UNIVERSIDAD DE CANTABRIA
E.T.S. de Ingenieros de Caminos, Canales y Puertos

Tesis Doctoral

"METODOLOGÍA PARA EL FOMENTO DE LA PARTICIPACIÓN CIUDADANA EN LA TOMA DE DECISIONES EN MATERIA DE PLANIFICACIÓN DEL TRANSPORTE."

"METHODOLOGY FOR PROMOTING CITIZEN INVOLVEMENT IN TRANSPORTATION PLANNING DECISION MAKING."

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A mis padres y amigos

RESUMEN

La presente Tesis Doctoral tiene como objetivo el desarrollo de una metodología aplicable a cualquier campo del transporte, y cuyos cimientos residen en la elaboración de una investigación de tipo cualitativo (basada en la realización de mega grupos focales, grupos focales y entrevistas en profundidad) para la posterior obtención de las variables necesarias para la realización y diseño de encuestas (de movilidad, de preferencias declaradas y preferencias reveladas), y cuyo objeto final ha sido el de la modelización del comportamiento humano para el diseño de políticas de planificación y gestión del transporte, tomando como ejemplo diversos ámbitos (movilidad sostenible, seguridad ferroviaria y calidad en este caso).

Para ello se exponen tres artículos incluidos en la relación de revistas del Journal of Citation Reports Science Edition (JCR-SCE), que ejemplifican diversos ámbitos de estudio en materia de gestión y políticas de transporte teniendo como pilar básico la participación ciudadana para para la extracción de las principales variables que determinan el posterior diseño de un cuestionario (piloto y definitivo).

En el primer caso, en el artículo titulado "Citizen involvement in promoting sustainable mobility", se ha propuesto una metodología de participación ciudadana basada en la realización de Mega Grupos Focales (MGF) y Grupos Focales (GF) para el conocimiento de las opiniones y percepciones de los ciudadanos acerca de la movilidad sostenible en un ámbito urbano. La realización de Grupos Focales ha servido para la obtención posterior de las variables necesarias para el diseño de una Encuesta Piloto de Movilidad.

En el segundo caso, en el artículo titulado "Passenger behavior in trains during emergency situations", se ha propuesto una metodología para el análisis del comportamiento humano ante una situación de emergencia en trenes de pasajeros, que gira en torno a una investigación de carácter cualitativo efectuada a través de Grupos Focales (GF) para la posterior extracción de las variables determinantes del comportamiento de los pasajeros y de la tripulación. En base a ello se ha procedido al diseño de una Encuesta de Preferencias Declaradas (PD) cuyos datos han sido utilizados para la posterior modelización a través de modelos de elección discreta tipo Logit para caracterizar y cuantificar el comportamiento.

En tercer lugar, en el artículo titulado "Modeling public bike perception of quality considereing users heterogeneity" se ha propuesto una metodología basada en la realización de Grupos Focales (GF) a través de los cuales se han identificado las variables relevantes para el diseño de una encuesta de Preferencias Reveladas (PR) sobre la calidad percibida por los usuarios de un servicio de bicicletas públicas. En base a los resultados obtenidos en la encuesta se han calibrado modelos de tipo Ordered Probit.

En la presente Tesis Doctoral se ponen de manifiesto algunos conceptos sobre el análisis de información proveniente del estudio del comportamiento del usuario en redes de transporte. Se abordan así pues los métodos de investigación cuantitativa y cualitativa, como aristas de una metodología de investigación mixta y se exponen los conceptos y componentes de ambos métodos y su complementariedad a través de diversos ejemplos prácticos.

Con todo ello cabe destacar que la línea de investigación seguida en la presente Tesis Doctoral puede identificarse con la construcción de una metodología participativa de carácter científico que puede ser aplicada a diversos ámbitos del transporte y a diversas escalas geográficas.

ABSTRACT

The purpose of this Doctoral Thesis is to propose a methodology applicable to any field of the transport studies, in order to produce a qualitative type research (based on focus groups and mega focus groups) to obtain the required variables for designing mobility surveys (stated and revealed preferences surveys). The aim of these surveys is modelling the human behaviour for simulating planning and management policies, in diverse fields (sustainable mobility and railway safety in this case).

Three papers are exposed, all of them published in journals indexed in the Journal Citation Report Science Edition (JCR-SCE). These papers exemplify different case studies taking as a basic pillar the citizen participation in order to obtain the main variables that are determinant in the survey design (pilot and final).

In the first case, in the paper titled "Citizen involvement in promoting sustainable mobility", a methodology has been proposed for citizen participation based on the organization of Mega Focus Groups (MFG) and Focus Groups (FG). These Groups aim to capture the opinions and perceptions of the citizens about sustainable mobility in urban areas. The realization of FG has been useful to determine the required variables for designing a pilot mobility survey.

In the second case, in the paper title “Passenger behaviour in trains during emergency situations”, a methodology for the analysis of human behaviour in an emergency situation in passenger trains has been proposed. This methodology is the consequence of a qualitative research made using FG as a tool to extract the main variables which influence passenger and crew behaviour.

On this basis, a Stated Preference (SP) survey has been developed. The data obtained with this survey have been used to estimate a Logit type discrete choice model for the simulation of the individual behaviour.

Thirdly, in the paper presented as "Modelling public bike perception of quality considering users heterogeneity" a FG based methodology has been proposed. This methodology allows to identify relevant variables for the design of a Revealed Preference (RP) survey about the users perceptions of public bike services. Based on the results obtained in the survey, Ordered Probit models have been calibrated.

This Thesis reveals some concepts about the information provided by the demand behaviour in transportation. Both quantitate and qualitative research methods are approached as the edges of a mixed research methodology. In addition, the concepts and components of each methodology and its affinities are exposed through various practical examples.

To sum up, it should be noted that the research line followed in this doctoral thesis can be identified with the construction of a scientific methodology that can be applied to various transport areas and at various geographical scales.

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Mi agradecimiento también al Ministerio de Fomento por la financiación de los dos proyectos que han hecho posible el desarrollo de los tres artículos que conforman la investigación de la presente Tesis Doctoral. Por un lado, el proyecto titulado "PROBICI, Metodologías de planificación y gestión de estrategias de promoción de la bicicleta", que ha hecho posible la investigación fruto de la cual han surgidos dos de los artículos presentados en la presente Tesis Doctoral titulados "Citizen involvement in promoting sustainable mobility" y "Modelling the service quality of public bicycle schemes considering user heterogeneity"; y por otro lado el proyecto titulado "Sistema Automatizado para la Toma de Decisiones de Seguridad en Trenes de Pasajeros de Alta Velocidad ante situaciones de Emergencia" por haber hecho posible la realización de la investigación de la cuál ha sido extraída el artículo titulado "Passenger behavior in trains during emergency situations".

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PREÁMBULO

La presente Tesis Doctoral se encuentra constituida por el compendio de tres artículos de investigación publicados en tres revistas científicas indexadas de índole internacional, incluidas en la relación de revistas del Journal of Citation Reports Science Edition (JCR-SCE).Las referencias exactas de los artículos publicados son:

1. Citizen involvement in promoting sustainable mobility. Ángel Ibeas, Luigi dell'Olio , Mª Rosa Barreda. Journal of Transport Geography 19 (2011) 475–487.
2. Passenger behavior in trains during emergency situations. Luigi dell'Olio, Ángel Ibeas, Mª Rosa Barreda, Roberto Sañudo. Journal of Safety Research 46 (2013) 157–166.
3. Modelling the service quality of public bicycle schemes considering user heterogeneity. María Bordagaray, Luigi dell'Olio, Ángel Ibeas, Mª Rosa Barreda, Borja Alonso. International Journal of Sustainable Transportation (2014), http://doi.org/10.1080/15568318.2013.838722.

Para reflejar la importancia y calidad científica de los artículos contenidos en la presente Tesis Doctoral, a continuación se detallan los índices de impacto de cada una de las revistas en los años en los que han sido publicados cada uno de los tres artículos presentados.

1. Journal of Transport Geography: En 2011 esta revista tuvo un factor de impacto de 2.538 situándose dentro del 1º cuartil (Q1) en dos categorías, Transportation and Geographic. Dentro de la categoría Geographic se situó dentro del ranking en el puesto 7 de 73 y en la categoría Transportation se situó en el puesto 2 de 24.
2. Journal of Safety Research: En 2013 esta revista tuvo un factor de impacto de 1.303, situándose dentro del 1º cuartil (Q1) en dos categorías: Social Science Interdisciplinary and Transportation. Dentro de la categoría Social Science Interdisciplinary se situó dentro del ranking en el puesto 14 de 93 y en la categoría Transportation se situó en el puesto 16 de 29.

3. International Journal of Sustainable Transportation: En 2014 esta revista tuvo un factor de impacto de 2.548, situándose dentro del 1º cuartil (Q1) en la categoría.

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CAPÍTULO 1

INTRODUCCIÓN Y APORTACIONES DE LA TESIS

INTRODUCCIÓN Y APORTACIONES DE LA TESIS

1.1. HIPÓTESIS DE PARTIDA Y PREGUNTAS A RESOLVER CON LA INVESTIGACIÓN

En lo referente a la Hipótesis de partida desde la cual nace la presente Tesis Doctoral, puede destacarse que las cuestiones planteadas al inicio de la investigación han partido de las siguientes premisas:

¿Cómo se puede efectuar una gestión eficaz de las políticas de transporte desde una perspectiva científica a través de la cual se garantice la veracidad de los resultados obtenidos?

¿Es necesaria una herramienta metodológica de carácter científico para apoyar en las actuales carencias dentro de la gestión de las políticas de transporte?

¿Cómo de importantes son las percepciones y opiniones de los usuarios del transporte para la formulación de estrategias adecuadas de planificación y gestión?

¿Cómo se pueden integrar estas percepciones y opiniones de los agentes implicados para la correcta formulación de políticas de gestión del transporte, en todas sus vertientes, a través de un método científico que pueda dar validez y consistencia a los resultados obtenidos?

¿Cuán importante es el desarrollo de una metodología mixta (cualitativa-cuantitativa) dentro del contexto de las políticas de planificación del transporte?

¿Cuál es la ventaja de modelizar el comportamiento de los usuarios del transporte en base a técnicas de participación ciudadana?

En base a estas preguntas de investigación, el fin de la presente Tesis Doctoral ha se corresponde con la construcción de una metodología aplicable a cualquier campo del transporte, y cuyos cimientos residen en la elaboración de una investigación de tipo cualitativo (mega grupos focales, grupos focales y entrevistas en profundidad) para la posterior obtención de las variables necesarias para la realización y diseño de encuestas (de movilidad, de preferencias declaradas y de preferencias reveladas).

Dentro de la línea de investigación presentada en esta Tesis no existen fronteras rígidas entre los métodos de investigación cualitativo y cuantitativo, tratándose de una metodología mixta donde ambos métodos se complementan dándose paso el uno al otro, con la finalidad de poder modelizar el comportamiento humano en base a las experiencias vividas por una determinada muestra de población.

En el primer caso, en el artículo titulado "Citizen involvement in promoting sustainable mobility", se ha propuesto una metodología de participación ciudadana basada en la realización de Mega Focus Group (MGF) y Focus Group (FG) para el conocimiento de las opiniones y percepciones de los ciudadanos acerca de la movilidad sostenible en un ámbito urbano. La realización de Grupos Focales ha servido para la obtención posterior de las variables necesarias para el diseño de una Encuesta Piloto de Movilidad.

Dentro del método propuesto en la presente tesis, es en este artículo donde se asientan las bases participativas y metodológicas globales a utilizar a través de la definición de los MGF. Así, al centrarse exclusivamente en la fase inicial del proceso muestra de manera más detallada y exhaustiva el desarrollo de la parte cualitativa del método. En él, queda de manifiesto la existencia de una fórmula que democratiza la toma de decisiones en planificación del transporte contando con la opinión ciudadana desde la fase inicial de la planificación.

En el segundo caso, en el artículo titulado "Passenger behavior in trains during emergency situations", se ha propuesto una metodología para el análisis del comportamiento humano ante una situación de emergencia en trenes de pasajeros.

En este caso se ha efectuado una investigación de carácter cualitativo a través de Focus Group (FG) y Entrevistas en Profundidad, para la posterior extracción de las variables determinantes del comportamiento de los pasajeros y de la tripulación. En base a este proceso participativo, se ha procedido al diseño de una Encuesta de Preferencias Declaradas (PD) cuyos datos han sido utilizados para la posterior modelización a través de modelos de elección discreta tipo Logit para caracterizar y cuantificar el comportamiento.

En este caso, la fase inicial correspondiente a la participación ciudadana tiene la finalidad de entender el comportamiento humano en situaciones de emergencia, y servir de apoyo en la tipificación de conductas asociadas a determinados incidentes dentro del ámbito ferroviario. Igualmente en esta primera fase cualitativa de la investigación, se ha indagado acerca de cuál es la información recibida por los pasajeros de trenes en el caso de producirse una situación inusual. Además se ha logrado un acercamiento al conocimiento de la relación existente entre la tripulación y los pasajeros ante este tipo de situaciones.

En tercer lugar, en el artículo titulado "Modeling public bike perception of quality considereing users heterogeneity" se ha propuesto una metodología basada en la realización de Grupos Focales (GF) a través de los cuales se han identificado las variables relevantes para el diseño de una encuesta de Preferencias Reveladas (PR) sobre la calidad percibida por los usuarios de un servicio de bicicletas públicas. En base a los resultados obtenidos en la encuesta se han calibrado modelos de tipo Ordered Probit.

La aplicación de esta metodología científica con base participativa ha supuesto la base para la construcción de modelos de lección discreta centrados en conocer cuál es el comportamiento y la percepción de la calidad de los sistemas de bicicletas públicas desde el punto de vista de los usuarios. En este caso, se ha logrado efectuar la caracterización socioeconómica de los usuarios y una caracterización de la calidad percibida por los mismos sobre el servicio de préstamo de bicicletas públicas. Todo ello se ha desarrollado a través de un ejemplo práctico tomando como escenario una ciudad de tamaño medio (Santander).

Con todo ello se concluye que en los tres casos presentados la investigación se centra en el conocimiento del comportamiento de los usuarios para su posterior modelización matemática. Para ello se ha construido una herramienta metodológica de carácter participativo, en base a Mega Grupos Focales (MGF), Grupos Focales (GF), y Entrevistas en Profundidad, para la extracción de las variables determinantes del comportamiento, el diseño de encuestas y la posterior modelización de los datos obtenidos.

1.2. MOTIVACIÓN

La originalidad de la presente investigación y las circunstancias que han empujado a su ejecución se corresponde con el hecho de la necesidad de generar una herramienta rigurosa bajo parámetros científicos, que ayude al planificador en la gestión y en la toma de decisiones para la correcta formulación de políticas de transporte, tomando como base las percepciones y opiniones de los diversos grupos objeto de estudio en cada caso.

Como justificación previa, hay que realzar que debido a que la democracia es un principio fundamental de una sociedad, ésta exige que los afectados por las decisiones igualmente se encuentren involucrados en los procesos de toma de decisión. Esta afirmación no significa que exclusivamente se deba escuchar a las personas, pero si significa incluir una retroalimentación ciudadana en la definición de los planes y políticas de transporte con anterioridad a la toma de decisiones.

Hoy en día los procesos de participación se muestran como una parte esencial dentro de la planificación urbana de las sociedades democráticas. Gracias a la participación activa de los ciudadanos en la planificación de su ciudad, y de los vecinos en el desarrollo de sus barrios, estos hechos contribuirán muy probablemente al desarrollo de ciudades en las cuales a sus habitantes les guste vivir identificándolas como "su ciudad", como una ciudad accesible y donde la movilidad y el sistema de transporte no sea un problema sin solventar.

Como antecedentes cabe destacar que en numerosas ocasiones las entidades locales y empresas de transporte, formulan políticas en las cuales tan solo consideran para su desarrollo estudios técnicos (muy necesarios) basados en datos y estadísticas oficiales, sin tener en cuenta la opinión y vivencias de la ciudadanía, y justamente por ello, estas políticas fracasan en un elevado porcentaje.

El término "participación ciudadana" describe el proceso de consulta a diferentes grupos de interés, como por ejemplo los ciudadanos, vecinos, propietarios de empresas de transporte, o ciertos grupos de interés más concretos como usuarios/no usuarios de determinados modos de transporte, en cuestiones referidas a la planificación urbana, y

más concretamente a la planificación del transporte en el caso que ocupa esta Tesis Doctoral.

Por otro lado, cabe destacar cuales han sido las motivaciones que empujaron a escoger la movilidad sostenible, la seguridad ferroviaria y la calidad de sistemas de bicicletas públicas como casos prácticos para el desarrollo del método presentado en esta Tesis.

Por otro lado, las principales motivaciones que han impulsado la aplicación de la metodología presentada en esta Tesis Doctoral al campo de la movilidad sostenible y la calidad percibida de los sistemas de bicicletas públicas se corresponden a que:

- en la actualidad numerosos ámbitos urbanos presentan crecientes problemas derivados del uso del vehículo privado como medio de transporte en los desplazamientos cotidianos, lo que perjudica enormemente el medio ambiente y la sostenibilidad.
- la consideración de seguir avanzando hacia nuevos modelos de movilidad más sostenibles con el entorno urbano.
- la necesidad de avanzar hacia el diseño de ciudades de calidad, donde el uso del vehículo privado sea más racional, para lo cual es imprescindible ofrecer alternativas que propicien una movilidad sostenible.

