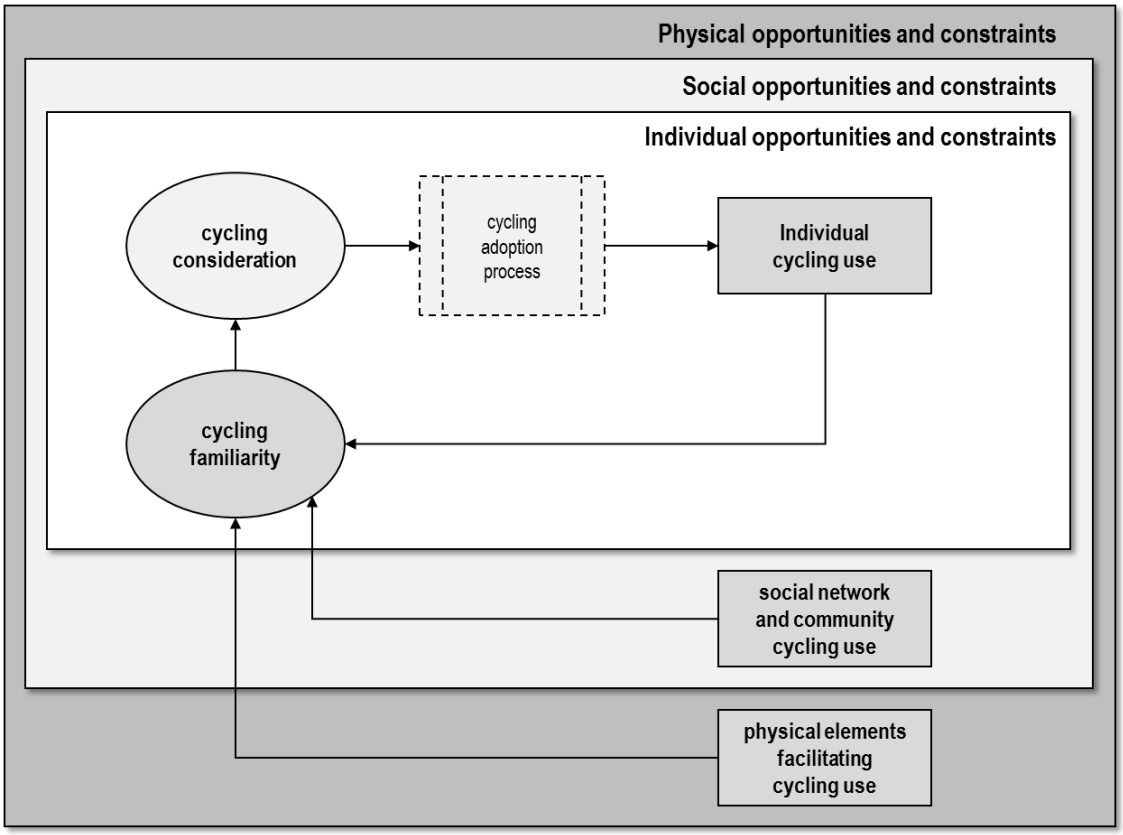


Figure 64. Influences of cycling familiarity at three distinct ecological layers

Bearing in mind that Objective 1, besides the building of a conceptual framework, is also focused at allowing the development of a methodology for the measuring of the cycling familiarity construct, attention is now geared at examining how such higher ecological layers may be integrated in the measuring of the construct of cycling familiarity.

A concern, though, refers to the scope of current research and the motivations which generated it. The problem of the recursive cycle of cycling consideration posed in Chapter 1 is inherently related to the so called 'low-cycling contexts', as they were defined in the introductory chapter. The inclusion

of components of the social and the environmental domains should therefore be applied in a low-cycling context as Vitoria-Gasteiz is. By doing so, two consequences are expected:

- Since individuals in the same context share almost the same common circumstances regarding the social and the environmental domains regarding their cycling practices or their views of those practices (as seen in Section 4.3.2 and as results from the qualitative stage of the research), the potential sources of variability from the inclusion of higher layer components for a sample taken from the same context would be (almost) null for the majority of the population[18].
- Since in low-cycling contexts there are few cyclists, little infrastructure and a marginal cycling culture, any additional element measured at the social and the environmental domains would consequently decrease the level of individual cycling familiarity, such it has been defined.

The combination of these two expected consequences has a relevant heuristic relevance in the light of the general aims of the thesis, i.e. disentangling the problem of recursive cycle of cycling consideration. Together, those consequences lead to opt for considering only measures at the individual level as components of cycling familiarity. In fact, a hypothetical cycling familiarity measures including also higher level components for each individual would have the following features:

a) the relative weight of higher level components would presumably take the main part in the measuring because of the theoretical definition given to cycling familiarity;
b) at the same time, the effect of such higher level components would presumably be similar for the whole sample.

In such a situation, the variability of such measures at the individual level would be necessarily lower than a measure based on solely individual components, but at the same time, their influence on cycling consideration (Objective 2) would be higher, implying consequently a much bigger challenge for the interpretation of results presented in previous section.

Discarding the inclusion of higher levels in the measuring of the cycling familiarity construct has therefore a motivation that arises from research strategy concerns. In fact, being a 'low-cycling context' the object of the study and being cycling consideration and cycling familiarity both concepts hold at the individual level, the inclusion of measures giving a small source of variability at the individual level is useless for tackling the problem posed.

But also on theoretical grounds the discarding has relevant motivations. In fact, if evidence on the role of cycling familiarity on cycling consideration can be found even at the individual level (that is, Research Questions 1 and 2 are answered solely with components taken at the individual-level), an

[18] The statement refers to the shared views of cycling among the majority of the urban population, without diminishing the distinct practices of specific social groups, made of actions, meanings, values, rules, artefacts and competences, which may be very different in a same cultural context (Aldred 2013; Daley & Rissel 2011; Steinbach et al. 2011). For an analysis of the cultural context of cycling in Spain refer to Fernández-Heredia, Fernández López, et al. (2014).

even stronger role may be hypothesised if higher ecological layers are included in the measuring of cycling familiarity, since it is assumed they have a stronger effect. The latter can only be hypothesised as a conjecture because no empirical support is provided in the context of current investigation, but whether adequate methodological efforts were attempted, the resulting evidence would lead to a more solid support of the theoretical framework proposed. In conclusion, this reasoning may be an indirect answer to the first of the Discussion Questions posed in Section 3.1.2, leading to quit further discussion for Objective 1, leaving the task to further investigate such relationships to future research, as discussed in Section 7.4.

Different should be the reasoning on methodological grounds. The inclusion of higher levels in the measuring of the cycling familiarity construct would be essential in the case of a cross-sectional comparative study across distinct places in terms of 'cycling context' in order to identify key factors associated with higher levels of transport cycling (Handy et al. 2014). Likewise, higher levels components would also be necessary in the case of longitudinal studies that measure cycling conditions before and after the implementation of specific strategies (Forsyth et al. 2009; Handy et al. 2014) in order to account for the changes occurred over time. In such cases, the variability of a measure of cycling familiarity would rely mainly on those higher levels and would be useful to extend the scope of cycling familiarity as an antecedent of cycling consideration. Unfortunately, due to the intrinsic limitation of current research (see Section 3.2.3, page 69), those methodological approaches cannot be taken and the theoretical framework proposed can only rely on previous theoretical insights.

6.4 Methodological proposal for the measuring of the cycling familiarity construct

The research conducted so far allows us to make a methodological proposal for the measuring of the cycling familiarity construct, which could be used in future works in the context of the conceptual framework provided. As a result of an exploratory work, the measure still lack of sufficient internal and external validity, consistency and reliability, even for a field of applied social science like the one of this research (Campbell 1986). Nonetheless, replication of the measure in future works and in distinct context would provide valuable insights on the potential role of the new construct to disentangle the problem of cycling (or alternative mode) consideration as defined in Chapter 1.

The construct of *cycling familiarity* is hypothesised in the relationship between behaviour and the set of constructs that are supposed to precede it. Cycling familiarity is conceived as a measure of the real

and the perceived relative intensity of use of a bicycle, which may be differently formed for commuting or non-commuting purposes. The construct is assumed to be related to the amount of time, the intensity and the regularity an individual spends in using a bicycle for the two distinct categories of purposes, gaining in this way a certain level of acquaintance with the mode. Such acquaintance is consequently purpose-specific and it can be distinguished between what has been called 'cycling familiarity to commuting use' and 'cycling familiarity to non-commuting use'. The construct has also a dimension which refers to the ability to perform some basic tasks in the practice of cycling, i.e. referring to the competences a person has got to perceive herself able to carry out a commuting trip by this mode of transportation.

The measures of cycling familiarity have been defined making use of exploratory factor analysis (Section 5.3.2). Dimensions of *cycling familiarity* were measured on two distinct ordinal variables (whether based on the commuting or non-commuting use) comprising four stages from 'not' to 'fully' familiar:

- *0 - not familiar*;
- *1 - barely familiar*;
- *2 - moderately familiar*;
- *3 - fully familiar*.

A third continuous variable measures the '*Competence familiarity*', namely the specific skills required for cycling in an everyday settings. Such measurement is expressed by judgments regarding the respondent's perceived ability to perform the specific act of riding a bicycle in an urban setting: the ability to go uphill and overcome slopes, to ride bicycle in car traffic, to manoeuvre the bicycle safely or to fix a flat tire on a bicycle wheel.

The expression to compute each of the construct measures is as follows:

$$CF_k = \sum_{i=1}^{n} \alpha_i \cdot x_i$$

where x_i is the psychosocial indicator gathered in a survey questionnaire for every one of the constructs k, multiplied by its weight (α_i,) as detailed in Table 27. The result value should be successively shifted to the range 0 to 3 and rounded to integer in order to range from 'not' to 'fully' familiar.