En lo referente a las motivaciones que han impulsado la aplicación de la metodología presentada en esta Tesis Doctoral al campo de la seguridad ferroviaria destacan:

- la complejidad y el gran abanico de posibles y situaciones inusuales que pueden acontecer a bordo de en un tren ha planteado numerosas dificultades a los psicólogos expertos en análisis de accidentes.
- la inexistencia de un método científico que tipifique los comportamientos y conductas de los usuarios ante un posible incidente ferroviario.
- las investigaciones existentes hasta el momento se centran exclusivamente en averiguar cuáles han sido las causas sin hacer un tratamiento específico de las posibles conductas de los agentes involucrados durante el transcurso de los acontecimientos.

Debido a esto se hace necesaria la aplicación de un método de predicción del comportamiento ante estas situaciones, que ayude en el diseño de estrategias y en la mejora de los escenarios.

1.3. OBJETIVOS DE LA INVESTIGACIÓN

El objeto principal de la presente Tesis Doctoral es el de la construcción de una metodología aplicable a cualquier campo del transporte, y cuyos cimientos residen en la elaboración de una investigación de tipo cualitativo (mega grupos focales, grupos focales y entrevistas en profundidad) para la posterior obtención de las variables necesarias para la realización y diseño de encuestas (de movilidad, de preferencias declaradas y de preferencias reveladas). El objeto final del Método propuesto es el de la modelización del comportamiento humano para el diseño de políticas de planificación y gestión del transporte, tomando como ejemplo diversos ámbitos del transporte (movilidad sostenible, seguridad ferroviaria y calidad en este caso).

De manera individual los objetivos generales perseguidos en los tres artículos presentados se corresponden, en todos los casos, con el conocimiento de opiniones, percepciones y conductas de los usuarios en diversos modos de transporte ante diversas situaciones (transporte público, calidad del servicio de bicicletas, comportamiento ante situaciones inusuales en trenes de pasajeros).

Dentro de este objetivo general pueden desagregarse tres grandes grupos de objetivos específicos:

- Desde una perspectiva teórica y metodológica se pretende demostrar la importancia y complementariedad de los métodos de investigación cualitativos (a través de técnicas grupales y encuestas) y cuantitativos (modelización matemática) en la simulación del comportamiento de la demanda de transporte.
- En el plano de aplicabilidad de los resultados obtenidos, se pretende contribuir y servir de apoyo en la toma de decisiones y en la correcta planificación de políticas de transporte: políticas para el fomento de la movilidad sostenible, políticas para enfrentar situaciones inesperadas y diseñar protocolos de actuación, y políticas que contribuyan a la mejora de la calidad de los servicios ofertados.

- Por último, la presente Tesis Doctoral pretende realzar la importancia de los procesos participativos como fase previa y base para la posterior modelización econométrica del comportamiento de los usuarios del transporte.
- Estos tres grandes grupos de objetivos son comunes a los tres artículos en los que se basa la tesis. Todos ellos se han desarrollado con el fin de aportar en el plano científico y metodológico, además de encontrar su motivación en la aplicabilidad poniendo de manifiesto tres casos reales.

En la presente Tesis Doctoral se ponen de manifiesto algunos conceptos sobre el análisis de información proveniente del comportamiento de la demanda de transporte. Se abordan así pues los métodos de investigación cualitativa y cuantitativa, como aristas de una metodología de investigación mixta y se exponen los conceptos y componentes de ambos métodos y su complementariedad a través de diversos ejemplos prácticos.

La presente Tesis Doctoral cumple el objetivo primordial de presentar una metodología de carácter científico con base participativa para el estudio de las percepciones y opiniones de los grupos objeto de estudio (por ejemplo: ciudadanía en general, usuarios/no usuarios de bicicletas, usuarios de trenes).

En base a este objetivo general, se establecen una serie de objetivos específicos derivados de cada una de las áreas que han sido objeto de estudio en cada uno de los artículos que componen esta tesis.

En el ámbito de la movilidad sostenible los objetivos son:

- El conocimiento de las percepciones y opiniones de los ciudadanos acerca del funcionamiento general del transporte (tanto público como privado) para posteriormente determinar la posible implantación de un modelo de movilidad sostenible a través de modos de transporte alternativos.

En el ámbito de la seguridad ferroviaria, los objetivos son:

- Conocer la conducta de los pasajeros ante situaciones inusuales no previstas a bordo de un tren de alta velocidad.

- Extraer las variables que más afectan a los usuarios de un tren ante una posible situación de emergencia.
- Comprender y conocer las reacciones, comportamientos y actitudes de los pasajeros ante una situación inusual.
- Conocer la información recibida referida a la seguridad a bordo de trenes de alta velocidad ante una situación inusual.
- Conocer la relación existente entre los pasajeros y la tripulación a bordo de trenes de alta velocidad ante una situación inusual.

En el ámbito de la calidad de la calidad percibida en los sistemas de bicicletas públicas, los objetivos son:

- La aplicación de una metodología científica con base participativa para la construcción de modelos de lección discreta.
- El conocimiento del comportamiento y la percepción de la calidad de los usuarios de los sistemas de bicicletas públicas.
- Caracterizar la calidad percibida por los usuarios del servicio de bicicletas públicas.
- Aportar conocimiento sobre la sensibilidad de la población respecto a la disposición del uso de la bicicleta y sus percepciones.

El primer artículo presentado "Citizen involvement in promoting sustainable mobility" sustenta las bases de la metodología global a utilizar definiendo los Mega Grupos Focales (MGF). En este caso la investigación presentada forma parte de una primera fase de carácter exploratorio (cualitativa) para posteriormente desembocar en otra fase de carácter cuantitativo.

Destacar que, en los artículos 1 (Citizen involvement in promoting sustainable mobility) y 3 (Modeling public bike perception of quality considereing users heterogeneity), la participación ciudadana se muestra además como una fórmula para "democratizar" la toma de decisiones contando con la opinión de los colectivos involucrados.

En el segundo caso "Passenger behavior in trains during emergency situations", la fase de participación ciudadana tiene la finalidad exclusiva de entender y servir de apoyo en la tipificación del comportamiento humano ante situaciones de emergencia.

En los artículos 2 y 3, la investigación presentada atraviesa las tres fases metodológicas que abarcan una fase cualitativa de carácter exploratorio (a través de Grupos Focales y Entrevistas en Profundidad, en cada caso), una segunda fase de muestreo (diseño de encuestas piloto y definitivas de preferencias declaradas y preferencias reveladas), y una tercera fase de modelización de los datos obtenidos.

1.4. PRESENTACIÓN DEL MÉTODO PROPUESTO

Cada uno de los artículos expuestos abarcan una o diversas fases dentro del método de investigación propuesto (véase figura 1).

La metodología diseñada y presentada puede ser aplicada no solo a los diversos ámbitos de la planificación del transporte, sino a cualquier campo que requiera una investigación de demanda y del estudio de la conducta humana. Es por ello que se presenta como una aportación metodológica de gran importancia debido a su gran aplicabilidad y rigor científico en el desarrollo de cada una de sus fases.

El método se compone de tres fases claramente diferenciadas.

Existe una primera fase donde exclusivamente se tratan informaciones y datos de carácter cualitativo. Dentro de ella se efectúa un estudio del estado del arte a través del análisis de la literatura existente a nivel mundial, lo cual ayuda a una primera identificación de las variables relevantes para la investigación. A través de los datos obtenidos en el estado del arte, se procede posteriormente a la construcción de una pauta guía para la constitución de los/el mega grupos focales (MGF) y/o grupos focales (GF), y/o entrevistas en profundidad.

A través de la realización de las diversas dinámicas grupales se procede a la identificación de las variables a tener en cuenta en la investigación. En base al análisis de los resultados obtenidos en este proceso son extraídas las variables determinantes para el diseño de una

encuesta piloto. Las siguientes fases (fase 2 y 3) se caracterizan por ser de índole cuantitativa.

En la segunda fase el método de investigación se centra en el diseño y realización de cuestionarios donde se procede al diseño y realización de una encuesta piloto (de preferencias reveladas y/o preferencias declaradas). En base a los resultados obtenidos en la encuesta piloto se procede al rediseño de una encuesta definitiva.

En la tercera fase de esta metodología, fase de modelización, se realiza la encuesta definitiva a una muestra de población determinada y calculada en base a los objetivos del estudio. En ella se procede a la explotación de los resultados y al desarrollo de modelos matemáticos (normalmente tipo Logit y Orderer Probit).

Finalmente, se presentan unos resultados, conclusiones y discusión que servirán como base para la formulación de futuras políticas de gestión y planificación del sistema de transporte.

Teniendo en cuenta las fases del método propuesto, como se puede observar en la figura 1, el artículo "Citizen involvement in promoting sustainable mobility" recorre la primera fase metodológica en profundidad, dando una visión muy cercana de esta fase de investigación, muy necesaria para la correcta comprensión de todo el proceso desde el inicio. Esta primera fase en todos los casos debe ser de excelente calidad, ya que supone la base sobre la cual se sustentan las siguientes fases que configuran la metodología científica expuesta en la presente tesis.

El segundo y tercer artículo, titulados "Passenger behavior in trains during emergency situations" y "Modelling the service quality of public bicycles chemes considering user heterogeneity" han recorrido las tres fases del método aplicadas a diferentes ámbitos del transporte. En ambos artículos se ha pasado por la segunda fase del muestreo a través de la realización de encuestas piloto y definitivas (de preferencias declaradas, PD).

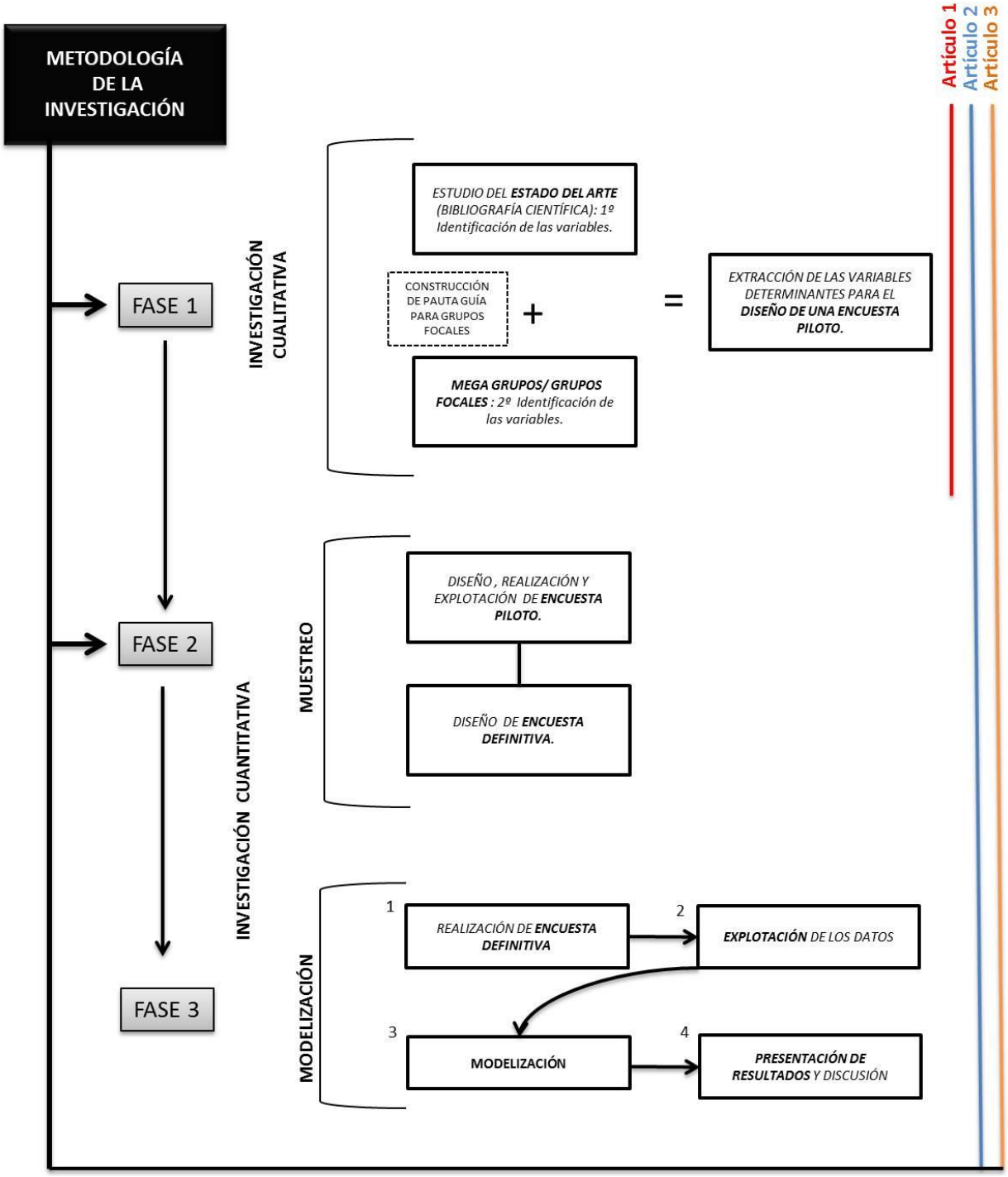

Figura. 1 Metodología de investigación de la Tesis Doctoral.

En conclusión, la presente Tesis Doctoral ha cumplido el objetivo clave de crear una herramienta metodológica con alto valor dentro de la planificación del transporte. Esta herramienta tiene sus cimientos en el conocimiento de las percepciones y opiniones de los usuarios a través de un proceso participativo. Éste ha servido como punto de partida

para la recolección de datos a través de cuestionarios diseñados en base a las variables extraídas de los megos grupos focales (MGF), grupos focales (GF) y Entrevistas en Profundidad, para una posterior modelización del comportamiento a través de modelos de tipo Logit y Orderer Probit.

1.5. APORTACIONES DE LA TESIS

La aportación al conocimiento por parte de la presente tesis consiste en la presentación de una metodología habiendo quedado demostrada su viabilidad y aplicabilidad a través de su implementación en diversos ámbitos del transporte. Se ha diseñado un método científica de carácter mixto (combinando técnicas de carácter cualitativo y cuantitativo) aplicada al campo del transporte que podría ser aplicada a cualquier disciplina en la cual se requiera un estudio de similares características.

Para lograr dicho objetivo, la presente Tesis Doctoral ha puesto de manifiesto avances generales en los siguientes aspectos:

- La presente Tesis sirve como precedente para llevar a cabo un proceso de participación ciudadana siguiendo una pauta científica en su desarrollo metodológico lo cual certifica la validez de los resultados obtenidos en este tipo de investigaciones.
- A través de los procesos participativos consultivos tan solo se obtiene una pequeña representación (valoración y percepción) de las opiniones que en ningún momento se cuantifica. Sin embargo, el aporte metodológico propuesto agrega un insumo a través de la cuantificación de estas percepciones, valoraciones y priorizaciones en base a la realización de cuestionarios a una muestra científicamente representativa de población. Estos cuestionarios se diseñan en base a las variables extraídas de los Mega Grupos Focales (MGF), Grupos Focales (GF) y Entrevistas en Profundidad. De esta manera, opiniones de carácter cualitativo son cuantificadas y expandidas al total de la ciudadanía, echo que supone una potentísima herramienta para la correcta formulación de políticas territoriales y de transporte.
- Se logra dar una mirada tanto cualitativa como cuantitativa de las percepciones ciudadanas y de los usuarios del transporte, y se consigue hacer partícipe a toda la comunidad en la toma de decisiones. Esto conlleva innumerables beneficios

dentro del sistema de políticas locales, beneficios tales como, una buena imagen del municipio o institución/empresa objeto de aplicación, al tener en cuenta de manera igualitaria a los agentes implicados. Cabe reseñar que, el método presentado a través de esta tesis puede servir como herramienta de apoyo para el desarrollo de determinadas líneas de acción dentro de planes territoriales a diversas escalas de intervención (Planes de Movilidad y Protocolos y Planes de Evacuación, por ejemplo).

- A través de la aplicación de las técnicas grupales (MGF y GF) y entrevistas en profundidad, se ha conseguido investigar las interacciones entre los diferentes comportamientos de los usuarios, incluso se ha observado cómo podrían modificarse sus conductas ante la introducción de determinadas variables de interés para el caso de estudio. Se consiguen identificar todas aquellas variables que se muestran de manera más influyente en las percepciones, conductas y comportamientos de la población que ha sido objeto de la investigación. Han sido estudiadas las reacciones de los usurarios ante una determina situación y esto ha servido para el posterior diseño de una encuesta piloto y definitiva efectuada a una muestra de población.

Por otro lado, la presente Tesis Doctoral ha puesto de manifiesto avances específicos en cada uno de los tres artículos presentados dentro de temáticas que han servido como ejemplo del desarrollo metodológico expuesto:

- Artículo 1: "Citizen involvement in promoting sustainable mobility".

El principal aporte de esta investigación se corresponde con la creación de un nuevo concepto dentro de mundo científico en lo referente a las técnicas de participación ciudadana, en este caso aplicadas a la movilidad: el concepto de Mega Grupo Focal (MGF).

Los Mega Grupos Focales (MGF) se han utilizado para que todos los segmentos de la población tengan representación en este proceso de participación y no existiese discriminación ninguna.

Los MGF se pueden ver como una estrategia política de atracción de la ciudadanía a través de temas generales de interés ciudadano (problemáticas del transporte público y privado), para el logro de un objetivo más específico: la realización de Grupos Focales (GF) sobre un tema más específico (en este caso bicicletas públicas) a través de los cuales se han obtenido las variables necesarias para el diseño y realización de una encuesta piloto, que posteriormente da lugar al diseño de una encuesta definitiva.

- Artículo 2: "Passenger behavior in trains during emergency situations".

El primer aporte de esta investigación, se corresponde con el desarrollo de una herramienta capaz de complementar los actuales y futuros modelos de evacuación, ya que a través de la aplicación del método presentado, se obtienen datos valiosos que pueden formar parte de un modelo global de evacuación. Las variables proporcionadas en los FG han sido utilizadas para establecer una serie de respuestas y líneas de acción que deben de seguir tanto pasajeros como tripulación.

Por otro lado, se han logrado sistematizar y tipificar las pautas de comportamiento de todos los agentes implicados (pasajeros y tripulación) para el logro un mayor control de la situación de emergencia. En esta línea, la revisión del estado del arte pone de manifiesto la inexistencia de una metodología científica que tipifique los diferentes comportamientos y conductas ante un incidente/accidente ferroviario. Por ello la presente investigación ha puesto atención en el desarrollo científico y metodológico del estudio del comportamiento humano de los diferentes agentes implicados en estos sucesos.

El tercer aporte se corresponde al hecho de que se han incluido dos tipos de emergencias (parón por un lado e incendio-explosión/colisión-descarrilamiento por otro) que actualmente no se encuentran contempladas en los modelos de evacuación existentes y que son exclusivas del ferrocarril.

Otro aspecto novedoso de esta investigación, se corresponde con el hecho de la especial utilidad de este método en el diseño de encuestas relacionadas con los problemas de evacuación, sin que éstas tengan la pretensión de representar la población de comportamientos.

Finalmente, otro de los aportes se manifiesta en que es la primera vez que se aplican Modelos Logit Multinomial para estudiar el comportamiento de los usuarios ante una situación de emergencia a bordo de un tren. Aunque la eficacia de estos modelos para estudiar el comportamiento humano está ampliamente documentada en la literatura internacional, cabe destacar que esta es la primera vez que se aplican estos modelos para estudiar el comportamiento de los usuarios a bordo de un tren en situaciones de emergencia.

Con todo ello se trata de un método de gran utilidad, ya que al conocer cómo reaccionan los usuarios ante ciertas circunstancias a bordo de un tren, esto va a facilitar el hecho de poder anticipar las situaciones más complicadas (predicción) contribuyendo a que la tripulación sea capaz de controlar y efectuar las medidas oportunas.

- Artículo 3: "Modelling the service quality of public bicycles chemes considering user heterogeneity".

La metodología expuesta aporta todo un proceso metodológico de participación ciudadana desde las primeras fases para asegurar una fehaciente representación de la realidad en el proceso de modelización. Los datos recogidos en el proceso, son resultado de las fases consecutivas de identificación de variables y diseño del cuestionario y han sido introducidos en modelos Ordered Probit para conocer la percepción de la calidad del servicio en función de las características que lo definen.

El modelo presenta resultados muy interesantes sobre diversos aspectos. La investigación demuestra una vez más, la diferente percepción de la calidad del servicio antes y después de la reflexión y valoración de los distintos aspectos de éste.

Así se demuestra que variables como la seguridad en el viaje y la información disponible pasan desapercibidas en una primera valoración de la calidad global mientras que resultan ser las de mayor peso al final de la entrevista. Al contrario ocurre con la tarifa, cuya valoración es la más importante a priori, pero deja de influir tras la reflexión del usuario. Este dato y la escasa presencia de las variables de nivel de servicio arrojan la conclusión de que este tipo de atributos influyen en la valoración de la calidad del servicio pero no resultan decisivos. Esto también puede deberse al aún reducido reparto de la bicicleta en

la movilidad de la ciudad que sirve de ejemplo práctico (Santander) y el hecho de que su uso mayoritario es recreacional.

Otro de los aportes a destacar se corresponde con el hecho de que los modelos expuestos constituyen una herramienta de gran potencial en la gestión del servicio de préstamo de bicicletas ya que no sólo informan de las variables y el grado en el que influyen en la calidad, sino que también aportan información sobre la variabilidad poblacional y las variaciones sistemáticas en las percepciones debido a características socioeconómicas y del viaje.

La heterogeneidad en la población se presenta en la valoración de la distribución de los puntos de toma y deje de las bicicletas mientras que entre las causas de variación sistemática de las percepciones de diferentes atributos se encuentran el sexo, la edad, los motivos del viaje, el tipo de abono adquirido y los tiempos de acceso y de viaje. Concretamente, el tiempo de acceso presenta el máximo peso para los usuarios que han percibido más de diez minutos en acceder al sistema. En consecuencia, tal y como se refleja en el valor acumulado de los efectos parciales correspondientes, la mejora de este atributo es la que generaría un impacto más notorio en la percepción de la calidad global del sistema en este conjunto de usuarios.

CAPÍTULO 2

CITIZEN INVOLVEMENT IN PROMOTING SUSTAINABLE MOBILITY

CITIZEN INVOLVEMENT IN PROMOTING SUSTAINABLE MOBILITY

2.1. RESUMEN

El presente artículo propone una metodología basada en la participación ciudadana para la promoción de la movilidad sostenible. Los Mega Grupos Focales (MGF) se han utilizado para que todos los segmentos de la población tuviesen representación en este proceso de participación y no existiese discriminación ninguna. Se pueden ver como una estrategia política de atracción de la ciudadanía a través de temas generales de interés ciudadano (problemáticas del transporte público y privado), para el logro de un objetivo más específico: la realización de grupos focales (GF) sobre bicicletas públicas.

Los mega grupos focales (MGF) proporcionan así mismo una representación territorial de las opiniones de los ciudadanos y sirve como mecanismo para la selección de los participantes de los grupos focales (GF) de menores dimensiones. La información extraída tanto de los mega grupos focales (MGF) como de los grupos focales sobre las percepciones de las personas acerca de la movilidad, han servido para la obtención de las variables necesarias para el posterior diseño y realización de una encuesta piloto de movilidad. Para una mejor comprensión del desarrollo de este método y sus posibles aplicaciones en cualquier ámbito territorial, en este artículo se presenta un caso práctico en una ciudad de tamaño medio (Santander).

A través del presente artículo se ha demostrado la enorme importancia que tiene la participación ciudadana para el desarrollo de políticas y planes relacionados con la movilidad sostenible. Los ciudadanos son el núcleo esencial de cualquier política ya que sobre éstos van a recaer los efectos, tanto positivos como negativos, de una determinada actuación. Además se han conseguido varios logros y aportaciones cumpliéndose así los objetivos iníciales marcados antes del comienzo de la investigación. La información proporcionada por los grupos focales (GF), de menores dimensiones, tiene un mayor nivel de detalle que la información que proporcionan los grupos más grandes.

En los grupos focales (GF) una muestra pequeña de la población se encuentra interactuando entre sí lo que es ideal y óptimo para el tratamiento de temas de especial relevancia e interés (por ejemplo, el transporte en bicicleta). Sin embargo, para el caso de

grupos de mayores dimensiones a través de un proceso de participación ciudadana (con un mayor impacto social), estos son ideales para tratar temas más genéricos y donde se requiere una representación más amplia de la sociedad (asociaciones de vecinos).

El objetivo principal de la celebración de los Grupos Focales (GF) y Mega Grupos Focales (MGF) es el de ayudar al planificador a diseñar encuestas de movilidad. Las opiniones ofrecidas y extraídas de los GF y MGF han sido incorporadas al Plan de Movilidad de la ciudad de Santander (gestión del sistema público de bicicletas, el diseño de una red de carril bici, el reajuste de las frecuencias de algunas líneas de autobús, la reordenación de las líneas y la modificación de ciertas rutas). Este tipo de investigación, que tiene como pilar básico la participación ciudadana, es de vital importancia dentro del ámbito de la planificación aunque los resultados siempre deberán de ser técnicamente revisados y probados. Por otra parte, cabe destacar que también deben de llevarse a cabo desde una perspectiva social y no basándose exclusivamente en la rentabilidad económica.

Para el desarrollo de la presente metodología se han dado varios pasos. En primer lugar, la ciudad ha sido dividida en tres zonas macro a través de los cambios en el uso del transporte público comprando las situaciones del año 2005 y 2007. Esto se logró mediante la simulación de todo el sistema de transporte, tanto público como privado, en la ciudad de Santander para ambos años utilizando un modelo de equilibrio simultáneo del paquete de software ESTRAUS (Siegel et al., 2006). Otro punto a destacar es la obtención de la percepción de los usuarios para el diseño posterior de encuestas piloto sobre la movilidad sostenible en el medio urbano y los cuestionarios de las encuestas definitivas.

Los MGF se han utilizado para que todos los segmentos de la ciudadanía tuviesen representación en este proceso de participación y no existiese discriminación ninguna. Se puede ver como una estrategia política de atracción de la ciudadanía a través de temas generales de interés ciudadano (problemáticas del transporte público y privado), para el logro de un objetivo más específico: la realización de Grupos Focales (GF) sobre bicicletas públicas (un tema de menor interés y que contaría con una menor participación). Otra de las aportaciones metodológicas de este concepto es que sirve como filtro o método de selección en la búsqueda de participantes para la realización de Grupos Focales (GF)

de menores dimensiones (bicicletas públicas). Por último hay que destacar que los Mega Grupos Focales (MGF) han servido para tener una representación territorial de las percepciones y opiniones de la ciudadanía a través de una zonificación.

2.2. INTRODUCTION

The work presented here is part of the first phase of the sustainable mobility plan. In recent years European cities have seen an increase in problems associated with large-scale use of the private car as a daily means of transport: increased congestion, wasting time looking for a parking place, stressful situations which worsen people's quality of life, an inefficient use of resources, atmospheric pollution and noise pollution.

Faced with this situation, the local authorities have started a process aimed at improving the town's transport system in favour of a transition towards a sustainable system which will always take into account public opinion. The political leaders have considered it opportune that civic society informs about and participates in the development process for current and future transport projects.

For that the citizens should establish their opinions in such a way that it allows them to get involved in decision making (Fontaine, 2006). The concept of democratic involvement includes listening to interest groups. The lack of public participation not only affects the interests of society in general, but also damages the image of politics, thereby causing great distrust of the authorities, as well as badly spent resources for transport planning. Citizen involvement can therefore be seen as a strategic value which enriches the social process, and as a resource which qualifies or strengthens some parts of it, legitimizing it or making it more pertinent or effective (Mideplan, 2005). Social involvement mainly operates in the immediate territorial and functional environment and is channelled through membership of a network of associations.

The main objective is to achieve improved lifestyle conditions at both an individual and collective level, and only when the people are well informed and feel they belong will agreement exist to move the community forward (Hill, 2007).

Based on these premises, the content of this article is aimed at the implementation of a process of citizen involvement to study public opinion using various qualitative

techniques: mega focus groups (MFG) and workshops leading to smaller focus groups (FG) where subjects are dealt with in more detail (tactical level). The proposed methodology introduces a concept which will be explained throughout this article: the mega focus group. The overall objective of the study is to know what the people think about the general workings of transport (both public and private) to determine the possibility of introducing a model of sustainable mobility through the promotion of sustainable alternative modes of transport to the private car and the bus, mainly, bicycles and, more precisely, public bicycles. There are two specific objectives worthy of mention. On the one hand, the development of a new methodology based on many dynamic groups and, on the other hand, to determine the variables to be used in designing any future pilot survey on sustainable mobility.

It must be pointed out that the FG have been very useful during the design phase of the questionnaires, in the development of plans, and in testing the new programmers and ideas (Roettinnget al., 2003). All of which appears to justify the use of FG in this investigation. The work described here forms part of an initial exploratory phase at a strategic level (qualitative) leading to a second phase of a quantitative character (tactical level). In this case there are no rigid frontiers between both methods (mixed methodology) rather they complement each other with the common goal of modelling human behaviour based on the life experiences of a small sample of the population. Faulkner et al. (1982) defends the combination of both methodologies and states that qualitative techniques have more proximity to social reality, meaning a greater probability of validity, nevertheless the reliability of the information can only be guaranteed after applying quantitative techniques. In fact, qualitative techniques are more sensitive, they are helpful at the start of an investigation and they should be complemented and corroborated with quantitative techniques, meaning that the most useful system would be to use a mixture or combination of both methods (Douglas, 1981). In view of the foregoing, during recent decades numerous social scientists have used a great variety of qualitative methods of investigation, including focus groups, to try to understand people and the social and cultural context in which they live (Klein et al., 2007) thereby constituting the continuation or starting point of many a quantitative study.

This introduction looks at the international literature, the current state of investigation into processes of citizen involvement using FG for introducing sustainable transport systems in urban environments. Several studies try to achieve and fulfil this objective and apply it to transport, the more recent and noteworthy are presented below. Firstly, it is worth noting the work done by Huang et al. (2005) using nine FG with 66 participants bringing together a huge volume of qualitative data about driver attitudes. A series of questionnaires were later designed based around the variables obtained in the FG. It is also worth mentioning the study done by Looukopoulos et al. (2006), who elaborated a series of surveys based around two previous studies; one based on holding FG which examined the reaction of a group of participants faced with proposals for private vehicle use through diverse demand management measures; and another, a study of real answers about how road users react when a toll system is introduced. In this case the FG were held in order to obtain the main variables to use and also for later survey design.

Another line was taken by Hull (2008) who studied the rules and values of local public authorities affecting mobility within local transport in the United Kingdom. In this case the methodology used was based on individual exploratory interviews with national experts, environmental civil servants, transport planners and various professionals connected with business policies. This method was thought to have too many limitations and was ruled out for the present investigation, because with in-depth interviews the interviewee only answers the questions given by the expert, without allowing any interaction with the opinions of others (which is just the opposite of the goals of the present investigation).

Quist and Vergragt (2006) have carried out research related to back casting and Stenberg (2008) carried out research using techniques involving citizen participation (interviews with tenants and workers) in housing and environmental studies. Finally, it is worth noting the recent and innovative work done by Sikron et al. (2008) which, in contrast to other qualitative techniques like FG and in-depth interviews, generates an open debate with the public at large to provide information on road user attitudes and traffic accidents. In this case, the data source was an open debating forum on a web site where news stories on traffic accidents were placed and people commented on them with a 10 line opinion, talking about road use regulations, aggressive driving, etc. Just like in the previous case,

there is limited interaction between those involved; nevertheless, it does have the advantage of having an unlimited number of participants.

2.3. METHODOLOGY: HOLDING MEGA FOCUS GROUPS AND FOCUS GROUPS

Before explaining the methodology followed in this investigation, a series of key concepts must be clarified which appear constantly throughout this article. Firstly, the MFG are meetings comprising of between 40 and 60 people which take place with a moderator and guidelines. They function in the same way as a normal focus group, the only difference being they are much larger. This technique is also combined with the use of ‘‘workshops” in which the members of the MFG are reorganised into sub-groups to provide solutions through a series of exercises. Those involved in the MFG may belong to groups or associations in a city (neighbourhood associations, youth groups, commercial organizations, etc.) depending on the objectives of holding that particular group. These MFG will discuss subjects of a generic nature which affect the city as a whole (example: problems with public transport) and will also serve as a selection process for choosing candidates to take part in smaller FG on more specific subjects (example: bicycles).

The advantage of this system is that the interaction between those involved is much greater than in a focus group of only nine people or in a web based forum, given that the influence of exchanges of opinions and ideas is much greater and valuable because of the information that can be obtained. The sessions take place in an ordered way directed by expert moderators (just the opposite to what happens in an ordinary open forum).

Another of the methodological contributions presented here refers to the fact that the MFG act as a filter or selection method when looking for members to participate in smaller focus groups at the tactical level, i.e., for more specific subjects such as using the bicycle as a form of public or complementary transport. As shown below, the creation of MFG and FG is helpful for those involved because the process of group reflection on a determined problem happens in a synergetic way. As the participants interact, their ideas are fed from one to another, potentially creating an effect which allows them to develop new thoughts which may not have occurred independently (Ulwick, 2002). Based on this, it must be assumed that the FG provide an ‘‘observation window” about how social

interaction can affect the attitudes of the users and orientate their behaviour towards previously established objectives.

Therefore, working with FG can also show how to obtain the key inputs to modify people's behaviour so they use more sustainable modes of transport. The focus group (FG) is one of the qualitative tools used in social investigation for the process of citizen involvement. The FG allows social discourse to be reproduced on a small scale using a selection of adequate participants (eight or nine members) defined according to the objectives of the study. Pichón Riviere (1978), master of social psychology and investigator of the laws of group phenomena, states that a group is not only the mere sum of the individuals, rather the group constitutes an integrated organism, with its own rules of play. This technique was developed during the 1930s as an answer by the social scientists after their dissatisfaction with the traditional method of performing in-depth interviews where the subject merely responded to the questions put to them. As an alternative, some social scientists tried out the technique of bringing together various people at the same time, and saw that this method allowed those involved to play a more active role, because they were participating in an open debate about a particular subject (Klein et al., 2007). This type of FG was initially used to check the effect of broadcasting on consumers, and later, to look at moral questions during the Second World War. So, the FG is an investigative tool that has continued to grow in popularity in recent years and at many levels of investigation (O'Connell, 2002).

On the other hand, a ''workshop" is defined as a meeting space for subjectivities and a means of sharing work load, that has grown to the dimension of participative construction where the subjects, guided by common purposes and the desire to reach them by a determined, generally short time, are prepared to construct a situation of learning and creation geared towards reaching its objectives (Rojas, 2004).