Table 27. Components for the three proposed measures of cycling familiarity

Measure	*Item name (x)*	*Weight (α)*	*Description*	*Type and range of values*
CF_U - Familiarity to utilitarian use			*Construct variable for "Familiarity to utilitarian use" built with the following items:*	
	COMMUTEFREQ	.87	How often have you ridden a bicycle in the last year for travelling to your workplace or study centre?	Ordinal; ranging from 0 to 3 (Never < Occasionally < Almost always < Always)
	HISTORYYEARS	.72	Nº of years commuting by bicycle	Scale; >= 0
	SHOPPFREQ	.54	How often have you ridden a bicycle in the last year to make arrangements, go to the doctor, shopping, visits…?	Ordinal; ranging from 0 to 3 (Never < Occasionally < Almost always < Always)
CF_{NU} - Familiarity to non-utilitarian use			*Construct variable for "Familiarity to non-utilitarian use" built with the following items:*	
	LEISUREFREQ	.95	How often have you ridden a bicycle in the last year for leisure?	Ordinal; ranging from 0 to 3 (Never < Occasionally < Almost always < Always)
	SPORTFREQ	.62	How often have you ridden a bicycle in the last year to practise sport?	
CF_{COMP} - Competence Familiarity			*Construct variable for "Competence Familiarity" built with the following items:*	
			How much would / do you consider yourself able to perform the following tasks?	
	GOUPHILL	.70	- To go uphill and overcome slopes by bicycle	Likert scale (interval) on respondent's perceived ability to perform the specific task, ranging from 0 (Not able) to 6 (Totally able)
	RIDEINTRAFFIC	.68	- To ride your bicycle in car traffic	
	MANEUVERS	.66	- To manoeuvre a bicycle safely	
	FLATTIREFIX	.65	- To fix a flat tire on a bicycle wheel	

The methodological proposal, at the current stage of development, include exclusively psychosocial measures of how cycling is practised individually. As we mentioned above, the proposal may constitute a preliminary step to develop a path of future research, but, as theoretically hypothesised, the mode familiarity construct should also include:

- measures of how cycling is practised around the individual (see Figure 23, p.67);
- measures of how cycling is fostered by elements of the physical environment (see Figure 24, p.68).

as detailed in Section 3.2.3. On one hand, among the elements of how cycling is practised around the individual (at the social level), the measure should include the perception of how much cycling (intensity, frequency and history) is practised among distinct groups of people (family, friends, co-workers/schoolmates, young/older people, public figures, immigrants, etc.) who interact with the individual or who constitute her social and cultural context. On the other hand, among the elements of how cycling is fostered by features of the physical (and institutional) environment, the measure should include the individual perception of physical elements believed to facilitate or foster the practice of cycling; the individual perception of normative features believed to facilitate or foster the practice of cycling; and the individual perception of how much cycling is fostered and facilitated by public bodies and public policies.

A more precise definition of its measures and of the methodological requirements required to better operationalise the suggested construct are needed in order to be useful, for example, within the contexts of travel demand modelling. A statistical modelling effort that would be able to infer the likelihood of cycling based on, not only internal factors (attitudes, norms, self-efficacy) as it is claimed by socio-psychological theories, but also on the base of the cycling familiarity measures –which theoretically are based also on external factors– may be useful to improve the forecasting power of transport models, especially in the case of predicting cycling demand that by definition constitute a new demand in current socio-technical systems of transportation and land use.

7 Discussion and conclusions: the role of mode familiarity

This final chapter intends to sum up the dissertation (Section 7.1), giving a synthesis and discussion of the results in relation to the research questions and the objectives set in Chapter 3. Where relevant, links to existing literature are made and key findings are assembled to be the base for the building of a different theoretical model for the cycling consideration process. That theoretical model is proposed at the light of the theoretical implications presented and discussed along with the policy implications and recommendations generated (Section 7.2). Afterward, the weaknesses and limitations of this thesis are discussed (Section 7.3) followed by the directions for future research (Section 7.4).

7.1 Overview and discussion of results

The thesis has attempted to face (and provide some insights for the disentangling of) the problem of the recursive cycle of cycling consideration. The problem has been defined as the low probability of including cycling in the set of possible options to be considered in the mode choice process when individuals holds negative beliefs and attitudes toward the mode. Such beliefs are assumed to vary with the practice of cycling since people who show more *acquaintance* with its specific characteristics is likely to hold more positive beliefs and attitudes. Nonetheless, in low-cycling contexts the practice of cycling require people to 'go against the grain' (Horton & Parkin 2012) in order to be practised or attempted, with the result that cycling is little practised and that such acquaintance is not formed or enhanced, then limiting the possibility that negative beliefs may be modified.

The problem is neglected by current literature on travel behaviour and mode choice processes because inverse relationships between behaviour and its supposed antecedents are not properly taken into account in the understanding of how people define the decision-making context in which travel mode choices are taken (see Chapter 2 and specifically Section 2.3 where knowledge gaps are identified).

To deal with the problem posed, the thesis hypothesises the presence of a new construct in the relationship between behaviour and the set of constructs that are supposed to precede it, the construct of *cycling familiarity*. Cycling familiarity is conceived as a measure of the real and the perceived relative intensity of use of a bicycle (building upon Diana & Mokhtarian 2009) which may be differently formed for commuting or non-commuting purposes. The construct is assumed to be related to the amount of time, the intensity and the regularity an individual spends in using a bicycle for the two distinct categories of purposes, gaining in this way a certain level of acquaintance with the mode. Such acquaintance is consequently purpose-specific and it can be distinguished between what has been called 'cycling familiarity to commuting use' and 'cycling familiarity to non-commuting use'.

The new construct has been built both theoretically (Section 3.2) and methodologically (Section 5.3), and empirical tools have been employed to get evidence on its role as a mediator in the relationship between cycling use and the formation of beliefs and attitudes toward cycling (Section 6.2). The aim was to explore and look for hints on the nature of a possible and, until now, unknown relationship in order to build a conceptual framework for further research on its understanding. Results of the cross-sectional design instrument employed constitute some initial, although incomplete, answers to the research questions posed.

Table 28. Synthesis of results for both research questions and their relevancy

Research Questions	*Results*	*Relevancy*
RQ1. Are there differences in cycling consideration indicators according to levels of cycling familiarity?	Yes, consistently people at the lower levels of cycling familiarity have a lower consideration of the positive aspects of cycling and conversely they exhibit higher concerns towards the negative characteristics than those individuals more familiar in cycle commuting.	The possibility that higher levels of cycling use for utilitarian purposes may lead to more positive levels of cycling consideration opens up to important theory and policy implications
RQ2. Are higher levels of cycling consideration associated with lower levels of familiarity? And, how much likely is such probability to occur?	An association between measures of cycling familiarity to commuting use and cycling consideration exists and seems direct (the more familiarity, the more positive consideration levels) although its size effect is medium. The probability of showing a high consideration level with low levels of cycling familiarity seems very low since the odds of considering cycling if people displayed lower levels of familiarity were 5.29 times lower than if they had higher levels.	The measurement of a medium strength of the association at stake does not lead to any causal relationship but it is a further support for the possibility of the presence of a backward relationship between mode use and mode choice consideration in the case of cycling in a 'low cycling context'.

Table 28 offers a synthetic view of the results obtained for both research questions set in Section 3.1 and the corresponding relevancy for the current knowledge on travel behaviour and mode choice processes. The main contribution to such knowledge lies on the clues these results generate, which give support to some general theoretical statements that are discussed in the next session.

The first question inquired whether differences in levels of cycling consideration exist by distinct stages of cycling familiarity. To respond to this as well as to the remaining questions, measures of both cycling consideration and cycling familiarity were defined making use of exploratory factor analysis (Sections 5.3.1 and 5.3.2).

Four distinct continuous *cycling consideration* measures were created, based on attitude expressions on four underlying factors relating to the cycling commuting behaviour:

- on how cycling commuting is considered *green and smart* (G&S);
- on *its pleasant and suited* character (P&S);
- on its *efficiency* as a mode of transport for commuting (E);
- and on the main drawbacks of its use, namely the *difficulties* implied (sweating and being exposed to adverse weather conditions) *and* the sense of *unsafety* it generates (feeling at risk of accidents and getting stressed by traffic) (D&U).

Dimensions of *cycling familiarity* were measured on two distinct ordinal variables (whether based on the commuting or non-commuting use) comprising four stages from 'not' to 'fully' familiar:

- *not familiar*;
- *barely familiar*;
- *moderately familiar*;
- *fully familiar*.

For each of the four stages of cycling familiarity defined, statistical significant differences were found, especially for the measure related to the commuting use. Consistently, people at the lower levels of cycling familiarity have a lower consideration of the positive aspects of cycling and conversely they exhibit higher concerns towards the negative characteristics than those individuals that are more familiar in cycle commuting. Using a bicycle occasionally for practical purposes, as opposed to not using it at all, seems associated to significant higher scores in the three positive factors (G&S, E, P&S) while it appears to be associated to significant lower scores in the factor relating with the negative characteristics of cycling commuting (D&U). A same pattern also occurs with a moderate use, as opposed to an occasional one, especially for the consideration of the negative characteristics. The results are in line with previous literature based on similar variables (e.g. de Geus et al. 2008; Stinson & Bhat 2003; Stinson & Bhat 2004; Hunt & Abraham 2006; and van Bekkum et al. 2011a, among others), but in this study the differences are observed in a low-cycling context and derive from an analysis of the entire population of commuters, which rises the reliability of results.

The possibility that higher levels of cycling use for utilitarian purposes may lead to more positive levels of cycling consideration opens up to important theory and policy implications discussed in the next two section (Sections 7.2.1 and 7.2.2).

The second question referred to the strength of the association between measures of cycling familiarity and cycling consideration. Since both of the constructs are measured on not validated scales, the degree of the association had to rely on relative measures referred to the extremes of the scales used. Specifically, we were wondering whether higher levels of cycling consideration were associated with lower levels of familiarity and whether such probability could be quantified.

Before doing so, rank correlation coefficients were calculated for each pair of relations between measures of cycling consideration and cycling familiarity. As expected and similarly to what resulted previously, looking at the differences in levels of cycling consideration by stages of cycling familiarity, also in this case measures of the associations were more pronounced for cycling familiarity to commuting use than to non-commuting use. Associations result to exist in all cases and seems direct, that is to say that the more familiarity, the more positive consideration levels. However, the size effects ranged from .16 to .33, then they can be considered as a small to medium effect size if referred to Cohen's criteria (Cohen 1988). Particularly interesting is the fact that effect sizes are stronger for the efficiency character of cycling commuting (E) and for its drawbacks (D&U) which are the element that most characterise the distinction between the familiarity linked to commuting use from the familiarity associated to non-commuting use. Is in those dimensions of cycling consideration that a stronger role of cycling familiarity may be hypothesised.