After these definitions, the general method followed must now be defined (see Fig. 2). Firstly, various MFG have to be formed using members of interest groups and citizens representatives (neighbourhood associations, commercial organisations and youth groups, etc.). Generic and common interest subjects must be dealt with in these sessions (for example, problems of public transport and congestion) to get full attendance and

involvement. In other words, the MFG are used as a magnet to attract the population to the process of involvement. It is a good idea to zone all the membership organizations to group them in sessions of between 40 and 60 people. One of the zoning criteria could be increasing or decreasing numbers of bus journeys, thereby grouping the participants into homogenous zones sharing common situations and smoothing the way for debate. The advantage of grouping neighborhood associations into zones comes from the fact that each of them represents an area with similar transport problems and characteristics. The FG (with eight and nine participants) allow us to study the iterations between different user behaviors unlike the MFG which deal with common problems to each of them.

In these meetings the people are divided into interest groups (around bicycle use) to be later brought together in successive FG whose primary objective is promoting sustainable mobility. From all the data collected in the FG people are chosen who best fit the profile of the objective groups defined beforehand (see Fig. 2). Depending on the characteristics of the city being studied all the necessary FG are held with bicycle users, potential users, technical experts in mobility, etc. until the final objective of the study is defined along with the variables used in a pilot survey on sustainable mobility.

All this process has become framed within the sustainable mobility plan for Santander (see Fig. 2). The main objective of the mobility plan has been to improve overall mobility by reducing the need to use the private car and facilitating mobility using the public transport collective, travelling on foot or by bicycle. This is the justification for the present research, serving as a base for the introduction of a sustainable mobility plan. The city council and GIST – Transport Systems Research Group brought together the neighbourhood associations and with them established three MFG grouped together depending on the increase and decrease of bus journeys in the city. These MFG dealt with generic subjects around the problems of using public transport and also served as a filter (based on sex, age, and user or not of bicycle) to choose and recruit the participants in the smaller FG on a more specific subject (about bicycles). The results of the FG and MGF fit perfectly into the Analysis and Diagnosis phase of a sustainable mobility plan (see Fig. 3, stages of a mobility plan). This methodology is essential for the data collection, choice of action and the definition of scenarios and strategies within the Plan.

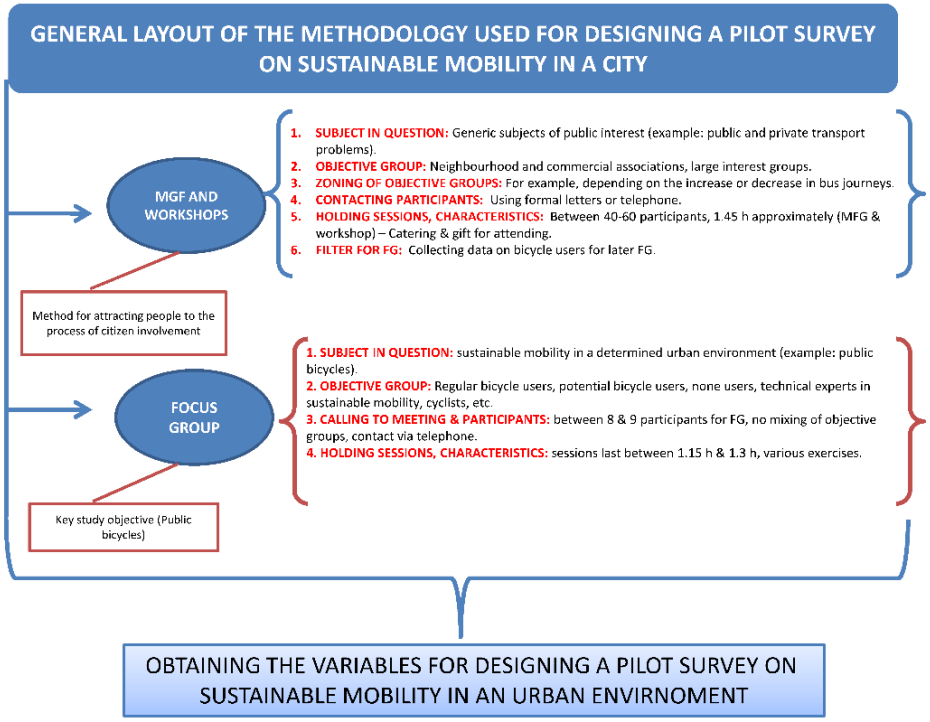

Figura. 2 Methodology for designing a pilot survey on sustainable mobility.

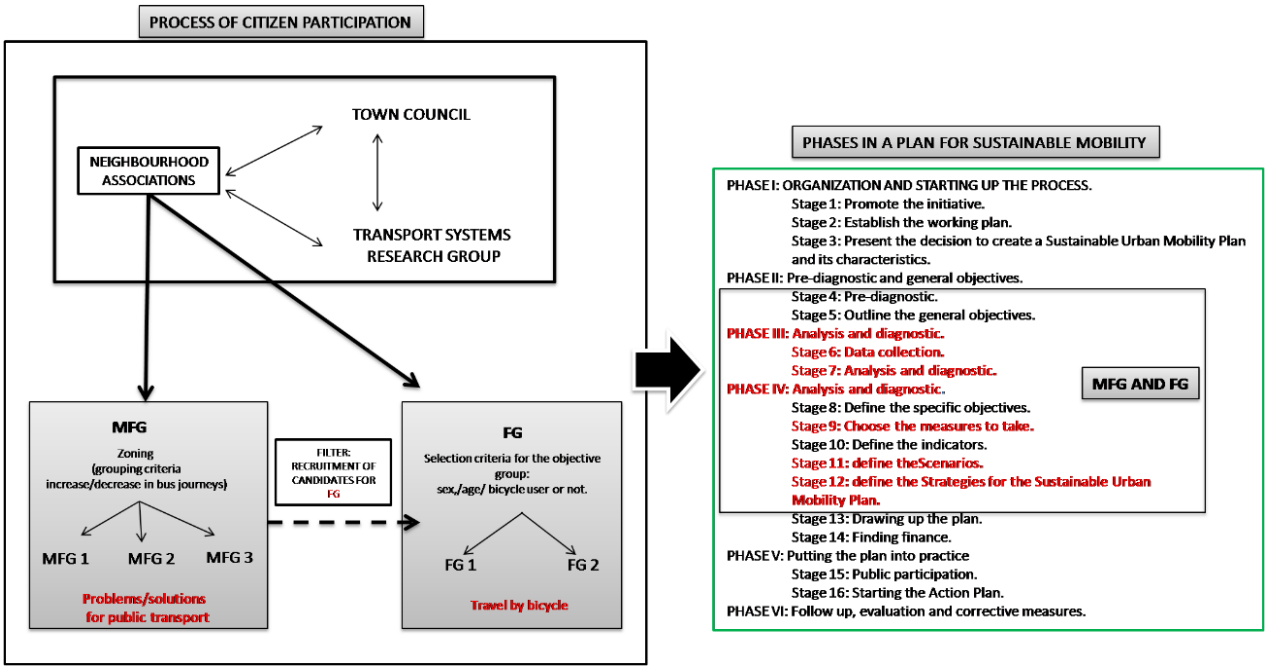

Figura. 3 The role of MFG and FG within a sustainable mobility plan.

2.4. PRESENTATION AND ANALYSIS OF RESULTS

A better presentation of how a MFG and FG should be organized is described below using the practical application carried out in Santander.

The University of Cantabria together with the city council of Santander called together all the representatives of the city's neighbourhood associations to get them integrated into the process of citizen participation in the form of MFG. The aim of using this process was to get to know the experiences, perceptions and opinions of the residents of Santander about the city's transport system as a whole (both public and private transport). This method has revealed problems from the point of view of the user of the urban transport networks (general transport problems, specific problems with certain bus routes, specific problems associated with certain parts of Santander, and specific problems with certain sections of the population).

The MFG have been used as a magnet to draw in the people so they can speak about a subject of real interest to them: the problems of public and private transport; although the key objective of the study was to promote sustainable transport, especially the bicycle. The workshop groups also served as a filter for choosing the best members for focus groups about a more specific subject: public bicycles as a means of transport in the city of Santander. Two focus groups were held on the use of the bicycle.

Their members were, on the one hand bicycle users chosen from data provided by the neighbourhood associations and, on the other hand, a group of students from the University of Cantabria (UC) (users and non-users of bicycles). The student FG is an objective study group for this case because the University of Cantabria has a very large student community of potential bicycle users (12,704 under graduates and 739 post graduates, UC data, 2008).

Daily, they generate and attract a large number of journeys to and from the campus. Finally, it should be noted that the information obtained in this phase will help to design a pilot household survey on mobility in Santander.

The University of Cantabria and the City Council made contact by sending a formal letter to 60 neighbourhood associations in Santander. These letters were sent on 5th May, 2008

asking for two members from each association for various days of the same month, between 18.30 h and 20.45 h in one of the class rooms provided by the University's Civil Engineering School. With a total of 60 neighbourhood associations the initial zoning took place1; after locating their offices the following criteria were used: zones in the city where the number of passengers using public transport went down, stayed the same or rose, compared with data from simulations performed in 2005 and 2007 in simultaneous equilibrium models for the user and the transport system using the software package Estraus (Siegel et al., 2006). They were finally grouped into three macro zones using a geographical information system (GIS) (see Figs. 4–6) following the above mentioned criteria.

These three workshops or mega focus groups were held on three different days (13, 14 and 15 of May 2008). Data with the name, address, telephone number, and chairman of the association were supplied by the register of associations held by the town hall.

The MFG and workshops were distributed in the following way: 24 associations (48 participants expected) on 13th May; 21 associations (42 participants expected) on 14th May, and, finally, 15 associations (40 participants expected) on 15th May. The sessions can be said to have been successful as approximately 55% of the associations contacted actually turned up. After the initial contact was made by post, each of the association chairmen were called by phone to confirm their presence at the event, they were told what was going to take place and they were thanked in advance for their support.

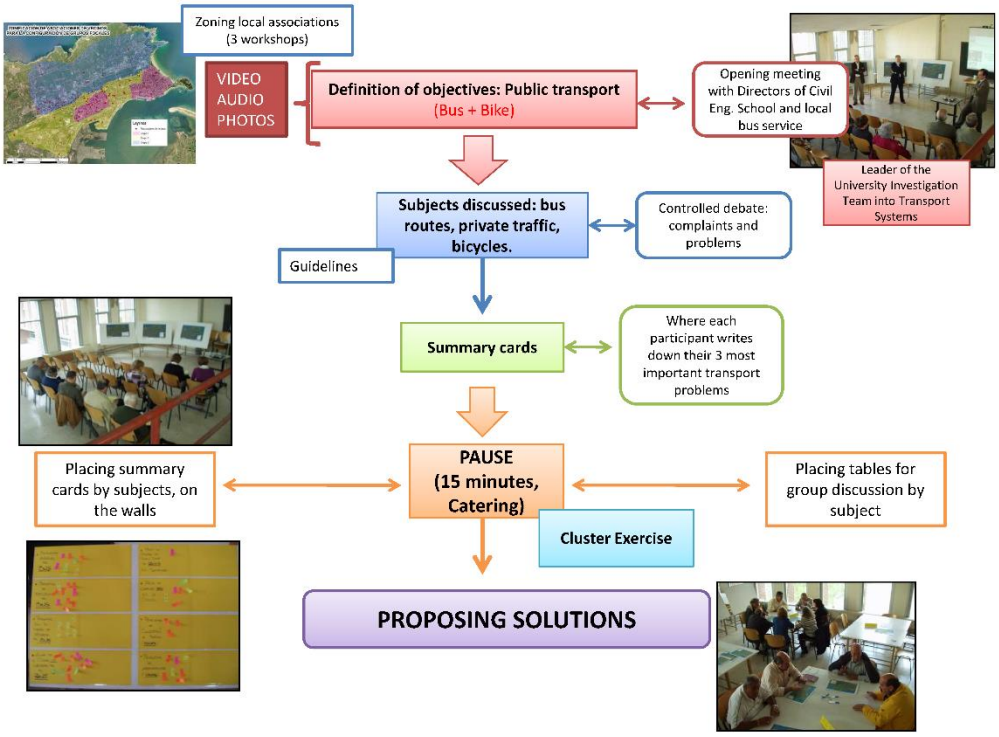

Figura. 4 Summary of the methodology followed in the workshops on the problems of public transport in Santander

- Holding the MFG

The sessions took place over three stages which can be distinguished schematically: Stage 1: The participants and their neighbourhood associations lay out their problems with public transport.

Stage 2: Discussion work in small groups about possible solutions.

Stage 3: A spokesperson presents the proposals and possible solutions at a general meeting of the participants.

A brief introduction took place once the session was open describing the actual situation in Santander with transport in general, but with emphasis on public transport, i.e., the bus service, their routes, etc.

Mention was also made of the existing bike lane and the four projected, with their respective three docking stations for the municipal bicycles. Four A1 sized plans showing

the actual bus routes were strategically located in front of the workshop participants so they were available for reference at any time.

Previous experience has shown that the duration of the MFG has to be 2 h at the most: participants find it impossible to provide more time due to other commitments (work, studies, etc.) and the group loses effectiveness after 2 h (anxiety, lack of attention, lack of participation, tiredness, etc.)".

- Phase 1: generic approach to the problems of transport

After the brief introduction, the first part of the MFG began, in which the participants were allowed to debate for 45 min exclusively about the problems which they face on a daily basis with the transport system of the city of Santander, mainly with public transport both by bus and by bicycle. The problems associated with the bus service occupied most of the meetings. This part of the session was governed by a series of turns in which each representative put across their point of view about the problems and the reasons behind them in the area they represented. Even though they were given free reign when putting across their complaints the MFG coordinators used a thematic template designed beforehand (see Fig. 4) by which they directed the meeting so that nobody got bogged down and all the important subjects were covered.

The subjects to be inquired about in the group sessions were written down based on the specific objectives of the study. This is what has been denominated the guidelines or the template, it is essential to help the moderator guide the group towards the subject of interest. After the 45 min of open debate finished, the participants were asked to summarize on a card, which in their opinion were the three or four most important problems they would act on first. This exercise lasted approximately 5 min.

After finishing this part of the MFG, they were given a 20 min break (catering) before starting the second part of the session. The coordinators took advantage of the break to prepare the room for the next session and order the cards that the participants had filled in with the most important problems.

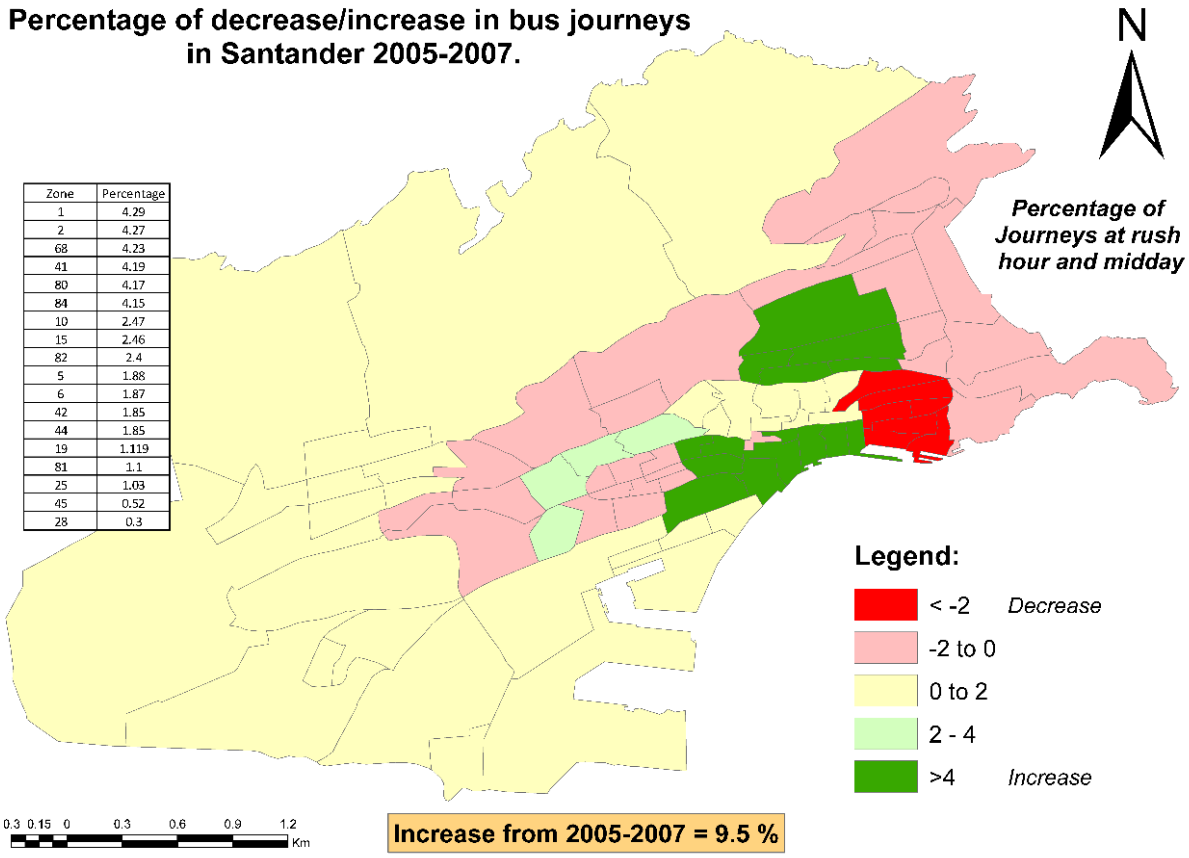

Figura. 5 Percentage of decrease/increase in bus journeys in Santander 2005–2007.

- Phases 2 and 3: development of workshops and proposal of solutions

At the start of the second part of the session, the participants return to continue with the group discussions. As they enter the room each person is given three post-its which they are asked to stick on what they see as the three most important problems from the seven which had been defined earlier. These problems referred to the private car as well as the bus and bicycle. In this way it was possible to count the problems with more weight for the participants.

After this brief exercise was completed, groups of participants chose specific themes which had been discussed earlier and they proposed possible solutions. Four debating tables were prepared for this workshop, each with its own subject for discussion (see Fig.8):

- Headways and timetables of buses.
- Connections with peripheral areas.
- Traffic congestion and private vehicles.
- Bicycles and bike lanes.

Each participant had to decide if they spoke about public transport, private transport or bicycles. They were organised into groups and after a moderate discussion (this time about solutions and not problems as covered in the first part), a spokesperson read out the conclusions reached by each sub-group of participants.

This exercise lasted approximately 20–25 min. During this part of the session the participants were given a 10 journey bus pass to thank them for their presence and collaboration in the workshops. Finally, to conclude the session they were given a questionnaire (filter) to fill in with their personal details, questions about bicycle use and details of anybody they knew who was a bicycle user in Santander. This filter found most of the participants of the first focus group on bicycles. It must be pointed out that the sessions were recorded both on video and audio, as well as photographs being taken of the key moments in each meeting, in order to facilitate later data analysis and diagnosis.

The quality of the data is controlled using corrections to details in the transcriptions, checking the recordings and videos where the coordinator and the FG experts have evaluated the quality of the information obtained: discussion management, clarity of conclusions, clarity in the transcription and trustworthiness. The quality of the information obtained in the development of this technique depends largely on the correct direction followed by the group moderators.

In order to retain personal information on participant sex, age, etc. a telephone survey on these aspects was held before the MFG. Each member was also given an identification tag which created a record of the location of each person in the room. This allowed the transcription of the data to be much more efficient.

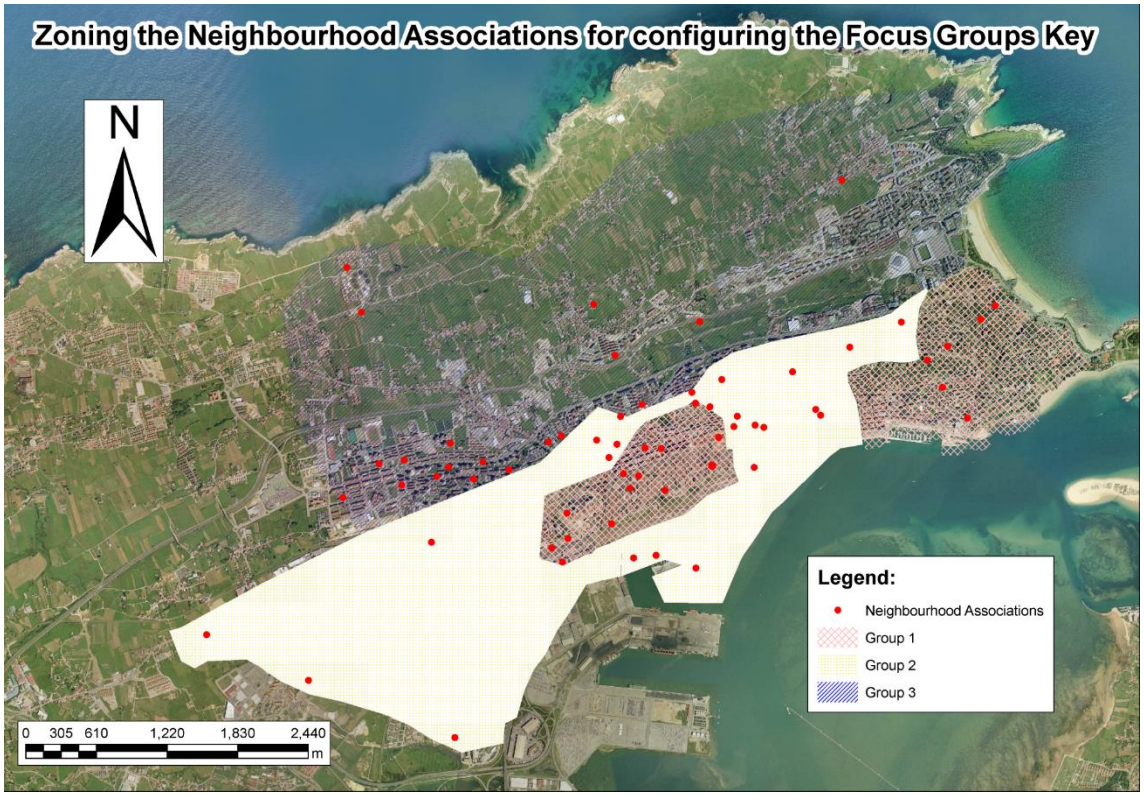

Figura. 6 Zoning of neighborhood associations depending on increase or decrease in bus journeys in Santander.

- Holding the focus groups.

As mentioned in the previous section, this study included holding two focus groups (FG) (see Fig. 9): one made up of university students (nine participants) and another with bicycle users (eight participants). The members of the student focus group were chosen randomly from the University of Cantabria list, and in the case of the bicycle users' group the members were chosen using information provided in the MFG. They were all called together (by telephone) in the meeting room of the Department of Transport, Project Technology and Processes of the UC Civil Engineering School. Firstly, they were told why they were there and given a brief presentation about the actual situation in Santander and the individual and collective benefits of using the bicycle. After this introduction, the participants were given a small opening exercise consisting of a card on which they had to write three advantages and disadvantages of using the bicycle in the city of Santander. They were given approximately 3–4 min to do this.

This was followed by a debating session among the participants which lasted about 45 min. After a short rest, they were given a second exercise lasting 10–15 min, in which the participants drew on a A3 sized photo map of Santander the possible ‘‘desirable routes” for bike lanes in the city, in other words, where they considered a network of bike lanes could be introduced in the city. Finally, in the students’ focus group, a third exercise consisted of showing them an informative video about bicycle use and the cycling culture in cities like Bogota, Amsterdam, etc. called ‘‘Cycling Friendly Cities”. The end of this exercise (lasting about 17 min) was observing how the young people reacted on seeing that there were cities with similar climatic characteristics and terrain to Santander where the people regularly use the bicycle as a means of transport without any problems at all.

- Results from the MFG

The citizens of Santander showed a general perception of the existence of high levels of traffic congestion concentrated around: rush hours in the city centre; in the maritime area during the summer at times of going to and from the beach; in the university area at times of starting and finishing classes; and finally, at the entrance to the city on one of its main avenues. It is worth noting that there is a certain conscience about the need to dissuade the use of the private car in favour of improvements in public transport; showing that the citizens value alternative modes of transport like the bicycle and scooters as means of reducing congestion in the city.

Looking at the results of the MFG it was possible to establish zoning in three areas and compare the results obtained in each of them.

1. Zones which have seen an increase in the number of journeys (peripheral areas experiencing urban growth).

2. Zones where the number of journeys has stayed the same (established residential areas).

3. Zones where the number of journeys has decreased (city centre and tourist areas).

THE BUS AS A MEANS OF TRANSPORT

Decisive factors for using/not using the bus.

USER How do they decide whether or not to use the bus? When choosing your means of transport what makes you decide to use or not use the bus?
Occasions when used.

When do you prefer to use the bus?
Listen to spontaneous answers and then inquire further: Situations, season, places when bus use is preferred.

Reasons for use / non use

Why do you like/ not like to travel by bus?
What do you gain? / What do you lose?

Modes of transport used :

Only by bus or combined with other modes of transport?
How do you combine the bus with other modes of transport?
With reference to the combination of bus and another mode of transport,
Inquire further about:
Examples of types of journeys done most frequently.
Benefits and barriers detected. What are the advantages? What problems are found when using the bus?

NON USERS Why don't they use the bus? Have they ever thought about using the bus?
Advantages and disadvantages of the bus. Change of mode of transport.

Points supporting changing to the bus
Why did they change over to the bus or why might they change over to the bus?

Comparison with other means of transport
Compare using the bus with other means of transport:
Public transport. What advantages do other types of public transport have compared to the bus? What disadvantages?
Car: What advantages does the car have when compared with the bus? What disadvantages?

Suggestions and Synthesis
What are the key variables which would support using the bus as a means of transport?

Figura. 7 Guide lines used in the workshops.

Figura. 8 Workshops discussing proposals and solutions.

It should be noted that the current transport problems are different in each of the three zones. This analysis of the results by zone is presented in Tables 1 and 2 on problems and proposals.

- Results obtained from the FG: bicycle users and university students

This analysis has only taken into account the overall results; further differentiation is only registered when different perceptions are observed in the groups consulted. The following points are worth mentioning from the populations perceived barriers to using bicycles: the lack of education and culture, Santander's topographical irregularity, the rainy climatic conditions and the perception of insecurity. Changes to population habits should be made from childhood, in schools, colleges, universities, etc. To manage to introduce a change in habits at a university level is a move forward that would benefit years to come: ''. . .the biggest problem I see is one of culture and education. . .."

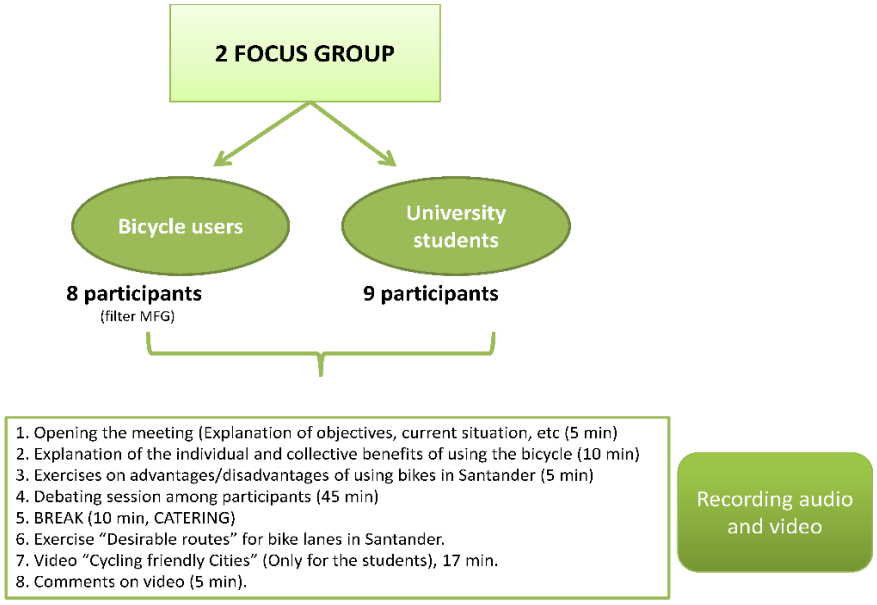

Figura. 9 Method for holding the group sessions.

Tabla 1 Comparison of results from MFG. Problems by zones.

PROPOSALS- COMPARISON OF RESULTS (MFG)		
Established zones (MFG 1)	Zones in urban expansion(MFG 2)	Tourist zones(MFG 3)
Zones surrounding the centre-neighbourhoods (number of journeys has stayed the same)	**Peripheral zones (number of journeys has increased or stayed the same)**	**Tourist zones – beach/city centre (number of journeys has decreased)**
Creation of park & ride system to promote public transport	Microbus connections between different areas	Problems with traffic congestion
Creation of an intermodal card to use in conjunction with other interurban companies	Creation of circular bus routes for the city's outer suburbs	Cars park at bus stops due to lack of parking spaces.
Introduction of microbuses to connect the hospital (North-south)	Introduce a new route connecting General Dávila (established zone) with this zone.	Creation of a bus/taxi lane
Modify the routes of certain lines (Line 14) and substitute it with a microbus	Increase the size of the bus fleet to enable higher frequencies.	Create park & ride system well connected with the city centre
Information panels at all bus stops	Create a bus/taxi lane	Close the centre to traffic and only allow buses , taxis, loading and unloading
Separate certain lines to create 2 routes	Have all routes in service at the weekend	Reinforce the lines with extra buses at rush hour
	Create car parks for Park & Ride to the west of the city	introduce N-S connections
		Improve and increase bus frequencies

Tabla 2 Comparison of results from MFG. Proposals and solutions by zones.

PROBLEMS – COMPARISON OF RESULTS (MFG)		
Established zones(MFG 1)	Zones in urban expansion(MFG 2)	Tourist and central zones (MFG 3)
Zones surrounding the centre-neighbourhoods (number of journeys has stayed the same)	**Peripheral zones (number of journeys has increased or stayed the same)**	**Tourist zones – beach/city centre (number of journeys has decreased)**
Badly designed routes on certain bus lines	Lack of bus routes that communicate between peripheral areas.	Problems with traffic congestion
Problems with delays on certain routes	Low frequency of lines serving these areas	Cars park at bus stops due to lack of parking spaces.
There are some routes which are too long	Lack of information (lack of information panels at stops showing waiting times, unlike in other areas of the city)	Too few buses at rush hour
	Lack of shelters to use during bad weather (unlike in the rest of the zones)	Bad communication between routes
	Bad communication with the rest of the city	Lack of transversal routes (linking Los Castros, General Dávila and the city centre).
	Overlapping of lines both in route and timetables	Lack of an exclusive bus lane
		Problems with controlling moving traffic

‘‘for example to get a 50 year old housewife to get on a bike. . ..is very difficult . . .”

On the other hand, there is a perception that Santander’s topography does not favour the use of the bike as a means of transport in many parts:

‘‘. . .the thing is the slopes in Santander are just too excessive. . .”

Besides, the climatic conditions are unfavourable from the user’s point of view, the rain means using the bike is seen as a seasonal thing. While bike users say that the rain is not a barrier for them, non users look very badly on using the bicycle in the rain:

‘‘. . .rain is not a problem, you wear a raincoat. . .” ‘‘. . ..but perhaps you get splashed a lot. . ..the cars splash you. . .”

Another factor taken into account by the people is the scarce infrastructure and the condition of the existing bike lanes. The bike lanes are not differentiated from the pavements used by pedestrians and the cars show no respect for the bicycles.

‘‘. . .they are not differentiated, paint them red. . .” ‘‘. . .people walk on the bike lane, or go on roller-skates. . ..you can’t see the lane. . .”

The key elements considered by the focus groups for promoting use of the bicycle can be grouped in the following way:

- Education and change the culture of the population. Changes inpeople’s habits normally happen very slowly because they largely depend on past experiences. In numerous studies that have been performed users’ past habits haven’t been taken into account. However, these are very important because they suppose previous learning experiences that could influence the later choice of mode of transport (Gärling and Axhausen, 2003). This is why it is a good idea to promote the use of the bicycle as a means of transport in schools and among young university students, so they acquire the habit of using the bicycle in the future.
- Adequate infrastructure to overcome existing barriers and facilitate the bicycle as a means of transport (creation of more bike lanes and parking spaces, mechanical escalators, and, systems for attaching onto buses).
- Detect and know who the potential users are. The results of the quantitative survey can be used to detect who the current potential bike users are in Santander. This report responds to an initial exploratory study that revealed the needs and requirements of potential users and existing users of bicycles.
- Means to dissuade using the private car in the centre of Santander.
- Locations for potentially building bike lanes (see Fig. 10).
- Offer a bicycle service. The offer of a service should come with some basic conditions as shown later on in this paper. In this respect, it is worth noting the experiences of other Spanish cities and European countries.
- Measures for dissuading the use of the private car in the centre of Santander. Restricting the use of the car can indirectly promote using other modes of transport

like the moped or the bicycle. Mention was made of charging a fee for entering the centre of Santander.‘‘. . .they should pay for taking the car into the centre. . ..”

- Promote the bicycle as a means of transport rather than for daytrips, entertainment or tourism.

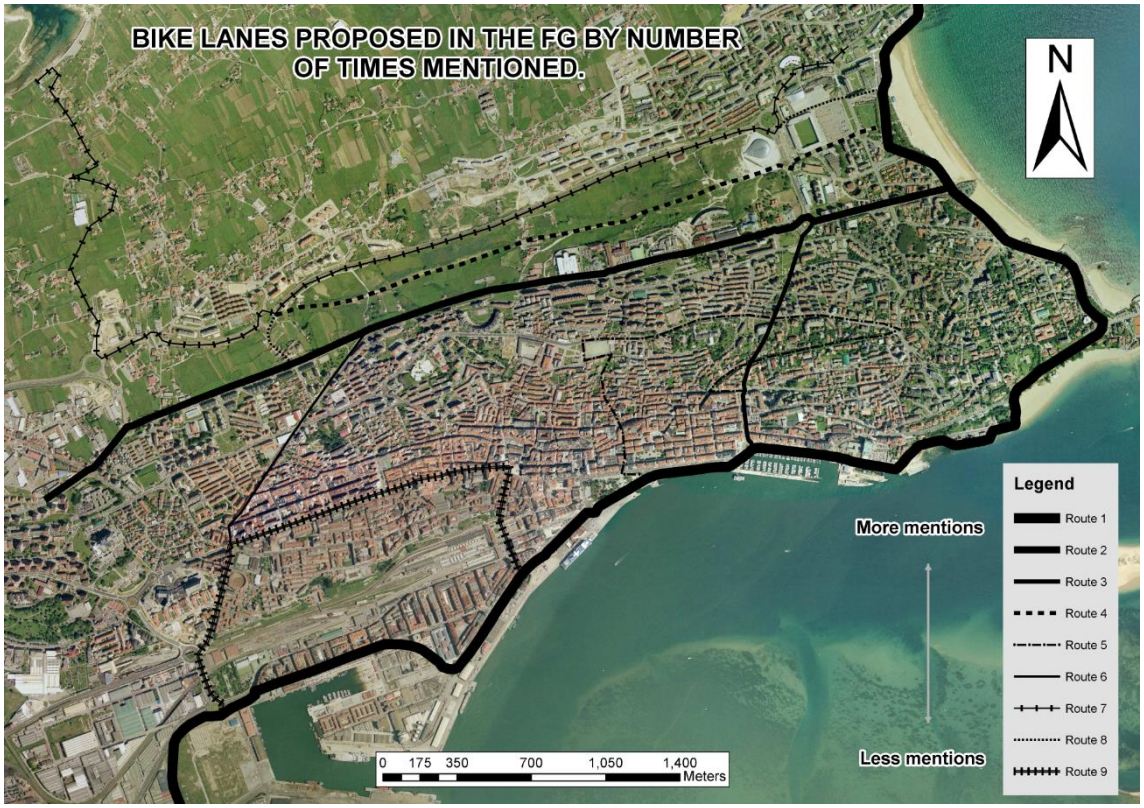

Figura. 10 Bike lanes proposed in the FG by number of times mentioned.