Turning to the main scope of the second research question, the results revealed a very low probability of showing higher consideration levels in presence of low levels of cycling familiarity since the odds of considering cycling if people displayed lower levels of familiarity were 5.29 times lower than if they had higher levels. The results suggest that being familiar to the particularities, the skills and the competences related to how cycling is practised individually for commuting or other utilitarian purposes (shopping, making arrangements, going to the doctor, visiting, etc.) has a certain influence on how the specific characters of cycling behaviour are considered, raising more questions which will be discussed in the section dedicated to further research (Section 7.4). In fact, the measurement of a medium strength of the association at stake does not lead to any causal relationship but it is a further support for the possibility of the presence of a backward relationship between mode use and mode choice consideration in the case of cycling in a 'low cycling context'.

Table 29. Synthesis of outcomes for the discussion questions and their research perspectives

Discussion questions	*Discussion outcomes*	*Research perspectives*
Are higher levels of familiarity likely to be reached if cycling is practised with low levels of intensities and low extensiveness across individual life courses? *How are opportunities 'to familiarise' with alternative modes created?* *Are such opportunities created in similar ways for all the modes?* *Are they 'sufficiently' and 'properly' created for cycling in order to let individuals 'tasting a different behaviour' and gaining a minimum threshold of cycling familiarity?* *Are such opportunities accessible and 'choosable' at the individual level?* *How could those opportunities be influenced and enhanced by policy tools?*	At a heuristic level, reasoning would lead to give a negative answer to the first of such questions because of the hypothesised role of influences at higher ecological levels. Following an ecological perspective and the rationale of socio-technical systems dynamics (Urry 2004; Geels 2005; Geels 2012; Marletto 2014), it is conceivable that the opportunities 'to familiarise' with alternative modes –especially cycling– would be generated and shaped by the current system of mobility/accessibility. Empirical evidence for this questions has to be reached in further research.	The possibility that evidence on the role of cycling familiarity on cycling consideration can be found even at the individual level opens up to the possibility of its stronger role if higher ecological layers are included in the measuring of cycling familiarity

The additional questions posed by this dissertation did not have a research objective associated, but were a stimulus for discussion on the conceptual framework proposed. They regarded the origins of the cycling familiarity construct and measures, wondering whether all sources of cycling familiarity are to be found inside the individual level or if additional sources may be found outside the individual level of influence. Main aim of the questions was the exploration of the role that distinct ecological layers may have on the measurement of cycling familiarity through asking whether the opportunities and constraints 'to familiarise' with cycling are generated only by the individual choice or whether they may also derive from the social and the physical environment. For this type of questions, empirical evidence has to be reached in further research, following the guide of the conceptual framework proposed. Yet, at a heuristic level, reasoning would lead to give a negative answer to the first of those questions because of the hypothesised role of influences at higher ecological levels. In fact, the inclusion of higher level components in cycling familiarity measures would have a substantial weight, making negligible the role of individual sources. The latter is due to the fact that, in low-cycling contexts, the same fact that there are few cyclists, little infrastructure and a marginal cycling culture are the main reasons for individuals to not practising cycling for utilitarian purposes, consequently those same higher components are the sources of a lack of individual cycling familiarity. The possibility that evidence on the role of cycling familiarity on cycling consideration can be found even at the individual level, without any consideration of higher ecological levels, opens up to the possibility of its stronger role if those components are included in the measuring of cycling familiarity.

Table 29 offers a synthetic view of the outcomes derived from the additional discussion questions set in Section 3.1 and the corresponding perspectives that such outcomes generate, either for theoretical and empirical research, both discussed in the next sessions.

7.2 Implications and recommendations

7.2.1 Implications for theory

Some general theoretical statements may arise from the results obtained in this thesis and discussed in previous section. The main one is that the findings provide a general level of support for the presence of feedback mechanisms between cycling behaviour and its assumed determinants like preferences or attitudes, as hypothesised in other works (van Acker et al. 2010; Handy et al. 2014). To the author's knowledge no studies had been carried out to empirically explore such relationships and this thesis is a first endeavour on such supposition. The effort has many limitations that are identified and discussed in Section 7.3, but this initial work may open a worthwhile line of further research in this sense, as discussed in Section 7.4.

Yet, what is relevant at the theoretical level is the possibility that behaviour may not be mainly determined by attitudes and intentions, as prevalent theoretical frameworks claim. The assumption of a strong one-way attitude-behaviour relationship may not be completely valid, at least for the behaviour of utilitarian cycling. In fact, attitudes toward cycling may be 'inferred' from past behaviour and more generally from the way people practise the act of cycling. The latter has also quite different policy implications which are discussed in the next session.

The hypothesised feedback mechanisms may act through the mediation of the new construct of cycling familiarity which allows to deal with two of the limitations of conventional approaches.

On the one hand, being conceived as an antecedent of beliefs and attitudes, cycling familiarity enables a new prospective approach to explore the process of their formation, permitting to account for the social and the environmental domains as higher level of influence on the individual level (Handy et al. 2014). This possibility is aligned with some recent studies that have qualitatively investigated how attitudes toward cycling are formed, exploring the role of past incident experiences (A. Lee et al. 2012) and of childhood experiences (Underwood et al. 2014).

On the other hand, as mentioned, cycling familiarity consents to conceptualise those backward relationships that challenge conventional understandings of travel behaviour and mode choice processes, allowing for a broader view that comprises *embodiment* of behaviours and habits. In fact, following some recent developing in cultural sociology and human geography (Sheller & Urry 2006;

Thrift 2008), the new thinking about socio-technical transitions in innovation studies (Geels 2012) and the linkages between these theoretical developments (Watson 2012), behaviour change my be better conceptualised if human behaviour is understood as part of a so called 'body-mind-world assemblage', as proposed by Schwanen et al. (2012) in their theoretical work about transport habits:

> *"As embodied beings, humans participate in and make sense of the world in ways that are predominantly practical, unreflective and habitual; reflection and intelligibility come from sensuous experience and practice rather than the reverse"*
>
> (Schwanen et al. 2012, p.524)

In such understandings, attitudes and beliefs are displaced from the central role they assumed in conventional frameworks in favour of a more decentred and distributed scheme of influences that allows for the existence of a positive conception of habits, as "pre-reflective embodied intelligence" (Schwanen et al. 2012, p.525) that are much more open to alteration and change than the scheme proposed by psychological theories. Is what people sensuously experience and practise in their 'body-mind-world assemblage' the leverage that allows for gradual recombination of new elements, then for integration of new habits that are congruent with and facilitate the desired behaviour and that "takes temporal and ontological precedence" over beliefs and attitudes.

Those approaches allow also for a different understanding of the problem of a possible recursive cycle of cycling consideration: individual beliefs and attitudes, from being considered 'determinants' that have to be modified in order to allow changes in behaviour through the mediation of intentions and individual choice, become less paramount to produce behaviour change since they come to change as a consequence of changing formal and informal 'customs' (collective habits held at the social and institutional level). Based on Deweyan ideas, those approaches conceive and envisage the materialisation of behaviour change by the conceptualisation of individuals' habits as "*embodied dispositions* and *abilities to act in particular ways*" (Schwanen et al. 2012, p.526). The construct of cycling familiarity conceptualised by this thesis is congruent with those theoretical approaches and constitutes an empirical effort along such line of research.

On the base of these theoretical insights, the problem posed in Chapter 1 and schematically represented in Figure 2, may be reconfigured as depicted in Figure 65.

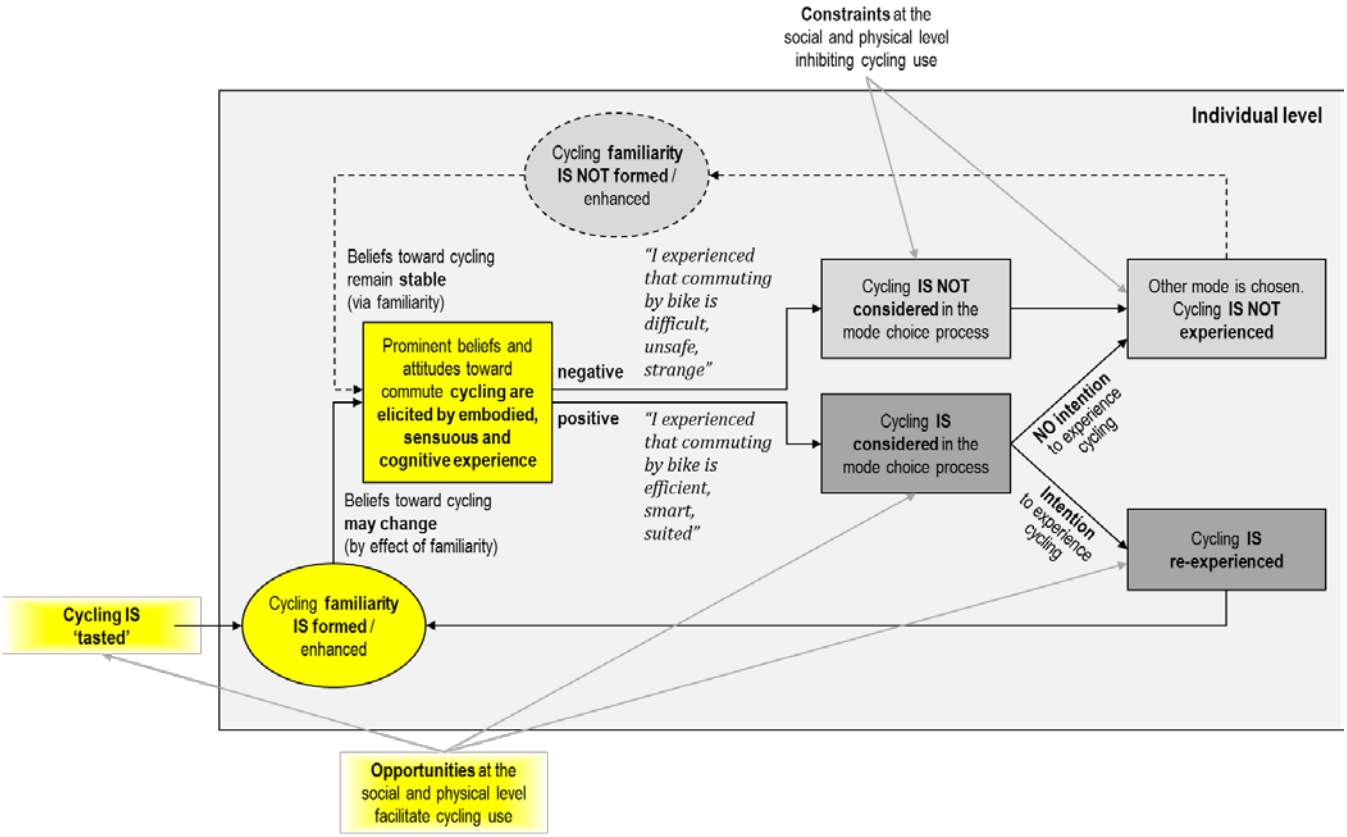


Figure 65. New conceptualisation of the recursive cycle of cycling consideration at the light of research's insights

Prominent beliefs and attitudes toward commute cycling are not just supposed to be originated by individual and household characteristics, by personal traits or by other elements pertaining to the individual sphere. They may be elicited by embodied, sensuous and cognitive experience through the act of 'trying out' a new behaviour, 'tasting' its features and functioning. By effect of generated environmental or cultural cues –i.e. making the 'behaviour tasting' accessible, feasible and attractive– or through spontaneous individual attempts, the act of tasting can encourage practices previously not included in the set of possibility considered for travelling or commuting. The 'behaviour tasting' may allow people to 'familiarise' with cycling, introducing new sensuous, emotional and cognitive elements that may reconfigure the 'body-mind-world assemblage' on which propensities and/or preferences are intertwined.

Consequently, cycling familiarity may not depend only on the opportunities and constraints hold at the individual level (propensity to cycle, riding skills and competences, bicycle availability, time budget, etc.) but also on opportunities and constraints set at higher levels, at the social (cultural, organisational and institutional) and the physical (material) ecological layers. Those opportunities are generated and fostered by policy action and are discussed in the following section.

7.2.2 Implications and recommendations for policy

Although behaviour change in the field of urban transport is the guiding motivation of this thesis, its development has been rather theoretically driven than policy orientated. Yet, insights and recommendations for policy makers and practitioners are possible, based on both the heuristic thinking and the empirical research carried out and on their relationship with the problem posed in Chapter 1. In fact, the problem posed by this thesis stems from concerns about the effectiveness of the strategies commonly taken to promote cycling, especially in the so called 'low cycling contexts'.

The results for the first two research questions suggest the possibility that higher levels of cycling use for utilitarian purposes (i.e. higher levels of cycling familiarity) may lead to more positive levels of cycling consideration. Such a possibility would imply that, if behaviour may also influence attitudes, the focus of strategies should not be put primarily on changing attitudes (i.e. providing information) but it should also consider a direct action on behaviour itself. An example taken from Lyons et al. (2008) may help elucidate this point. A person may begin driving because it is popular (social norms) or because it is easy for him to use a car (perceived ability) and may subsequently infer that driving is a good thing (an attitude). In the latter case, the behaviour preceded the attitude (Eagly & Chaiken 1993). This implies that active measures to encourage people to 'try out' a new behaviour may be able to induce positive attitudes subsequently (Lyons et al. 2008). If the same example is translated to the behaviour of commute cycling instead of driving a car, policies should focus on making cycling popular and/or making it easy to carry out or at least to 'try out', therefore to enable what can be called 'behaviour tasting'. Tasting a new behaviour which was previously unknown may generate new experiences that subsequently may lead to a recombination of cognitive elements previously based on pre-experience beliefs.

Another example based on empirical data may further elucidate this point. In a recent study conducted in the United States, Burbidge (2012) observed how experience living in a foreign country does impact the travel behaviour and transportation perceptions of U.S. residents upon their return to the United States. Her analysis revealed that individuals who have lived abroad do exhibit a significant change in travel behaviour upon returning to the United States. Although it appears that this change in behaviour upon their return to the U.S. may be a regression to the mean –manifested by individuals adopting travel behaviour similar to the transportation culture of their domestic environment– the observation concurs to the hypothesis stated in this research. In fact, if an individual's experience living abroad results in a change in attitudes, perceptions and (eventually) travel behaviour upon his return to the home country, it would be logical to infer that travel behaviour is not a mechanic effect of some precedents attitudes and that providing the right environmental or cultural cues –i.e. giving to individuals the opportunity to form or enhance a previously unknown familiarity with a specific mode– can encourage the uptake of a behavioural change previously not considered.

Enabling the opportunities for 'behaviour tasting' –and therefore for 'cycling familiarity forming'– requires action at different ecological, organizational and spatial levels which may range from easy

to implement policy initiatives to more integral and holistic behaviour change agendas aimed at transforming the fundamental pillars of current transportation systems. Three sets of policy recommendation may be identified based on previous implications.

First, in line with the recommendations of much of the policy driven literature on cycling promotion (Parkin, Ryley, et al. 2007; Pucher & Buehler 2008; Forsyth & Krizek 2010), there is a need to create a 'tasting' environment where sensuous experience and embodiment with the practice of cycling may be carried out by people, especially by young people and children, without feeling that they are exposed to undue risk (Pooley et al. 2013). This seems to be a *sine qua non* condition for every promotion strategy aspiring to be successful and effective in attracting new cycling users (Handy et al. 2014). However, the means to produce such a 'tasting' environment, sufficiently safe and at the same time sufficiently useful for utilitarian use for as many new users as possible, differs among researchers and policy makers. This is not the place to enter the debate on how a safe built environment is best reached, whether by means of fully segregated cycleways or by means of the removal of sources of danger for cyclists and pedestrians. The dispute is effectively described and discussed by Horton (2007) who, in identifying *fear* as the essential cognitive and emotional element which underlies most of the common consideration of cycling, especially in low cycling contexts, reveals how such element is *socially constructed* through a number of policy initiatives. Measures such as road safety campaigns, cycle helmet campaigns and segregation of cyclists from cars, which focus on presenting cycling on the roads as unsafe and placing the onus of responsibility on cyclists as opposed to car drivers, have often obtained the backlash outcome of reinforcing fear and further consolidating the image of cycling as a risky behaviour, not feasible to be included in the set of options to be considered for commuting or other utilitarian trips. Consequently, producing the expected effect of keeping new potential users away from regular cycling, and also away from 'tasting' cycling and gaining cycling familiarity. Adopting a pragmatic and progressive approach, such an environment which could enable the 'tasting' of the practice of utilitarian cycling may be easily obtained through the implementation of the so called 'ciclovías', a temporary closure of roads to motor vehicle traffic firstly introduced in Bogotá, Colombia, and allowing big masses of people to 'taste' cycling in a protected but familiar environment (Pucher et al. 2010). Such initiatives may be extended on regular bases since their cost is not even comparable to infrastructure building and are an effective way to make people with low levels of familiarity to experiment, try out, 'taste' for the first time a behaviour previously not included in their set of options to be considered for travelling or commuting. Although it cannot be considered a policy initiative in a strict sense, another way of fostering cycling 'tasting' has been the phenomenon of 'critical mass', which in many cities has functioned as a facilitator of opportunities to experience urban cycling for the first time for large numbers of people, acting as a trigger for new cycling practices (for more details see Rondinella 2004).

Rising on the ease of implementation scale previously mentioned, a second set of initiatives aimed at creating a 'tasting' environment for developing and enhancing cycling familiarity may be based on regulative measures and programs that expand the 'exposure' to cycling to as many people as

possible. Besides the common communication campaigns which only act of provision of information without altering the embodied, sensorial and cognitive grounds of individuals, possible initiatives to enable 'tasting' for large numbers of people include alterations to the driving test. Changes may be introduced to place more emphasis on the vulnerability of other road users and even requiring new drivers to spend some time on a bicycle (Pooley et al. 2013). Such changes could be implemented relatively easily by national governments and are almost cost-free. Other possible initiatives along this line include programs designed to increase bicycling skills and knowledge of bicycling laws in schools and other educational agencies. The recommendation of placing more attention at educational and training efforts than is currently the case concurs with previous research (Forward 2014; Nkurunziza, Zuidgeest, Brussel, et al. 2012; de Geus et al. 2008) which shows that merely providing cycling infrastructure, –such as cycleways– is apparently insufficient to prompt a mode change toward cycling (Giles-Corti & Donovan 2002; Wardman et al. 2007). Encouraging cycling 'tasting' in urban settings may be achieved also through a broad range of measures: training programs in real traffic conditions; easy access to bikes, including the introduction of public bike services; provision of free bikes for company employees; tax incentives for bicycle commuting managed by firms and companies; tax rebates on bicycles purchase; the integration of bicycle into the public transport system with informational, regulatory and pricing measures aimed at favouring the mixed use of bicycle and public transport services.

Nevertheless, the encouragement of cycling 'tasting' and the eventual forming or enhancing of what we called cycling familiarity accompanied by a supposed effect on the cycling consideration indicators is unlikely to generate appreciable changes *per se*. The difficulties of hostile built environments which developed during decades around the prevalence of automobile access to activities and places are likely to remain unaltered even though the best set of the incremental initiatives outlined above is effectively put in place and implemented. More profound and fundamental changes are needed, with policy efforts aimed at modifying and reconfiguring the conditions on which individual practice and deliberation is premised (Schwanen et al. 2012). Following research on socio-technical transitions (Geels 2012; Marletto 2011; Marletto 2014), action is needed adopting a *systemic* approach on the current conglomerate of technologies, infrastructures, regulations, user practices, cultural preferences that have grown around the automobile (the current "socio-technical system of urban mobility", see Urry 2004; Geels 2005; Geels 2012), in which cycling is commonly considered as *difficult* / *unsafe* / *abnormal* (Pooley et al. 2013). The recursive nature of the cycle of cycling consideration feeds stability processes (lock-in) that in the current socio-technical systems of urban mobility impede behavioural change to occur. A durable reconfiguration on those systems should be a coherent objective for a policy agenda aimed at transforming the way people consider cycling in 'low cycling contexts', but this topic override the scope of this thesis, then such considerations are postponed and merely mentioned in the concluding section (see Section 7.5).

7.3 Limitations

The research presented in this dissertation has obtained and discussed original and promising insights regarding the understanding of mode choice processes of cycle commuting. However, it is important to make clear the limits of these findings stemming from both the data collected and the methodology taken.