The Mobility Council at Santander City Hall currently offers a bicycle lending service to promote the use of the bicycle for days out and urban use. This service is known to bike users and is very well accepted.

The users see it as a means of transport but mainly for leisure for the following reasons: the limited time table at 6 h reduces its possibilities as a means of transport, the docking stations are scarce and not sufficient for using the bike as a means of transport, and there is insufficient infrastructure for bicycles. The current docking stations favour the tourist and not the resident:

‘‘. . .the three docking stations are tourist locations, they are of no use to anybody, it’s for tourists. . . who goes to Piquío or the Magdalena to work? ”

With reference to willingness to pay, the users are generally positive about the service being free. However, some participants in the focus groups declare that the service should at least have a minimum cost: ‘‘. . . anything that’s free is not valued. . .”, ‘‘. . . at least some modicum amount should be paid for the service. . .”

One of the basic aims of optimizing the service is to steer its use towards the bicycle as a means of transport. Several actions need to be taken to do this, such as: create more docking stations, longer lending periods, solve the problems of the slopes (‘‘. . .In Sweden and Finland there are systems where you arrive with the bicycle, you attach it and it pulls the bike up with a belt, leaving you at the top. . .it was for the bike, because it was in the bike lane. . .”).

This initiative on bicycle lending, presents a whole series of pros and contras that have been classified in a SWOT matrix (Strengths, Weaknesses, Opportunities, Threats) (see Table. 3). The SWOT method is an analysis tool for planning strategies to help in decision making and problem solving. In this study it is a key element for classifying the ideas put across in the focus groups, it helps synthesize and emphasize key points dealt with in the meetings. More exactly, it represents a qualitative analysis methodology, through which the variables or their importance have been determined by a small population sample (nine people for each of the two FG held) for use in the revealed preferences pilot survey on population mobility in Santander. From the very beginning, the SWOT analysis has proved to be very efficient at controlling variables in business management, even becoming an essential technique in diagnosing the current situation (Bradford et al., 1999) in many disciplines.

The city council of Santander is trying to steer the bike lending service towards people who would mainly use it as a means of transport (potential users). After confirming the results of the mobility survey and based on the focus groups held the areas with most potential users appear to be the university sector and business areas with a young and middle aged workforce.

It is also necessary to detect which places are the starting points for most people’s journeys going to the zones determined above, and what means of transport do the potential bicycle users use that come from further away (other towns). For these latter

potential users it would be advisable and convenient to introduce the docking stations at the locations where they reach the city by car or public transport. Therefore, these points would be located at: park and ride, bus and train stations, university campus, trading and industrial estates, and various points located along the bike lane soon to be constructed. There are various ideas about how to pay for the service: intelligent cards, pick-up and drop-off systems and magnetic cards.

Similarly, it is essential to provide bicycle parking places in as many locations as possible throughout the city centre: shops, banks, institutions, etc. Companies should also be motivated to provide their employees with adequate installations related to using the bicycle (showers, places to park, etc.) and appropriate bike lanes should be built for high speed use, with the following conditions: exclusive use for bicycles, delimited lanes, well surfaced, differentiated by a bright colour.

Moving onto the advantages and disadvantages of using a bicycle in Santander, below are the results obtained from the first exercise performed in the focus groups, where the participants were asked to give their opinions (advantages and disadvantages) about using bicycles in the city of Santander (see Fig. 11).

Of the advantages seen in the FG, it is worth noting that in both cases (students and bicycle users) 17% of the group valued the bicycle as an economic means of transport compared to other modes. Moreover, the regular bike users valued the bicycle very positively as a means of transport which is healthy, improves your physique and doesn't generate stress.

Tabla 3 SWOT matrix for analysing the FG on bicycle use in Santander.

Strengths	**Weaknesses**
Promote bicycle use in the community.	A good level of acceptance Weaknesses.
The service is known to bicycle users.	The service is less well known by non bicycle users.
	The service is aimed at tourists and leisure use.
	It is mainly used for just going for a ride.
	Limited possibilities of being used a means of transport, because of:
	Limited time table,
	Few pick up and drop off points,
	Not enough adequate infrastructure in Santander.
Opportunities	**Threats**
Helps in changing habits and attitudes towards using the bicycle, an improved service can be offered if there is a charge:	The service promotes the use of the bicycle as a means of taking a stroll and not as a means of transport.
- more extensive time table,	Bad treatment of the bicycles by certain users of the system.
- more possibilities for parking,	
- modicum amount for payment,	
- the vision of cyclists in the city is an incentive that promotes bicycle use.	

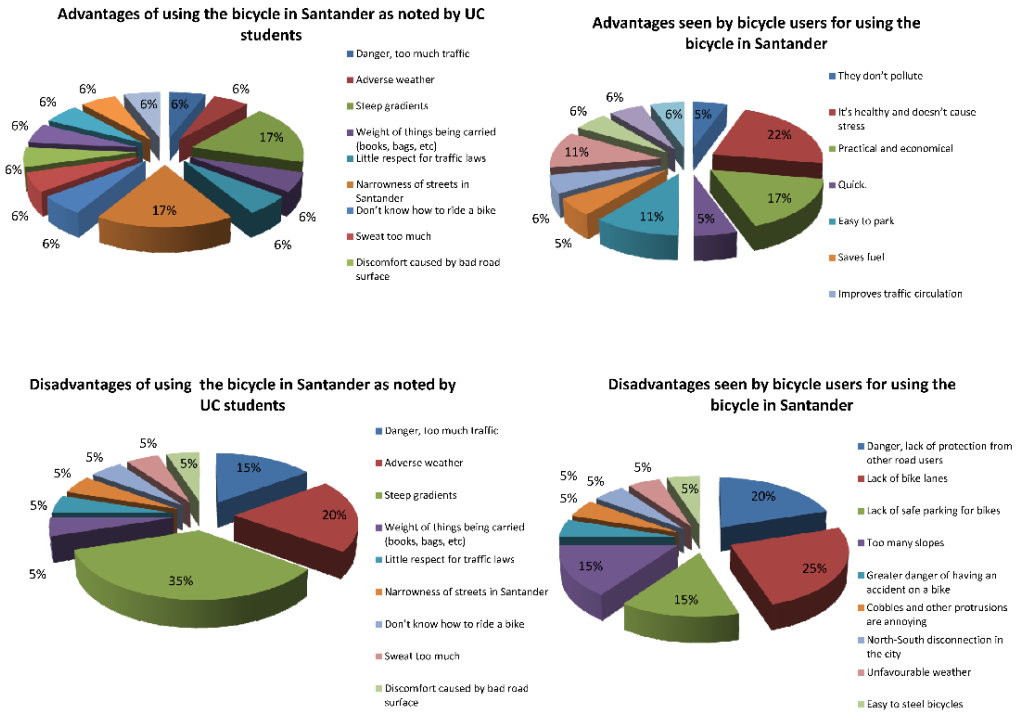

Figura. 11 Advantages and disadvantages noted by the FG of bicycle users and UC students.

On the other hand, referring to the disadvantages seen with using the bicycle in Santander, the group of regular bike users found various factors to explain the little use of the bicycle in the city. Firstly, 25% thought that the lack or scarcity of bike lanes was the main problem. Secondly, linked to the previous problem, 20% thought that there was a lot of danger and a lack of protection for cyclists from other road users. Finally, 15% of the bike users stated that an important inconvenience was the lack of safe places to park.

The noteworthy disadvantages found by the group of students are as follows: 35% considered the steep slopes in the city to be very dissuasive; 20% pointed out the weather conditions (rain); and, finally, 15% of the participants noted the danger due to excess traffic in the city.

2.5. DISCUSSION AND CONCLUSIONS

This article has shown the great importance that citizen involvement can have in developing policies and plans related to sustainable mobility. The citizens are the essential nucleus of any policy as the effects, either positive or negative, of a certain act are going to fall on them. The initial objectives established before the study commenced have been achieved.

Several reflections can be made on the application of the methodology presented here. The information provided by the FG is more detailed so the quality is greater than that provided by the larger groups (MFG).

A smaller sample of the objective population is interacting together which is ideal for dealing with subjects of particular relevance and interest (e.g., bike transport). However, the use of larger groups is much more appropriate as a process of citizen participation (generating greater social impact), perfect for dealing with more generic subjects and where a wider representation of society is required (neighbourhood associations). The advantage of grouping neighbourhood associations into zones comes from their representation of a uniform area with similar problems and characteristics relating to transport.

The FG (eight and nine participants) allows us to study the iterations between different user behaviour contrary to the MFG which deal with similar problems in each of them. The development of this methodology represents a fundamental tool for planners allowing them to better understand the perceived reality, in this case of public transport users, and study possibilities to improve supply and thereby better satisfy the demand. The main objective behind holding the FG and MFG was to help the planner design mobility surveys.

The development of this methodology has led to a process of citizen empowerment. The opinions proffered by the FG and MFG have been incorporated into the mobility plan for Santander (management of the public bicycle system, design of a bike lane network, readjustment in the frequencies of certain bus lines, rearranging lines and modifying certain routes). This type of study, with citizen participation, is very important to

planning, but the results should always be technically checked and tested. Moreover, they should also be carried out from a social perspective and not exclusively based on economic profitability.

Several steps have been taken in the development of this methodology. Firstly, the city was divided into three large macro zones through the criteria ‘‘changes in the use of public transport comparing the situations in 2005 and 2007”. This was achieved by modelling all the transport system, both public and private, in Santander for both years using the simultaneous equilibrium model of the software package Estraus (Siegel et al., 2006).

Another highlight is obtaining user perceptions for the design of pilot surveys on sustainable mobility in an urban environment and from those, questionnaires for definitive surveys. The MFG has been used so that all segments of society had some involvement in the process without any discrimination. This can be seen as a political strategy to attract public involvement by using a subject of general interest to all (problems with public and private transport), to later achieve a more specific objective: holding FG about public bicycles (a subject of less interest which would involve less participation).

Another of the methodological contributions of holding MFG is the creation of a selection mechanism for finding participants for smaller FG (public bicycles). It is also worth mentioning that the MFG have been useful in providing a territorial representation of peoples’ perceptions and opinions through the zoning process.

CAPÍTULO 3

PASSENGER BEHAVIOR IN TRAINS DURING EMERGENCY SITUATIONS

PASSENGER BEHAVIOR IN TRAINS DURING EMERGENCY SITUATIONS

3.1. RESUMEN

En la presente investigación se expone una metodología para el análisis del comportamiento humano (de pasajeros y tripulación) ante una situación de emergencia en trenes de pasajeros.

Esta herramienta metodológica gira en torno a un estudio de carácter cualitativo efectuado a través de grupos focales (GF) y entrevistas en profundidad, para posteriormente extraer las variables que son determinantes en el comportamiento de los pasajeros y de la tripulación cuando se enfrentan a determinadas situaciones de emergencia a bordo de un tren.

A través de esta investigación se ha llevado a cabo la creación de posibles conductas o modelos de comportamiento asociados a cada tipo de incidente en función de ciertas variables. El estudio cualitativo se ha utilizado como base para la posterior modelización de los datos de preferencias declaradas (PD) utilizando modelos de elección discreta de tipo Logit para caracterizar y cuantificar el comportamiento.

Los resultados más importantes muestran que las variables determinantes en el comportamiento de pasajeros corresponden al tipo de emergencia producida (su grado de gravedad), el tipo de pasajero, el motivo del viaje (demandas de tiempo), la información recibida durante el incidente, la relación entre la tripulación y los pasajeros, la duración de los hechos y las condiciones (control de temperatura, disponibilidad de agua, la ocupación del tren), la distancia a la estación de destino y, por último, las condiciones climáticas externas. Esta investigación se llevó a cabo utilizando la red ferroviaria española como referencia, aunque es aplicable a cualquier área geográfica.

El carácter innovador de la investigación presentada se centra en la evaluación científica de cómo las personas involucradas en un incidente de estas características reaccionan y se comportan durante los mismos. Además también aporta el desarrollo de una metodología para la mejora de estas situaciones y el uso de modelos Logit para describir el comportamiento humano en situaciones de emergencia. Los modelos aquí presentados muestran cómo cuantificar las variables de comportamiento humano. El uso de una

metodología basada en modelos Logit no ha sido aplicado anteriormente en el estudio de la conducta humana en situaciones de emergencia a bordo de un ferrocarril.

La investigación cualitativa llevada a cabo en el presente artículo ha sido planteada para crear una clasificación de los incidentes en base a las reacciones de los pasajeros y la tripulación, es decir, una tipología de comportamiento de ambos grupos en función de cada tipo de incidente (conducta negativa y positiva) y para el establecimiento de las variables que rigen cada tipo de conducta de los pasajeros y la tripulación.

Esta investigación de índole cualitativa ha servido como base para el diseño de una encuesta piloto de Preferencias Declaradas (PD). La metodología a través de grupos focales (GF) para el diseño de la encuesta de Preferencias Declaradas (PD) se presenta en este caso como una aportación novedosa a la investigación, con el objeto de predecir el comportamiento humano y las reacciones ante situaciones de emergencia a bordo de trenes. Además, esta metodología se puede aplicar a la hora de proponer nuevas políticas que hagan frente a situaciones inesperadas con el fin de minimizar tanto los riesgos económicos como los humanos.

La presente investigación ha logrado establecer cuáles son las variables más relevantes que influyen en el comportamiento y en las reacciones de los pasajeros ante una situación de emergencia a bordo de un tren.

Estas variables dependen del tipo de emergencia (su grado y gravedad), del tipo de pasajeros (agrupados en diversos segmentos de acuerdo con una serie de variables fundamentales como son el género, la edad, el estado de salud, los rasgos de personalidad), el motivos del viaje, la información recibida (con / sin información, cómo se proporcionó la información, y la frecuencia con la que se proporciona), la relación de los miembros del personal con los pasajeros, la duración de los hechos, las condiciones durante el incidente (aire acondicionado / calefacción, disponibilidad de agua, la ocupación de tren), la cercanía a la estación de destino, y por último, las condiciones climáticas externas. Los resultados muestran que la variable información debe ser considerada de vital importancia y fundamental en el desarrollo futuro de la investigación y puede ser usado como complemento en los modelos de comportamiento utilizados para

modelar la evacuación de pasajeros en ferrocarriles ante las situaciones de emergencia estudiadas.

Todas estas variables llevan asociados consigo una serie de tipos de comportamiento que dependen del tipo de incidente (parón, colisión/descarrilamiento, y fuego/explosión) que se corresponden con irritación, caos, inquietud, confusión, ira, etc., así como una serie de reacciones positivas que pueden ayudar en la gestión de estos sucesos inesperados cuando se producen a bordo de trenes. Los resultados de esta investigación forman la base para el desarrollo de modelos de simulación probabilísticos que serán capaces de simular el comportamiento individual como una función de las características del usuario.

3.2. INTRODUCTION

The overall objectives of this research are, on the one hand, to find out how people behave in emergencies or unusual, unexpected situations when on board passenger trains and, on the other hand, to find the most important variables affecting this behaviour. There are other more specific objectives such as understanding the reactions, behaviour and attitudes of passengers associated to these types of emergencies, the safety information received on passenger trains, and investigating the relationships between passengers and crew in unexpected situations.

Part of the contribution made by this research is, given the enormous difficulty involved in explaining human behaviour when faced with the stress provoked by a railway incident, it tries to systemise and typify the guidelines for all those involved (passengers and crew) in order to have the greatest possible control in the event of an emergency situation.

The complexity of the scenarios creates numerous difficulties for expert psychologists in accident analysis, leading to the need to create a predictive tool for human behaviour like the one presented in this article, which could help in the design of strategies for correctly and effectively dealing with these situations.

Although it doesn't pretend to represent the full range of human behaviour, a further novel aspect of the research presented here is found in the design of surveys associated with the problems of evacuation. They prove to be very useful in identifying the relevant variables

describing the problem and whose influence in each situation has to be checked using an "ad hoc" survey.

The following section evaluates existing research on train safety, especially that dealing with causes, human factors and prevention. Section 3 includes a description of the methodology followed to carry out the research.