First, the main limitation of the study come from it being cross-sectional and correlational. It is well understood that the correlation does not imply causation. In other words, the statistical estimates this research obtained do not necessarily indicate that an increase in the hypothesised construct of cycling familiarity causes an increase in the cycling consideration indicators. The causality may lead in the other direction: precisely those individuals who like cycling may practise it more intensively and extensively through the life course, then gaining more experience and more familiarity. Only longitudinal and/or experimental designs can provide a more definite answers to research questions regarding causality. Although we assumed that cycling familiarity changes would be an influencing factor in driving a higher consideration of cycling in the mode choice processes, alternative explanations cannot be ruled out. The groups corresponding to the four levels of cycling familiarity defined may have differed in ways that resulted from the influence of other variables. Due to the exploratory nature of this study, we were not able to control for other candidates for such alternative explanations, i.e., differences in age, gender, job type, travel distance, frequency of the commuting trip. The results need to be more robust against these factors in order to be generalised. Likewise, it remains possible that other non-measured variables played a confounding role, for example the combination of commuting with other activities like family responsibilities such as transporting children, but these variables were not collected in the survey carried out in Vitoria-Gasteiz.

Second, the data collected were all self-reported, with no objective measures in place. As objective and subjective factors are understood to influence cognitions, it would prove challenging but valuable to supplement self-report data with observational data (van Bekkum 2011). Although this is a common practice in socio-psychological studies and has been an appropriate method to answer the two research questions of this thesis, the self-reported instrument used was not suitable to answer empirically to the questions on the role of higher ecological levels because of no data available. In addition, response sets, such as acquiescence and social desirability, were not taken into account in the building of the two sets of measures built. It is possible that people who responded with a high levels, either in the consideration measures or in the familiarity one, would demonstrate instead some lower levels of them if implicit or unconscious measures were taken (Fazio & Olson 2003) due to social desirability biases regarding cycling and environmental issues. Whereas implicit measures are unsuitable for a large sample because they are based on nonverbal behaviour, an estimation of such social desirability bias would be needed in order to properly answer research questions. However, since the effect of such social desirability bias is supposed to affect only people

who would have shown lower implicit scores, it would be logical to infer that the association measured were stronger, hence giving more support to the hypothesised relationships.

Third, in the measuring of beliefs and the importance attached to them, almost the same questions were asked to the entire sample[19], disregarding their current commute cycling status or their different stage in the process of change. If the stage model is valid, questions at a further level are non-important for people at a previous stages, and so in the reverse way (Bamberg 2013).

7.4 Further research

The promotion of urban cycling is a relatively new area of research in the studies on travel behaviour and mode choice processes, and many gaps in knowledge are recognised (Handy et al. 2014). This thesis has made an effort to bridge some of the gaps identified, especially relating to what has been defined as the 'problem of the recursive cycle of cycling consideration' which particularly affects the 'low cycling contexts', like Spanish and other southern European cities. The research carried out has generated some interesting insights but requires further improvement with a longer time frame and greater resources to be able to produce a robust assessment of the findings. Further research is recommended on the following issues.

The first line of research deals with the main limitation mentioned above. Being cross-sectional and correlational, the analyses carried out could not deepen into the hypothesised backward relationship between cycling use and the set of its assumed determinants, mainly beliefs and attitudes. It has already been observed the weakness of cross-sectional studies in performing causal inferences especially when relationships deal with people's past experiences and events (Chatterjee 2011). The construct of cycling familiarity requires deeper observational information since it deals with a dynamic process that include changes over time and this can only be detected with longitudinal data. In fact, the requirements of causal inference in relationships (association, non-spuriousness, time precedence, evidence of mechanism) are best achieved by longitudinal studies as suggested by Cao et al. (2009). They recommend natural experiments based on interventions as a good basis for longitudinal investigations and such recommendation can be possible with the data collected in Vitoria-Gasteiz, since it has been intended with a longitudinal design in mind.

A second line of further research involves the extension of this study to achieve a deeper understanding into the formation of beliefs and attitudes toward urban cycling (Handy et al. 2010; Heinen et al. 2011; Handy et al. 2014; van Bekkum 2011). The idea that individuals may learn from previous experiences and that components of cycling consideration (lifestyles, beliefs, attitudes and

[19] Only a little transformation in the tense of the questions was made, according if the interviewee was a current cyclists or not.

preferences) are not fixed in time constitutes a further concern which would deserve specific attention still not addressed by current research. The thesis already pointed out how a person needs to have a positive attitude toward a mode of transport in order to try it and to 'taste' the features and the functioning associated to it. Consequently, one of the origin of a positive attitude may derive from the act of trying such particular mode and behaviour. This observation points to the need for an investigation into attitude formation, using qualitative methods capable to detect the nuances of the individual experiences with cycling and with the events in the individual life-course that concurred to his acquaintance and familiarity in using bicycles, along the lines proposed by Life-course perspective especially by Chatterjee et al. (2012; 2013). In this sense a pretest-posttest action study that analysed the changes in cycling consideration occurred by effect of controlled ´tries' of the commuting behaviour (in line with Gatersleben & Appleton 2007) would contribute to such understanding. Further research is also required to determine the type of cycling experience that is most effective in producing changes in attitudes and in other possible elements of the user experience in the complex process of mode decision-making. An opportunity to answer these kind of research questions may be the case study of Madrid, with the recent implementation of the *BiciMad* bike-hire system. Launched on June 23, 2014, the system offers 123 self-service stands for 1,560 electric bicycles and constitutes an excellent and timely initiative that enables the researcher to continue his exploration into the dynamics of familiarity and consideration of cycling as a mode of sustainable urban transportation.

This research work has suggested the existence of the mode familiarity construct and its role in the mode consideration processes. However, the *origins* of this hypothesised construct and the domain of the elements that compose it were only theoretically hypothesised and, by means of heuristic thinking, limited to the individual ecological level. Those results may constitute a preliminary step to develop a path of future research, including empirical studies, geared at providing further development of such construct. A more precise definition of its measures and of the methodological requirements required to better operationalise the suggested construct are needed in order to be useful, for example, within the contexts of travel demand modelling. A statistical modelling effort that would be able to infer the likelihood of cycling based on, not only internal factors (attitudes, norms, self-efficacy) as it is claimed by socio-psychological theories, but also on the base of the cycling familiarity measures –which theoretically are based also on external factors– may be useful to improve the forecasting power of transport models, especially in the case of predicting cycling demand that by definition constitute a new demand in current socio-technical systems of transportation and land use.

7.5 Concluding remarks: considering an unfamiliar mode in a low-cycling context

If the formation of a certain level of acquaintance with a specific mode –what we called cycling familiarity– does matters in order to properly assess the *pros* and *cons* of that mode –what we called cycling consideration– then the process of choosing cycling in current systems of urban mobility would probably be not (entirely) a matter of 'choice' at the individual level, but it would depend (in some extent) on the opportunities that individuals have to acquire that certain level of cycling familiarity. Following an ecological perspective and the rationale of socio-technical systems dynamics (Urry 2004; Geels 2005; Geels 2012; Marletto 2014), it is conceivable that the opportunities 'to familiarise' with alternative modes –especially cycling– would be informed and shaped by the configurations of existent socio-technical systems of transportation and land use (Geels 2004; Rondinella 2007). Those configurations seem to considerably influence the opportunities to form the individual experience regarding a specific mode, cycling in this case. If such statement is supported by evidence to be found in future research guided by the conceptual framework proposed by theis thesis, on those configurations –made not only by physical and environmental characteristics, but also by the socio-cultural environment, the regulatory and policy environment– action is needed, following an ecological model approach. From a policy point of view, that means that goal oriented policies framed at a societal level (planning) should focus on creating structures that make possible for everyone the formation of a certain experience regarding cycling, then removing (or reconsidering the importance of) the logic of 'choice' at an individual level. In our current socio-technical systems of urban transportation that logic looks like a chimera since cycling is a difficult deliberative choice, not valid for everyone, requiring people to 'go against the grain' in order to be practised (Horton & Parkin 2012). In low-cycling countries, that implication could have major reflections to develop more effective behaviour change strategies in relation to car use and cycling.

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ANNEXES

Annex 1. Script of interviews

Outline of the interviews carried out, translated from the original Spanish version

OPENING

1. Presentation of the study (mobility in cities and transportation) and the interviewer.

- *No mention at any time information that could bias the responses of the interviewee, for example, talk about the benefits of cycling on the issue of sustainability, ecology, pollution.*

2. Report of the interview is to be recorded in order to transcribe.

- *Ensure that the information collected will be used only for research purposes.*
- *Tell the interviewee that "if there is something you want not to be recorded, please indicate".*

INTRODUCTION AND GENERAL CHARACTERIZATION

3. The interviewee and his/her movements.

- *Ask questions about the occupation, habits of displacement and the distance travelled by the interviewee.*

4. Rating and perceived mobility problems in the city.

- *Ask questions of inquiry for each problem mentioned (e.g. environmental, congestion, harm economic development, health, go deep)*
- *Evaluation of alternatives to solve problems spontaneously indicated.*

BELIEFS REGARDING CYCLING

5. What do you think about cycling in cities?

6. How are people using the bicycle?

- *Investigate what participant thinks on why people use the bicycle and the profile of the rider (gender, age, economic status, educational level).*

7. What do you think are the most positive (benefits) to travel by bike and less positive ones (disadvantages)?

- *Go deep on beliefs from the responses given.*
- *If there are no answers, turn to ask what benefits would be for him/her, what drawbacks.*

INCENTIVES AND BARRIERS

8. What are the main obstacles to get an increase in everyday cycling in your city?

9. What are the main obstacles for participant's use?

10. What has to happen to raise the use of bicycles in everyday mobility?

11. Do you think you would be encouraged to use it yourself if many people in your neighbourhood and/or job travelled by bike?

CITIES IN TRANSITION
[only for regular cyclists, advocacy group members, managers and politicians, with more technical and/or experiential knowledge]

12. Assessment of specific measures implemented in the city

13. (Current and future optimal routes for cycling trips)

14. Current infrastructures, services and regulation. Strengths, weakness and perspectives

Annex 2. Research materials of the TRANSBICI survey

Recruiting questionnaire

page 1

ENCUESTA PANEL VITORIA-GASTEIZ

Entrevistador _____ Fecha ___ / 03 /2012 Lugar _____

Nº cuestionario _____ Hora ___ : ___ ☐CM ☐TP ☐P ☐B

P1 **¿Cuál es su situación profesional?**

☐2 Ocupado ☐3 Estudiante ☐4 Ambos (trabaja y estudia)

☐1 Menor de 16 años *(no válido)* ☐5 Otras situaciones *(no válido)*

Pensando en sus desplazamientos habituales,

¿Cuántos días a la semana se desplaza a... *Si > 0* → **¿Qué modo de transporte utiliza habitualmente?**

[Si utiliza varios modos de transporte indicar con el que recorre más distancia. Una sola casilla por fila]

	Nº días [0-7]		Coche	Moto	Autobús urbano/ Tranvía	Autobús Inter-urbano	Taxi	Bicicleta	A Pie	Otro
P2 ...su lugar de trabajo?	____	P3	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
P4 ...su lugar de estudio?	____	P5	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8

...y el aparcamiento lo realiza en...

[Si compagina estudios y trabajo, referirse a la actividad que realiza con mayor frecuencia]

P6

☐1 Parking Gratuito Centro Comercial
☐2 Zona Azul/ OTA
☐3 Parking propio
☐4 Parking por horas
☐5 No aparca - dobles filas
☐6 En la calle - libre

P7

☐1 Atada a mobiliario urbano
☐2 Atada a aparca-bicis regulado
☐3 Bajo llave (trastero, deposito, parking)
☐4 Dentro del lugar de trabajo

Pensando en el desplazamiento habitual a su lugar de trabajo/estudios,

¿Puede indicar origen y destino del mismo y su hora aproximada de salida y llegada?

P8 *[Si compagina estudios y trabajo, referirse a la actividad que realiza con mayor frecuencia. Indicar calle y portal aproximativo (ej. "calle de Burgos 20" si Ud. Vive en calle de Burgos 16)]*

Hogar _____ Hora salida ____ : ____ h

Lugar de trabajo/estudios ☐ El mismo de la entrevista, si distinto indicar: _____ Hora llegada ____ : ____ h

page 2

P9 **Sexo** ☐1 Hombre ☐2 Mujer

P10 **Edad** _____ años

P11 **Nacionalidad** ☐1 Estado español ☐2 Otra: _____

P12 **Nº de personas que viven en el hogar** _____ personas

P13 **Situación en la vivienda**
☐1 Padre/Madre → P14 **Si Padre/Madre, ¿tiene hijos menores de 12 años?** ☐1 Sí ☐2 No
☐2 Hijo/a
☐3 Cónyuge o pareja sin hijos (o con estos fuera del hogar)
☐4 Sin lazos familiares (ej. piso compartido)
☐5 Otras situaciones: _____

P15 **Nivel de estudios terminados**
☐1 Ninguno ☐2 EGB/Graduado Escolar ☐3 Bachillerato superior/BUP/COU
☐4 Formación profesional ☐5 Estudios Universitarios ☐9 No indica

Consentimiento para ser contactado 3 veces en la Encuesta Panel telefónica

1ª OLA: marzo 2012
2ª OLA: septiembre 2012
3ª OLA: marzo 2013

De acuerdo con la LEY DE PROTECCIÓN DE DATOS y el código CCI ESOMAR, toda la información que nos facilite en este cuestionario será tratada exclusivamente con fines estadísticos no pudiendo ser utilizada de forma nominal ni facilitada a terceros.

Nombre: _____

Centro trabajo/estudio: *(opcional)* _____

Teléfono 1: ☐ Particular ☐ Trabajo _____ **Hora más adecuada para llamar:** _____

Teléfono 2: *(opcional)* ☐ Particular ☐ Trabajo _____ **Hora más adecuada para llamar:** _____

Correo-e: *(opcional)* _____@_____

Muchas gracias por su colaboración.

Presentation and thank-you letter signed by City Councillor for Mobility and Public Space

(in Euskera and Spanish)

Centro
de Estudios Ambientales

CEA

Ingurugiro
Gaietarako Ikastegia

Jaun/andre agurgarria:

Vitoria-Gasteizko Udala, Ingurugiro Gaietarako Ikastegiaren bitartez, Ekonomia eta Lehiakortasun Ministerioaaren dirulaguntzarekin Madrileko Unibertsitate Politeknikoa gauzatzen ari den ikerketa proiektu batean ari da parte hartzen. Proiektu horrek inkesta bat egitea aurreikusi du gure hirian dauden mugikortasun ohiturak aztertzeko, eta horretarako ezinbestekoa da langileen lantokietarako joan-etorrien ezaugarri batzuk ezagutzea, bai eta ikasleak eskoletara nola joaten diren ezagutzea ere.

Hori dela eta, APPEND Investigación de Mercados enpresako teknikariak inkestak ari dira egiten enpresetako langileei eta prestakuntza-zentroetako ikasleei. Eskutitz honen bidez zure laguntza eskatzen dugu lan hau burutzeko.

Agian jakingo duzunez, Datuen Babeserako Legearen arabera inkesta hau anonimoa da eta, beraz, emango diguzun informazio guztia estatistikak egiteko soilik erabiliko da, eta ez da inoiz izenarekin erabiliko eta ez da hirugarrenei emango.

Eskerrik asko zure laguntzagatik, adeitasunez.

Vitoria-Gasteizen, 2012(e)ko martxoaren (a)ren 20(e)an

Estimado Sr/Sra:

El Ayuntamiento de Vitoria-Gasteiz, a través del Centro de Estudios Ambientales, está colaborando en un proyecto de investigación científica financiado por el Ministerio de Economía y Competitividad y llevado a cabo por la Universidad Politécnica de Madrid. Dicho proyecto prevé una encuesta sobre hábitos de movilidad en nuestra ciudad, para la cual es imprescindible conocer algunas características del desplazamiento a los lugares de trabajo, así como a los centros de estudio.

Por éste motivo, los técnicos de la empresa APPEND Investigación de Mercados están realizando una serie de encuestas a los empleados de las empresas y a los alumnos de los centros de formación, para lo que solicitamos su colaboración.

Como ya sabe, de acuerdo con la Ley de Protección de Datos, esta encuesta es anónima, de forma que toda la información que nos facilite será tratada exclusivamente con fines estadísticos no pudiendo ser utilizada de forma nominal ni facilitada a terceros.

Agradeciendo su colaboración, reciba un cordial saludo.

Vitoria-Gasteiz, a 20 de marzo de 2012

Idoia Garmendia Tellería
Presidenta del Centro de Estudios Ambientales
Ingurugiro Gaietarako Ikastegiaren presidentea

Olarizuko Etxaldea
Casa de la Dehesa de Olarizu
01006 Vitoria-Gasteiz
Tel.: 945 16 26 96
Fax: 945 16 26 95
ceaadmin@vitoria-gasteiz.org
www.vitoria-gasteiz.org

Reminder cardboard

Cardstock given to people contacted through the recruiting the questionnaire containing a memo note of the scheduled phone calls and a graphical version of the 0 to 6 Likert scale to easily associate the questionnaire's values to their meanings once the person was called for the interview.

page 1

Encuesta telefónica sobre aspectos relacionados con la movilidad urbana en Vitoria-Gasteiz

La encuesta se compone de **TRES llamadas telefónicas** en los siguientes meses (duración 10-15 minutos):

☎ abril de 2012
☎ octubre de 2012
☎ marzo/abril de 2013

Entre los que contesten se sortearán los siguientes **PREMIOS**, en cheques regalo de El Corte Inglés:

- **3** cheques de **100 €** tras la 1ª llamada
- **5** cheques de **120 €** tras la 2ª llamada
- **10** cheques de **150 €** tras la 3ª llamada

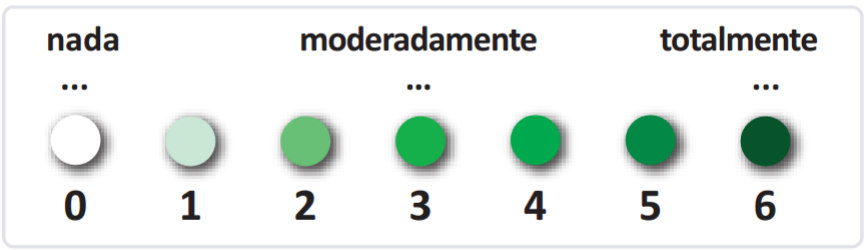
CONSERVE ESTE CUPÓN durante las tres fases de la encuesta, anotando el número que le comunicaremos. En caso de resultar agraciado, **le servirá para recoger el premio**.

CUPÓN nº: _____

De acuerdo con la Ley de Protección de Datos y el código CCI ESOMAR, toda la información que nos facilite en las entrevistas telefónicas será tratada exclusivamente con fines estadísticos no pudiendo ser utilizada de forma nominal ni facilitada a terceros.

page 2

Le rogamos tenga a mano este cupón en el momento de las llamadas.
Le vamos a pedir que exprese su opinión en base a la siguiente escala de 0 a 6:



Los responsables de la investigación y el Ayuntamiento de Vitoria-Gasteiz, le agradecen sinceramente su participación

Main survey questionnaire

(original Spanish version)

Leyenda de estilos usados en el cuestionario

- **Pregunta encuestador** (leer al encuestado)
- *Aclaración eventual de la pregunta* (leer al encuestado si necesario)
- Posibles respuestas del encuestado (leer al encuestado)
- *Instrucciones para el encuestador* (NO leer al encuestado)
- Notas de diseño (no estarán en la versión final)

Código color	**CAP_auto** (CAPTACIÓN – auto rellenado)	**EPx_tel** (OLA 1 – entrevista telefónica)	**EPx_tel** (OLA 2 – entrevista telefónica)	**EPx_tel** (OLA 3 – entrevista telefónica)
	X		X	X
		X	X	X
	X			
				X

INICIO

Buenos días/tardes, soy _____, entrevistador/a de un proyecto de investigación de la Universidad Politécnica de Madrid en convenio con el Ayuntamiento de Vitoria, financiado por el Ministerio de Economía y Competitividad, sobre aspectos relacionados con la movilidad urbana.

De acuerdo con la LEY DE PROTECCIÓN DE DATOS y el código CCI ESOMAR, toda la información que nos facilite en este cuestionario será tratada exclusivamente con fines estadísticos no pudiendo ser utilizada de forma nominal ni facilitada a terceros.

En el cuestionario NO HAY RESPUESTAS VERDADERAS NI FALSAS, conteste siempre la respuesta que usted considere que refleja mejor sus opiniones o gustos.