Section 4 presents the main results on the behaviour of the groups involved during the incident, the importance of the passenger-crew relationship, the information received as a determining factor in the reactions and behaviour of the users and, finally, a SWOT analysis points out the strengths, weaknesses, opportunities and threats extracted from the opinions of those involved in emergency situations on passenger trains. Section 5 introduces the models designed in this research. The response protocols for passengers and crew during emergency situations are presented in section 6 and finally, a series of conclusions are presented in Section 7.

3.3. STATE OF THE ART

The GIST group (Transport Systems Research Group) at the University of Cantabria has extensive experience using Focus Groups (FG) and Mega Focus Groups (MFG) to research human behaviour. This research has formed the basis for other research projects by providing a priori knowledge on existing problems in a determined field (in this case security on trains). The information proved to be very useful in modelling the behaviour of implicated sections of society. Ibeas et al. (2011) used FG and MFG for the research project "Citizen involvement in promoting sustainable mobility" to find out people's opinions and perceptions on mobility within an urban environment.

Following on from that research, the present article presents the design of a methodology which studies human behaviour in the field of safety on board passenger trains. It is worth pointing out that, in spite of its great complexity, the subject of safety on board trains has been looked at over many years and has been and still is the subject of scientific research.

Of the many projects that have been carried out the ongoing Japanese research projects started in 1927 are noteworthy for their content and longevity. Causality is the initial important factor to look at when investigating safety on trains. This is understood to be

the chain of events leading up to the incident/accident. Several world renowned authors have studied the causes of railway incidents and accidents. Fukuda (2002) defines an incident as an event which has the possibility of causing an accident or an abnormal event with no damage. Ugajin (1999) distinguishes between external causes of the incident/accident (crossings, trespassing on lines, and obstacles on lines) and internal causes (personnel, equipment, rolling stock).

This has led to the establishment of groupings for these phenomena such as those made by Fukuoka (1999) based on three categories (internal events, external events and fire). Many of the methodologies used for evaluating human behaviour in the field of safety on trains are based around the perceptions and opinions of both the train operators (drivers, inspectors, employees, etc.) and the passengers. Some of the more noteworthy cases found in the worldwide literature are described below.

Interesting work by Mivachi (2008) asked various questionnaires to different train operators in order to clarify the causes coming from "possible human error" in the unravelling of a railway incident or accident. Shinomiva (2002) carried out similar research but without using questionnaires, instead in-depth interviews were held with passengers who had been involved in a railway collision to collect information and data which enabled the safety level to be measured quantitatively for a similar situation.

Davey et al. (2008) also presented research about the perceptions and opinions of 17 train drivers in order to discover the most common causes of accidents on level crossings. Various research projects have studied the prevention of railway incidents and accidents by comparing events that have already happened. Santos-Reyes and Beard (2009) presented the results of the analysis of a railway accident in Edge Hill, Liverpool (UK).

They designed a methodology which could be used to identify the most relevant points for preventing similar accidents by comparing the features of the Edge Hill accident with the structural organisation of a Systemic Safety Management System (SSMS) model which was constructed by employing the concepts of systems. Baysari and McIntosh (2008) reviewed numerous safety reports on trains in Australia. They found that almost half the incidents were clearly due to failures in equipment caused by inadequate maintenance and monitoring programs. Important research was carried out by Radbo et

al. (2005) on increased safety systems on Swedish trains to avoid them being used for committing suicide. The methodology of this research was based on the synthesis of accidents which had happened and generic models on suicide prevention.

Although many research projects have been carried out on different aspects of railway safety, the originality and importance of the work presented here can be appreciated because no methodology has been found which standardises different behaviours and reactions when faced with a railway incident or accident.

Clearly, much of the existing research concentrates exclusively on discovering the causes of incidents without trying to deal with the conduct of the passengers and crew during their unravelling.

This question is vitally important when planning safety on board trains and shows the innovative character of the research presented here which concentrates on the scientific and methodological advancement of the study of human behaviour by studying the reactions of the different groups of people involved in these events. A very useful tool is presented which can be used to explain how the various operators behave and to provide a series of relevant variables to be used in more specific future research.

User behaviour has been defined by using Multinomial Logit models. The international literature provides many examples of research, which has used this type of model to study user behaviour in different situations. Multinomial Logit models were applied in studying user behaviour during residential location (Waddel, 1996 and Guo and Bhat, 2001) and other authors have used these models in the field of transport planning (Mohammadian and Kanaroglou, 2003). They have also been used to study the users' perception of the quality of service they receive from public transport (dell'Olio et al. 2010, 2011a, 2011b, Rojo et al. 2011).

Logit models have also been applied in the evaluation of user behaviour when parking (dell'Olio et al. 2009). Although the efficiency of these models in studying human behaviour has been well documented, this is the first time they have been applied for this purpose on-board passenger trains during emergency situations. The contribution of this research is not only in the use of the multinomial logit model, but also in the quantitative

evaluation of determined behaviours and the development of a response protocol based on the study's results.

3.4. METHODOLOGY

The methodology presented in this article forms the basis for performing research on human behaviour, not only in trains, but in any other scenario, making it an extremely useful tool which can be applied in a multitude of contexts.

Due to the difficulty of reproducing an accident itself. This methodology centres around a qualitative study based on 2 FG made up of passengers (between 8 and 12 participants each) who have been involved in incidents and frequent railway users who have not, as yet, been involved in incidents. Both FG provided valuable information on the reactions and visions of the passengers, essential data for the correct management of an emergency situation. Furthermore, 10 in-depth interviews were held with experts, directors, drivers, and inspectors from different areas of the Spanish railway network who have told of their experiences and opinions.

The results obtained from this initial qualitative phase have been used to establish a classification of emergency types according to passenger perception, along with a typology of their behaviour associated with each type of incident, making it possible to define the determinant variables on passenger behaviour when faced with a particular type of incident. The in-depth interviews provided an accurate description of reality, the available means for managing these situations, and the training and ability of the personnel. A review of the main determinants and definitions established by various expert authors on the subject provides the concept and theoretical framework to define a FG.

"A focus group is a research method designed to explore a particular topic by gathering the experiences and perceptions of selected target populations" (Ward and Alkins, 2002). Bruseberg and McDonagh (2002), where a moderator leads the group and guides the conversation. However, Krueger and Casey (2000) define a FG as a carefully designed discussion providing people's perceptions on a particular area of interest. The variables provided by holding the FG were used as the basis for designing a Stated Preferences

survey which was asked to passengers at railway stations. A qualitative study was followed by using logit type discrete choice models to quantify their effects.

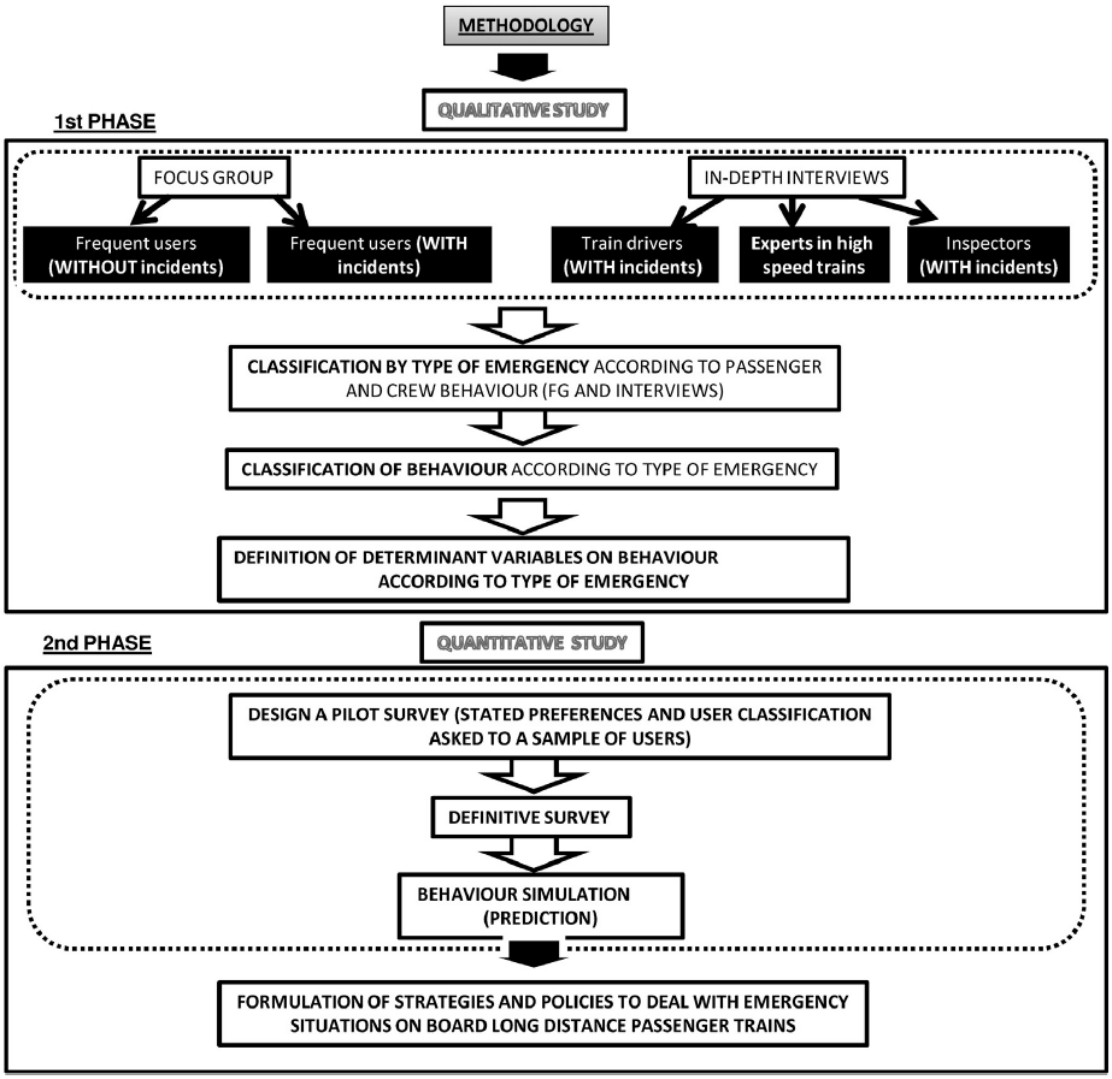

Figura. 12 Methodology followed.

3.5. ANALYSIS AND PRESENTATION OF RESULTS

The results from the FG and the survey data modelling will be presented below. Several noteworthy points appear from the FG results. Firstly, the results showing the behaviour of the agents (crew and passengers) involved in the incident are presented. The relationship between the behaviour of both agents during the event is then highlighted. This relationship has a direct affect on the behaviour of both groups. Thirdly, the information received (before and during the event) is explained as a factor, which determines the reactions and behaviour of the passengers. The effects of a possible absence of information are also shown. Finally, a SWOT matrix is created to find out the state of the Spanish railway network according to the perceptions and opinions of its passengers.

- The behaviour of the parties involved during the incident.

The passengers and crew also agree about the following influential variables on passenger reaction: level of seriousness and risk in the situation, extreme temperatures (lack of climate control on the train), time (at meal times the passengers become more intolerant), overcrowding, distance from the journey's end station, type of emergency, particular personal characteristics (personality traits, age, state of health), information received, and individual personal conditions related to the journey.

There is general agreement between the opinions of the staff and passengers about these variables, except for the safety information, which train users should receive.

According to the interviewees (the staff) the following behaviour by passengers has been commented on as positive conduct during emergencies: understanding of the situation, kindness towards staff and other passengers, recognition of the positive role played by the staff members, neutralising negative behaviour in other passengers, less urgency given to the perception of their own personal needs, solidarity with the problems and needs of other passengers, an attitude of patiently waiting and offering to help the staff.

In the case of stoppage, many different passenger reactions were observed:

- At high temperatures the passengers became impatient, showed a lack of understanding and could even go as far as breaking the glass in the windows to let air in (a situation related in one of the interviews).
- During cold weather the reaction of the passengers is not as alarming as it is during hot weather without air conditioning.
- The way in which a passenger reacts to a stoppage situation largely depends on their time table.
- During a stoppage the behaviour of the passengers varies depending on the information they receive, firstly over the speakers and then in person from the inspector.
- The lack of information causes uncertainty and irritation, which the passengers may express by protesting, criticising, or even insulting the inspector.
- A stoppage at lunchtime reduces the passengers' tolerance levels during an emergency.

Their need to take in some food increases the sensation of frustration. If an evacuation is needed then the reactions and behaviour of the passengers depend on the physical and technical factors associated with the evacuation. If all the necessary technical resources are available for the evacuation then negative conduct is not normally observed in the passengers. They are often prepared to help each other, young people helping old people and women with children, etc. An evacuation which includes a transfer to another means of transport is frequently seen as relief and the solution to the problem.

Therefore, the passengers actively participate in making sure that the exit from the train goes ahead in the best possible conditions. In the case of a collision, some members of the focus groups felt that when the situation was more serious then the passengers normally show more understanding and are more prepared to collaborate than in simpler cases of a stoppage and consequent delay of the train

In the case of transfers, according to the experience spoken of in one of the interviews, the crew look after the needs of the passengers, especially in the cases of older or disabled people. There are acceptable levels of confusion, alarm and apprehension among the

passengers. In the case of somebody being run over, if there is a death involved then all the legal steps have to be taken before the train is allowed to continue, which could mean a wait of 2 or 3 hours. If the conditions of the wait are acceptable (air conditioning, food, drink, etc.) .then the passengers appear to be understanding.

- The importance of the passenger-crew relationship during the incident.

The inspector is the official who deals directly with the passengers. Generally, both the FG and the interviews showed that the passenger-crew relationship is of an acceptable standard.

As would be expected, the users demand, show their needs, consult, ask for information and the inspectors inform, organise, reply to requests, and try to provide for peoples' needs. The relationship of the inspector with the passenger depends on the personal ability developed by each one through experience gained in the role (there is no official training or formal preparation for developing these abilities). The inspectors are aware of the need to: appear confident and calm in front of the passengers, win the passenger's belief in them (transmit confidence, and avoid contradicting information), behave in a professional, coherent way in the role, treat all the clients well (with no exceptions even the more difficult ones).

The interviews with the members of staff showed that they understood the passengers' point of view. There is even one instance during the stories about real emergency situations in which the inspector tries to solve each of the individual situations of the train users.

On the other hand, the passengers believe or expect that the members of staff are trained and prepared for dealing with emergency situations. But, according to the interviews with crew members, experience is the only way that they acquire the abilities needed for dealing with passengers during emergencies.

- Information received as a determinant factor in user reactions and conduct.

There is agreement between passengers and staff that the information given to the clients and the way incidents are communicated are determinant factors in how train users react

and behave during an emergency. The reasons why the passengers think they should receive information during an incident or emergency, are: to calm down the passengers; to explain as much as possible about what has happened, without going into technical details; to estimate how much time the situation will last, with the understanding that they are estimates which may vary depending on how the situation develops; the information given out will allow the passengers to call their families, friends, or work places to explain what is happening, ask for personal help, reprogram their activities; talk about and look for possible solutions to the situation (for example, check out the availability of buses, or other trains, the eventual distribution of water, food, emergency services like ambulances, fire service, etc.); put across a unified and coherent version of events; and finally, let the passengers know how they are expected to behave.

The following table shows in which aspects these differences appear:

Tabla 4 Differences in the perception between passengers and crew about the information received by travelers during a train emergency.

Passengers	Crew
- Some of the users consulted in the focus groups stated that they had never received any information about real stoppages or emergencies they had lived through on some train journeys. - They don't report on the time they estimate it will take to solve the problem. - Information is passed on by word of mouth between the passengers. Sometimes the information gets distorted and some passengers are misinformed. - Some of the train passengers never receive any information.	- The crew who were interviewed stated that they always gave out information about emergencies to the passengers. - The staff cannot report on the time it will take to solve the problem. You can only give estimates which may not turn out to be true. - During serious emergencies the crew have to prioritize the reduction of risk. - During an emergency there is not always a speaker system available and the inspector does not have time to inform everyone up to the last carriage.

There are further secondary effects, which are derived from not providing the passengers with enough information. Note that, in an emergency situation the lack of information intensifies the feelings, which provoke negative reactions in the passengers.

Table 5 shows some examples of feelings, which may appear during emergency situations and the consequent negative conduct in the reactions of the passengers.

Tabla 5 Feelings and conduct of passengers in response to the lack of information in an emergency situation.

Feelings	Negative conduct
- Uncertainty. - Apprehension and fear brought on by thinking about possible risks. - Confusion - Frustration brought on by a lack of information which would enable them to reorganize their journey. - Anguish due to physical discomfort (for example, due to excessive heat).	- Irritation, uneasiness, expressions in questions, demands and even insults made to members of staff (represented by the inspector). - Irritation, anger, shouting, agitation. Prohibited behaviour (for example, trying to get off the train). Chaos and disorder, irritation, indignation, demanding information. - Prohibited behaviour opening doors, breaking windows, getting off the train.

Another particularly relevant aspect of this is the importance of providing the correct preventive information to the passengers. Preventive information is not generally given out on trains.

- SWOT analysis of the Spanish railway network.

Table 6 shows the results obtained from this exploratory research on the strengths, weaknesses, opportunities and threats around passengers and crew during emergency situations.

A SWOT (Strengths, Weaknesses, Opportunities, and Threats) matrix was designed based on the results obtained in the FG and in-depth interviews. The SWOT method is an analysis tool for strategic planning, which helps the decision making process and problem solving. In this research it represents a key element in the classification of the ideas provided in the FG by synthesising the main subjects they covered.