NOTAS para el Encuestador

1. *En caso de requerir más información del proyecto diríjase al 91 336 6657 (dar esta información solo a quien la requiera).*
2. *Las preguntas P1, P2 y P4 sirven para verificar que la persona se desplaza **AL MENOS UN DÍA A LA SEMANA** a su lugar habitual de trabajo o estudio. Si esta condición no se realiza, terminar la encuesta, pues no es válida.*

Hábito + Caracterización espacial del desplazamiento habitual (CAP_auto, EP2, EP3)

P1. **¿Cuál es su situación profesional?** *(leer)*

1. Menor de 16 años *(no válido)*
2. Ocupado
3. Estudiante
4. Ambos (trabaja y estudia)
5. Otras situaciones *(no válido)*

Si (*P1* = 2, 3, 4) se continúa la encuesta.

Si (*P1* = 1 o 5) se finaliza.

Pensando en sus desplazamientos habituales,

P2. *Si (P1= 2 o P1= 4)* **¿Cuántos días a la semana se desplaza a su lugar de trabajo?** *(leer)*

_____ días *[numero: 0-7]*

P3. *Si ((P1= 2 o P1= 4) y 0>0) …***¿y qué modo de transporte utiliza habitualmente para desplazarse al trabajo?** *(leer)*

[Si utiliza varios modos de transporte indique con el que recorre más distancia]

1. Coche
2. Moto
3. Autobús urbano / Tranvía
4. Autobús interurbano
5. Taxi
6. Bicicleta
7. A pie
8. Otro:_____

P4. *Si (P1= 3 o P1= 4)* **¿Cuántos días a la semana se desplaza a su lugar de estudio?** *(leer)*

_____ días *[numero: 0-7]*

Si (0=0 y P4=0) se finaliza.

P5. *Si ((P1= 3 o P1= 4) y P4>0)* **¿Qué modo de transporte utiliza habitualmente para desplazarse al lugar de estudio?** *(leer)*

[Si utiliza varios modos de transporte indique con el que recorre más distancia]

1. Coche
2. Moto
3. Autobús urbano / Tranvía
4. Autobús interurbano
5. Taxi
6. Bicicleta
7. A pie
8. Otro:_____

P6. *Si (P3=1)* **… y el aparcamiento de su coche en el lugar de trabajo/estudio lo realiza en…** *(leer)*
[Si compagina estudios y trabajo, referirse a la actividad que realiza con mayor frecuencia]

1. Parking Gratuito Centro Comercial
2. Zona Azul/ OTA
3. Garaje/Parking propio o alquilado
4. Parking por horas
5. No aparca - dobles filas
6. En la calle - libre
7. Le acompañan

P7. *Si (P3=6)* **… y el aparcamiento de su bicicleta en el lugar de trabajo/estudio lo realiza en…** *(leer)*
[Si compagina estudios y trabajo, referirse a la actividad que realiza con mayor frecuencia]

1. Atada a mobiliario urbano
2. Atada a aparca-bicis regulado
3. Bajo llave (trastero, deposito, parking)
4. Dentro del lugar de trabajo/estudio
5. Otro: _____

P8. Pensando en el desplazamiento habitual a su lugar de trabajo/estudios, ¿puede indicar origen y destino del mismo? *(leer)*
[Si compagina estudios y trabajo, haga referencia a la actividad con mayor número de desplazamientos semanales. Indique calle y portal aproximativo (ej. "calle de Burgos 20" si Ud. Vive en calle de Burgos 16)]

- **ORIGEN (dirección de su Hogar)**:
_____ Nº____ Código postal: _____
- **DESTINO (dirección de su lugar de trabajo/estudios)**:
_____ Nº____ Código postal: _____

P9. ¿Cuál es su hora aproximada de salida y llegada al lugar de trabajo/estudio? *(leer)*
[Por favor, intente ser lo más preciso posible]

- **Salida** ___:___ horas
- **Llegada** ___:___ horas

P8b **Indique por favor una de las siguientes posibilidades**:

1. El desplazamiento ES DIRECTO, no realizo otras actividades
2. El desplazamiento NO ES DIRECTO, realizo otras actividades antes de llegar al destino (acompañamientos, visitas, compras, etc.)

P8c **¿Qué tipo de jornada realiza?**

1. Jornada partida
2. Jornada continuada
3. Sin horarios fijos

Disponibilidad de modos (EPx_tel)

P10. **¿Dispone Ud. de permiso de conducir?** *(leer)*	**-a: Coche** (B) 1. Sí 2. No **-b: Moto** (A1/A2/A) 1. Sí 2. No
P11. **¿Dispone Ud. de coche para desplazarse a su lugar de trabajo/estudio?** *(Preguntar aunque no tenga permiso, adaptar) (leer)*	1. Propietario/conductor 2. Acompañante 3. Usuario no propietario 4. No dispone 5. No indica
P12. *Si (P11=1, 2, 3)* **El lugar de aparcamiento en el hogar del coche que tiene disponible es…** *(leer)*	1. En parking o plaza en el edificio de residencia 2. En parking o plaza en otro edificio en las inmediaciones 3. En la calle 4. No indica
P13. **¿Sabe montar en bicicleta?** *(leer)*	1. Sí 2. No
P14. *Si (P13=1)* **¿ Dispone usted de bicicleta para desplazarse a su lugar de trabajo/estudio?** *(leer)*	1. Bicicleta propia 2. Bicicleta de un familiar/amigo 3. Bicicleta pública 4. No dispone 5. No indica
P15. *Si (P13=1 y P14=1, 2, 3)* **El lugar de aparcamiento en el hogar de la bicicleta que tiene disponible es …** *(leer)*	1. Dentro de la vivienda 2. En un trastero, deposito, parking, en el edificio de residencia 3. En otro estacionamiento seguro 4. En la calle 5. No indica

Intención/Hábito de conducta ciclista (EPx_tel)

P16.	**Pensando en el desplazamiento habitual a su lugar de trabajo/estudios,**	
NO usa bici	*Si (P3<>6 o P5<>6)* **¿con cuál de las siguientes frases está más de acuerdo?** *(leer)*	1. Nunca me he planteado ir a mi lugar de trabajo/estudio en bicicleta 2. Nunca he ido a mi lugar de trabajo/estudio en bici, pero a veces me lo planteo 3. Alguna vez he ido a mi lugar de trabajo/estudio en bicicleta y me planteo seriamente hacerlo con más regularidad 4. Alguna vez he ido a mi lugar de trabajo/estudio en bicicleta, pero no me planteo seriamente hacerlo con más regularidad 5. Solía ir en bicicleta a mi lugar de trabajo/estudio, pero ahora ya no lo hago
SÍ, usa bici	*Si (P3=6 o P5=6)* **¿con cuál de las siguientes frases está más de acuerdo?** *(leer)*	6. Voy con regularidad en bicicleta a mi lugar de trabajo/estudio, durante todo el año 7. Voy con regularidad en bicicleta a mi lugar de trabajo/estudio, pero solo con buen tiempo 8. Voy con frecuencia en bicicleta a mi lugar de trabajo/estudio, aunque depende de razones coyunturales (salud, horarios, compromisos familiares, etc.)
SÍ	**P17.** *Si (P3=6 o P5=6)* **¿Desde cuándo va en bicicleta a su lugar de trabajo/estudio?**	_____ abierta, por codificar después del piloto

P18. *Si (P13=1 y P14 = 1, 2, 3)* **Pensando en otras actividades distintas al desplazamiento habitual a su lugar de trabajo/estudios, ¿con qué frecuencia ha utilizado la bicicleta?** *(leer)*				
- para ocio (paseo, turismo, salir…)	1. siempre	2. casi siempre	3. de vez en cuando	4. nunca
- para hacer deporte	1. siempre	2. casi siempre	3. de vez en cuando	4. nunca
- para ir a hacer gestiones, al médico, de compras, visitas…	1. siempre	2. casi siempre	3. de vez en cuando	4. nunca

Actitud hacia la conducta (EPx_tel)

NO bici

Sí bici

A*. *Si (P3<>6 o P5*<>6*)* **Teniendo en cuenta la posibilidad de utilizar la bicicleta para trasladarse a su lugar de trabajo o estudio, indique hasta qué punto estaría de acuerdo o en desacuerdo con las siguientes afirmaciones:**

A+. *Si (P3=6 o P5=6)* **Pensando en su desplazamiento habitual a su lugar de trabajo/estudios, indique hasta qué punto está de acuerdo o en desacuerdo con las siguientes afirmaciones:**

		Nada de acuerdo		Moderadamente de acuerdo			Totalmente de acuerdo	
		0	1	2	3	4	5	6
A7	Me desplazaría/*desplazo* con rapidez	☐	☐	☐	☐	☐	☐	☐
A1	Sabría/*Se* cuánto voy a tardar en llegar a mi destino	☐	☐	☐	☐	☐	☐	☐
A8	Me costaría/*cuesta* transportar personas	☐	☐	☐	☐	☐	☐	☐
A9	Me costaría/*cuesta* transportar objetos	☐	☐	☐	☐	☐	☐	☐
A2	Tendría/*Tengo* libertad, al no depender de ningún otro modo de transporte	☐	☐	☐	☐	☐	☐	☐
A4	Ahorraría/*Ahorro* respecto a otros modos de transporte	☐	☐	☐	☐	☐	☐	☐
A3	Tendría/*Tengo* un riesgo elevado de sufrir un accidente	☐	☐	☐	☐	☐	☐	☐
A5	Haría/*Hago* ejercicio físico	☐	☐	☐	☐	☐	☐	☐
A10	Aparcaría/ *Aparco* con facilidad	☐	☐	☐	☐	☐	☐	☐
A11	Tendría un riesgo elevado de que me robaran o dañaran la bici / *Tengo un riesgo elevado de que me roben o dañen la bici*	☐	☐	☐	☐	☐	☐	☐
A6	Contaminaría/*Contamino* menos el medio ambiente	☐	☐	☐	☐	☐	☐	☐
A19	Respiraría/*Respiro* aire contaminado	☐	☐	☐	☐	☐	☐	☐
A12	Causaría/*Causo* molestias a los peatones	☐	☐	☐	☐	☐	☐	☐
A13	Dependería/*Dependo* mucho de la climatología	☐	☐	☐	☐	☐	☐	☐
A14	Podría/*Puedo* vestir con ropa adecuada para mis actividades	☐	☐	☐	☐	☐	☐	☐
A15	Causaría/*Causo* una buena impresión a los demás	☐	☐	☐	☐	☐	☐	☐
A16	Llegaría/*Llego* estresado a mi destino	☐	☐	☐	☐	☐	☐	☐
A17	Me divertiría/*divierto* por el camino	☐	☐	☐	☐	☐	☐	☐
A18	Llegaría/*Llego* sudado a mi destino	☐	☐	☐	☐	☐	☐	☐
A20	Me relajaría/*relajo* durante el trayecto	☐	☐	☐	☐	☐	☐	☐

B. Y hasta qué punto es importante para Ud. en sus desplazamientos al lugar trabajo o estudio…

		Nada importante			Moderadamente importante			Totalmente importante
		0	1	2	3	4	5	6
B7	Desplazarme con rapidez	☐	☐	☐	☐	☐	☐	☐
B1	Saber cuánto voy a tardar en llegar a mi destino	☐	☐	☐	☐	☐	☐	☐
B8	Poder transportar personas	☐	☐	☐	☐	☐	☐	☐
B9	Poder transportar objetos	☐	☐	☐	☐	☐	☐	☐
B2	Tener libertad, no depender de ningún modo de transporte	☐	☐	☐	☐	☐	☐	☐
B4	Ahorrar respecto a otros modos de transporte	☐	☐	☐	☐	☐	☐	☐
B3	Minimizar el riesgo de sufrir un accidente	☐	☐	☐	☐	☐	☐	☐
B5	Hacer ejercicio físico	☐	☐	☐	☐	☐	☐	☐
B10	Aparcar con facilidad	☐	☐	☐	☐	☐	☐	☐
B11	Minimizar el riesgo de que roben o dañen mi modo de transporte	☐	☐	☐	☐	☐	☐	☐
B6	Contaminar menos el medio ambiente	☐	☐	☐	☐	☐	☐	☐
B19	No respirar aire contaminado	☐	☐	☐	☐	☐	☐	☐
B12	No causar molestias a los peatones	☐	☐	☐	☐	☐	☐	☐
B13	No depender mucho de la climatología	☐	☐	☐	☐	☐	☐	☐
B14	Vestir con ropa adecuada para mis actividades	☐	☐	☐	☐	☐	☐	☐
B15	Causar una buena impresión a los demás	☐	☐	☐	☐	☐	☐	☐
B16	No llegar estresado a mi destino	☐	☐	☐	☐	☐	☐	☐
B17	Divertirme durante el camino	☐	☐	☐	☐	☐	☐	☐
B18	No llegar sudado a mi destino	☐	☐	☐	☐	☐	☐	☐
B20	Relajarme durante el trayecto	☐	☐	☐	☐	☐	☐	☐

Norma descriptiva, validación social (EPx_tel)

G. ¿Hasta qué punto cree que los siguientes grupos de personas utilizan la bicicleta para desplazarse al lugar de trabajo/estudio en Vitoria-Gasteiz?

		No se utiliza nada o casi nada			Se utiliza moderadamente			Se utiliza mucho
		0	1	2	3	4	5	6
G1	Los jóvenes	☐	☐	☐	☐	☐	☐	☐
G2	Mis familiares	☐	☐	☐	☐	☐	☐	☐
G3	Mis amigos	☐	☐	☐	☐	☐	☐	☐
G4	Mis compañeros del lugar de trabajo o estudio	☐	☐	☐	☐	☐	☐	☐
G5	(Los turistas)	☐	☐	☐	☐	☐	☐	☐
G6	Los inmigrantes	☐	☐	☐	☐	☐	☐	☐

H. ¿Hasta qué punto le parece adecuado utilizar la bicicleta para desplazarse al lugar de trabajo o estudio?

Nada adecuado			Moderadamente adecuado			Totalmente adecuado
0	1	2	3	4	5	6
☐	☐	☐	☐	☐	☐	☐

Norma subjetiva (EPx_tel)

NO bici

C. Imagínese que decidiera desplazarse en bici a su lugar de trabajo/estudio…

¿En qué grado se mostrarían de acuerdo los siguientes grupos de personas?

Sí bici

Respecto a su decisión de desplazarse en bici a su lugar de trabajo/estudio…

¿En qué grado se muestran de acuerdo los siguientes grupos de personas?

		Nada de acuerdo			Moderadamente de acuerdo			Totalmente de acuerdo
		0	1	2	3	4	5	6
C1	Mi familia	☐	☐	☐	☐	☐	☐	☐
C2	Mis amigos	☐	☐	☐	☐	☐	☐	☐
C4	Los compañeros de mi lugar de trabajo o estudio	☐	☐	☐	☐	☐	☐	☐

D. Y, ¿cómo valora la opinión de estas personas a este respecto? La considero...

		Nada importante			Moderadamente importante			Muy importante
		0	1	2	3	4	5	6
D1	La de mi familia	☐	☐	☐	☐	☐	☐	☐
D2	La de mis amigos	☐	☐	☐	☐	☐	☐	☐
D4	La de los compañeros de mi lugar de trabajo o estudio	☐	☐	☐	☐	☐	☐	☐

Control conductual percibido – Controlabilidad (EPx_tel)

E. Indique hasta qué punto está Ud. de acuerdo con las siguientes afirmaciones:

		Nada de acuerdo			Moderadamente de acuerdo			Totalmente de acuerdo
		0	1	2	3	4	5	6
E1	Las infraestructuras existentes a lo largo de mi trayecto al lugar de trabajo/estudio (carriles, pistas y aceras bici) facilitarían/*facilitan* mi desplazamiento en bici	☐	☐	☐	☐	☐	☐	☐
E2	En mi lugar de trabajo o estudio podría/*puedo* aparcar la bicicleta con seguridad	☐	☐	☐	☐	☐	☐	☐
E3	En mi casa podría/*puedo* aparcar la bicicleta con seguridad	☐	☐	☐	☐	☐	☐	☐
E4	(El sistema de préstamo de bicicletas existente en VG facilitaría/facilita mis desplazamientos habituales) (no incluir en EP1_tel)	☐	☐	☐	☐	☐	☐	☐
E5	En mi trayecto al lugar de trabajo/estudio hay cuestas, desniveles, subidas, que dificultarían/*dificultan* el uso habitual de la bicicleta	☐	☐	☐	☐	☐	☐	☐
E6	La distancia que tendría/*tengo* que recorrer para mi trayecto al lugar de trabajo/estudio es adecuada para ir en bicicleta	☐	☐	☐	☐	☐	☐	☐
E7	El tráfico a lo largo de mi trayecto al lugar de trabajo/estudio me permitiría/*permite* desplazarme en bicicleta por la calzada junto a los coches	☐	☐	☐	☐	☐	☐	☐

Control conductual percibido – Autoeficacia (EPx_tel)

F. Indique hasta qué punto se consideraría /considera Ud. capaz de realizar las siguientes tareas:

		Nada capaz			Moderadamente capaz			Totalmente capaz
		0	1	2	3	4	5	6
F1	Conducir su bicicleta a través del tráfico	☐	☐	☐	☐	☐	☐	☐
F2	Aparcar su bicicleta de forma segura para evitar robos	☐	☐	☐	☐	☐	☐	☐
F3	Realizar controles periódicos de la bicicleta para mantenerla en buen estado.	☐	☐	☐	☐	☐	☐	☐
F4	Arreglar un pinchazo en una rueda de la bicicleta	☐	☐	☐	☐	☐	☐	☐
F5	Utilizar elementos de protección personal	☐	☐	☐	☐	☐	☐	☐
F6	Realizar las maniobras en bicicleta con seguridad	☐	☐	☐	☐	☐	☐	☐
F7	Subir cuestas o desniveles con la bicicleta	☐	☐	☐	☐	☐	☐	☐
F8	Planificar la ruta para desplazarse	☐	☐	☐	☐	☐	☐	☐
F9	Interpretar las señales de circulación y la normativa vial	☐	☐	☐	☐	☐	☐	☐

Identidad social (EPx_tel)

S. Por favor, señale su grado de acuerdo respecto a las siguientes afirmaciones:

		Nada de acuerdo			Moderadamente de acuerdo			Totalmente de acuerdo
		0	1	2	3	4	5	6
S1	Me identifico con "los ciclistas"	☐	☐	☐	☐	☐	☐	☐
S2	Me veo a mí mismo como "ciclista"	☐	☐	☐	☐	☐	☐	☐
S3	Creo que tengo cosas en común con "los ciclistas"	☐	☐	☐	☐	☐	☐	☐

Preguntas socio-económicas

S1. Sexo:

1. Hombre 2. Mujer

S2. Edad: _____

S3. Nacionalidad:

1. Estado español 2. Otra: _____

S4. Nº de personas que viven en su hogar (incluyendo Usted): _____personas (incluyendo Usted)

S5a. Situación en la vivienda *(leer)*

0. Padre/Madre
1. Hijo/a
2. Cónyuge o pareja sin hijos o con estos fuera del hogar
3. Sin lazos familiares (ej. solo/a, piso compartido, etc.)
4. Otras situaciones:_____

S5b. *Si (5a=1);* **¿tiene hijos menores de 12 años?**

1. Sí 2. No

S6. ¿Cuál es su nivel de estudios terminados? *(leer)*

1. Ninguno
2. EGB/GRADUADO escolar
3. Bachillerato superior/BUP/COU
4. Formación profesional
5. Estudios Universitarios

S7. ¿Puede decirme el rango de ingresos mensuales medios en el hogar? (solo en EP3_tel)

1. < 1.000€
2. 1.000 - 2.000€
3. 2.000 - 3.000€
4. 3.000 - 4.000€
5. > 4.000€

S8. ¿Tendría algún comentario que hacer?: _____(transcripción rápida)

Muchas gracias por su colaboración.

Annex 3. Descriptive data of the TRANSBICI survey

Table 30. Ability to cycle by gender and age group

Ability to cycle	*Gender*				*Total*	
	Male		Female			
	%	(N)	%	(N)	%	(N)
Yes	46.6	(343)	48.4	(356)	95.0	(699)
16-24 years	16.0	(118)	4.3	(32)	20.4	(150)
25-34 years	9.6	(71)	15.8	(116)	25.4	(187)
35-44 years	10.2	(75)	17.1	(126)	27.3	(201)
45-54 years	6.9	(51)	9.1	(67)	16.0	(118)
55-64 years	3.8	(28)	2.0	(15)	5.8	(43)
No	0.3	(2)	4.8	(35)	5.0	(37)
25-34 years	0.0	(0)	1.8	(13)	1.8	(13)
35-44 years	0.0	(0)	0.5	(4)	0.5	(4)
45-54 years	0.1	(1)	1.4	(10)	1.5	(11)
55-64 years	0.1	(1)	1.1	(8)	1.2	(9)
Total	46.9	(345)	53.1	(391)	100.0	(736)