Tabla 6 SWOT matrix for analysis of results.

SWOT matrix for analysis of results.	
Weaknesses	**Threats**
– No clear policy of research and analysis of emergencies, little transparency	– With little transparency in the policy there is no continual learning process about what actions to take in case of emergency
– Lack of staff training and preparation to tackle emergency situations, about dealing with passengers	– Greater risk of passengers behaving incorrectly
– Lack of development of some aspects of the policy on prevention in safety issues; information for passengers, sufficiently informative leaflet, mention of the leaflet on the speaker system, etc.	– Lower ratings of user satisfaction
– Problems with excessive luggage, lack of an adequate system for regulating luggage before boarding the train.	– Luggage may block walkways and escape routes during an emergency
– Weak coordination	– Greater risk of poorly dealing with passengers in case of transfers, incapability of solving passenger needs during emergencies, etc.
– Lack of a continuous systemized research and analysis program about experiences during emergencies which also involves the perceptions of the passengers and crew.	– Difficulties in providing for the needs of the users due to lack of knowledge about needs and opinions of passengers during emergencies
Strengths	**Opportunities**
– Crew members. Good attitude and willingness to deal with emergency situations and respond to the needs of the passengers.	Optimize the actions of the Train Operating Company in case of emergency:
– Good provision of technical resources by the train operating company.	– Define and implement a clear and transparent policy to get to know, study and analyze real experiences of emergencies. Include the perceptions of both the passengers and staff.
– Excellent willingness of the train operator to provide alternative means of transport in case of needing to make transfers and even in dealing with the particular needs of individual passengers.	– Learn from the continual research and analysis of experiences of emergencies.
– Willingness of the train operator to provide food and drink to the passengers.	– Better staff training.
– Good communication with the emergency services and the network of support institutions	– Allow for continual learning from experiences of emergencies.
	– Obtain better collaboration from passengers by:
	• Preventive information
	• Optimizing the information provided during emergencies.
	• Optimize the relationship between the staff and the passengers
	– Improve the satisfaction levels of both staff and passengers in journeys that have experienced emergency situations.

- Models used to estimate the behavior of high speed train passengers during emergency situations.

The methodology followed in the user behavior models applies discrete choice models, especially a Multinomial Logit model, to model user behavior as a function of incident type.

The discrete choice models are based on random utility theory whereby the modeler proposes a utility function (Ujq) for each possible choice that is equal to the sum of a systemic or measurable utility (Vjq) and a random part (εjq) representing idiosyncrasies and/or the tastes (preferences) of each individual. Any modeler errors in measuring and observation are also taken into account.

$$U_{iq} = V_{iq} + \varepsilon_{iq}$$

Although the term V has been defined as representative of the individual's measurable characteristics, the subscript q has been introduced when V is a function of attribute X and the semay vary from person to person. Without any loss of generality, it is accepted that the residuals εjq are random components with a mean of zero and a certain probability distribution to be specified.

$$V_{iq} = \sum_k \theta_{ki} \cdot X_{kiq}$$

Individual *q* chooses the alternative which provides maximum utility, i.e., they choose A_j if, and only if:

$$\boldsymbol{U_{jq} \geq U_{iq}}, \ \forall \boldsymbol{A_i} \in \boldsymbol{A(q)}$$

meaning:

$$\boldsymbol{V_{jq} - V_{iq} \geq \varepsilon_{iq} - \varepsilon_{jq}}$$

Therefore, the probability of choosing alternative A_j is given by:

$$\boldsymbol{P_{jq}} = \text{Prob}\left\{\boldsymbol{\varepsilon_{iq} \leq \varepsilon_{jq} + (V_{jq} - V_{iq})}, \ \ \forall \boldsymbol{A_i} \in \boldsymbol{A(q)}\right\}$$

Maximum likelihood (ML) is normally used to calculate the coefficients Θ_{kj}. The likelihood function is given by the product of the probabilities that each individual really chooses the option selected:

$$L(\theta) = \prod_{q=1}^{Q} \prod_{A_j \in A(q)} \left(P_{jq}\right)^{g_{jq}}$$

Defining the following fictitious dummy variable:

$$g_{jq} = \begin{cases} 1 \text{ if q choose } A_j \\ 0 \text{ otherwise} \end{cases}$$

The models used in the characterisation of user behaviour as a function of incident type are presented below.

3.6. MODELS DESIGNED FOR THE ANALYSIS OF USER BEHAVIOUR BY INCIDENT TYPE

The focus groups provided the basis for designing a Stated Preferences survey to study passenger behaviour during different kinds of incidents. An in-depth analysis of the FG concluded that there are two typologies of incidents that show clearly different behaviours. These typologies are the stoppage and the medium and high level accidents (fires on board, explosions, collisions, derailments, etc.). The middle and high level accidents were identical in terms of user behaviour. In other words, the passengers reacted in the same way when faced with these two levels of accident. It can be assumed that when a certain point is reached where the incident is associated with a certain amount of danger, the focus of the danger (fire on board, explosion, collision or derailment) is not as important as finding oneself in the situation of danger itself.

Therefore, the possible alternative passenger behaviours are given by accident typology, as shown in Table 7. The aim of the survey is to study typical passenger behaviour based on the situation they are presented with.

Tabla 7 Different user behaviours as a function of incident type.

Different behaviors as a function of incident type

Stop page	Fire/explosion/collision/derailment
1. Try to get off the train.	1. Search for crew member by themselves.
2. Search for crew member by themselves to ask about the current situation.	2. A wait instructions.
3. Await instructions from the crew	3. Try and get off the train.
4. Get together with other passengers and look for a crew member to obtain information about the current situation.	4. Provide assistance.
	5. Freeze, not do anything

The data obtained from this survey was used to calibrate multinomial logit style discrete choice models. Each choice alternative (see table 7) was given a utility function which depended on a series of variables defined using the methodology described above.

The final sample size (see number of observations in Table 8) was determined by considering the a priori parameters obtained by calibrating the models (one in the case of stoppage and another in the case of Collision /derailment-Fire/ Explosion) with the data from a pilot survey asked to a sample of 50 users, applying the following formula:

$$N \geq \left(\frac{se_{k(X,\beta)} t_{\alpha}}{\beta_k}\right)$$

his number (N) provides a lower bound on the necessary number of the sample size in order to obtain significant estimates for parameter (see Bliemer and Rose, 2009) considered to be the critical parameter for each model (where = 1,96 is the t -value corresponding to the confidence interval considered, is the standard error and X is the data array). The measure proposed by Bliemer and Rose (2009) is derived from the observation that if some parameters need much higher sample sizes than others, it may be better in the experiment to focus more on the parameters that are difficult to estimate significantly.

The results of the estimated discrete choice models are presented below.

Tabla 8 Values of the variables for the analysed incidents.

Table 8 Values of the variables for the analyzed incidents.

Variables	Stoppage		Collisision/derailment-fire/	
	Coefficient	Test-t	Coefficient	Test-t
ASCP1	− 8.692	− 4.465		
ASCP2	− 4.641	− 3.260		
ASCP3	− 1.907	− 1.640		
ASC1				
			3.058	3.003
ASC2			6.099	6.105
ASC3			5.954	7.107
ASC4			7.861	8.881
FREC	0.026	2.482		
DUR	− 0.038	− 1.751		
SDUR			− 0.043	− 3.231
EDU	1.905	4.244	0.339	2.871
FRVJ	0.356	3.090		
EVA	− 0.701	− 2.170	0.680	5.532
SEX	0.583	1.809		
PTM	− 1.535	− 3.176	− 0.771	− 2.953
DBPTM	2.060	2.856		
DBMG	− 1.878	− 1.734	1.847	2.305
RENTA PROX	0.001	1.835	0.001	− 3.532
PU			− 0.008	− 5.070
IE			− 0.665	− 2.596
			0.266	1.537
MU			2.391	3.938
Log C Log L	− 269.623		− 698.101	
Number of observations	− 225.848		− 638.079	
	306		585	

As is common with this type of study, when data are not available from other accidents or similar models, the only way to validate the model is by considering the coherence of the signs of the model's explanatory variables (marginal utilities) and the statistical significance of the estimated parameters (see Cascetta, 2009).

The variables used (table 8) for the studied incidents are explained below:

- ASCP: The specific constants of the choice alternatives associated with the stoppage (see table 9).
- ASC: The specific constants of the choice alternatives associated with "Collision /Derailment/Fire/Explosion" (see table 9).
- FREC: Time in minutes between announcements.
- DBMG: Iteration dummy variable (value of 1 if the message is over the speaker system and the estimated duration of the stoppage is low).
- DUR: Estimated duration (of the stoppage).
- SDUR: Iteration variable sex for the duration of incident variable.
- EDU: Standard of education. (From 1 (without qualifications) to 4 (university education)).
- FRVJ: Frequency of journey. (From 1 (never) to 5 (frequent))
- RENTA: Value of the variable representing passenger monthly income.
- EVA: Assessment of passenger mood (Calm/Nervous).
- SEX: Dummy variable (1 for women and 0 for men).
- PTM: Dummy variable (1 if the message is given in person (driver or crew member and 0 over the speaker).
- PROX: Proximity, in metres, to the place of the incident.
- DBPTM: Iteration dummy variable (1 if the message is given in person (driver or crew member) and the estimated duration of the stoppage is low (less than 45 minutes) and 0 if the message is over the speaker and/or the estimated duration of the stoppage is high).
- PU: Dummy variable (1 if the incident occurs on a bridge, 0 in other cases).
- IE: Dummy variable (1 if the type of incident is fire/explosion and 0 if it is collision or derailment).
- MU: Dummy variable (1 if there are fatalities, 0 in other cases).

Tabla 9 Elasticities obtained for the incidents studied

Stoppage	Variable	Elasticity	Collision/explosion	Variable	Elasticity
Search for crew member in group	FREC	0.523	Search for crew member individually	DBMG	0.076
	DUR	-15.026		SDUR	-10.525
	EDU	61.554		EDU	11.062
	FRVJ	13.686	Await instructions	SDUR	-0.803
Search for crew member individually	FREC	0.375		EDU	0.837
	DUR	-11.461		RENTA	-0.527
	EDU	4.852	Try to get off the train	SDUR	-0.876
	FRVJ	10.325		RENTA	-0.570
Await instructions	EVA	-16.249		PTM	-0.514
	SEX	0.236		EVA	18.984
	EDU	20.377		PROX	-0.580
Try to get off the train	EVA	-0.800		PU	-0.198
	PTM	-0.399	Provide assistance	SDUR (4)	-10.026
	DBPTM	0.027		PROX (4)	-0.380
	EVA	-20.903		IE(4)	0.066
	PTM	-0.960	Freeze/do nothing	EVA (5)	23.368
	DBMG	-0.430		PROX(5)	-0.6838
	RENTA	13.145		MU(5)	0.470

Varied results have been obtained considering the estimated coefficients and the elasticities of each variable with respect to the choice probability of the alternatives presented in table 9 for the stoppage incident.

On the one hand, if the time between successive transmissions of information is longer (FREC) then there is an increased probability that people will start to look for crew members. As the estimated duration of the incident (DUR) increases, there is a reduced probability that people will start to look for crew members, given that it is assumed they have already received some kind of information.

According to the elasticities the standard of education (EDU) has a positive effect mainly on the alternatives where the travellers look for crew members to ask for information. This is logical considering that the value of time rises with higher standards of education and, therefore, people need information in order to organise themselves. Furthermore, the frequency of journey (FRVJ) has a positive effect on the two alternatives which refer to

looking for crew members for information. In other words, as passengers' travel frequency increases it becomes more probable that they will look for crew members during a stoppage in order to get information. This is because experienced travellers are more confident about moving around the train and talking to crew members. It is also worth pointing out that as people become more nervous (EVA) they associate less utility to all the alternatives. It particularly influences the alternative "try to get off the train" negatively, which would have appeared to be the most likely alternative for a nervous person, however, it doesn't appear to be the case for the type of accident in question.

This research found that the gender variable (SEX) affects the behaviour of the passengers. Women were found to be more likely to look for a crew member to find more information. The way that the information is transmitted also has an effect, when the crew member is present and personally informs the passengers (PTM) it appears to reduce the probability that passengers will remain in their seats and await further instructions, given that speaker announcements can be quicker and avoid confusion.

This negative effect is partially compensated if the message communicates a short duration for the stoppage (DBPTM). The variable PTM also has a negative effect on the alternative "try to get off train", so there is a lower probability that, in case of stoppage, the users will try to get off the train after having been directly informed by crew members. Finally, it is worth noting that the alternative "try to get off train" appears to be less useful when a message is given over the speaker system relaying information that the stoppage will be of short duration.

In other words, the passengers are not expected to try and get off the train if they are told the stoppage will only last a short time.

Similarly, the estimated coefficients and the elasticities for each variable provide varied results about the probability of choosing one of the alternatives presented in table 9 for the following incidents: collision, derailment, fire and explosion.

On the one hand, it is worth pointing out that if the type of incident is a fire/explosion, or a collision/derailment and the speaker system is used to inform the passengers that the incident will be of short duration (DBMG), the passengers are more likely to get up and

look for a crew member. This is because such incidents or accidents are more serious than a stoppage and the passengers need to be informed in person.

Gender appears to have an effect on the perception of the duration of an incident (SDUR). As the duration of the incident lengthens a man becomes more likely to get up and look for a crew member. The same situation happens with the alternatives await instructions, try and get off train and provide support.

The alternative "search for crew member by themselves" has a positive relationship with the passenger's standard of education (EDU). As the standard of education increases so does the probability that a passenger will get up and try to find a crew member to find out more information in case of fire or collision. It can also be seen that higher standards of education increase the probability of a passenger remaining seated and awaiting instructions.

The coefficient associated to the variable "income level" has a negative sign and significance for the alternatives that group together those users who await instructions and those that try to get off the train by themselves. Therefore, in the event of an accident as an individual's monthly income increases there is a lower probability they will await instructions from the crew, or in other words, it is more likely they will try to get off the train by themselves.

The way that information is conveyed also influences passenger behaviour during accidents and of particular note in this case is that information provided in person (PTM) has a negative effect on the alternative try to get off the train by themselves. As in the previous case the presence of crew members appears to have a calming effect on the passengers.

The variable evaluating the effect of a person being nervous or calm (EVA) shows how the type of accident influences an individual's behaviour. In other words, while in the case of a stoppage a negative coefficient was obtained for the EVA variable associated wit the alternative "try to get off train", in the cases of fire/explosion or collision/derailment, there is a positive sign for the same alternative. In other words, a

more nervous passenger in a more serious situation is more likely to try to get off the train or, if the situation becomes very serious, freeze and do nothing.

The distance from the place of the accident (PROX) has a negative effect on the alternatives "try to get off train", "provide support" and "freeze/do nothing". In fact, as the distance from the exact place of the accident increases the danger perceived by the passengers decreases and, therefore, reduces the need to get off the train or get involved because the seriousness of the situation means others need to be helped or people freeze and do nothing.

Evidently, if the accident occurs on a bridge (PU), although the situation is serious, there is a lower probability that people would try to get off the train on their own accord. The dummy variable "IE" has also been introduced into the model to distinguish the case of fire/explosion from that of collision/derailment. Given the coefficient of elasticity it is noteworthy how in the case of fire/explosion, (presumably a more dangerous situation) there is a greater probability of providing support. Finally, the variable presence of fatalities (MU) increases the probability of "freezing/doing nothing".

All this information can be of great support in understand how people behave during an incident/accident on long distance trains. Knowledge about how passengers react under certain circumstances allows the authorities to anticipate more complicated situations and prepare train crews to take the correct measures (information, etc.) to deal with the incident.

All these results have been supported by passenger's surveys (passengers affected and no affected by railways accidents) as it is said previously. The models obtained from

Passenger's surveys data also support main conclusions in focus group analysis.

3.7. RESPONSE PROTOCOL

The data obtained in the present research has been used as the basis for designing response protocols to be applied for both passengers and crew. Whether the emergency situations are a result of incidents or more serious accidents, both crew and passengers should be aware of the behaviour that is expected of them for the situation to be managed correctly.

The general guidelines of the response protocols are shown below in Table 10 describing the action that should be taken in case of stoppage, collision with or without derailment and fire with or without explosion.

Tabla 10 Response protocol for crew and passengers.

RESPONSE PROTOCOL				
INFLUENTIAL VARIABLES	**STOPPAGE**		**COLLISION WITH/WITHOUT DERAILMENT/FIRE WITH/WITHOUT EXPLOSION**	
	LINES OF ACTION			
	CREW	**PASSENGERS**	**CREW**	**PASSENGERS**
Means of transmitting information	Information in person/speaker	Await instructions	Use speakers to inform everyone on board /Necessary information in person in the area affected	Await instructions/stay calm/ help people in need.
Duration of inciden	**Short duration**: inform via speaker **Long duration:** inform in person	Await instructions in all cases	Use speakers and crew in person to convey information	A wait instructions and do not attempt to leave the train (unless the reis a danger to life).
Frequency of receiving information	**Short duration:** inform continually (at short intervals) **Long duration:** inform at longer intervals both in person and via speaker.	Remain calm /A wait instructions	use speakers regularly combined with short periods of crew in person	Await instructions/Stay calm/ help people nearby
Place of incident	Inform about the place of incident	Await instructions	Guide the passengers to a safe area (on board or off the train)	Await instructions unless there is danger to life (in which case try to exit the train).
Attitud of the crew	Remain calm to help keep the passengers calm	Remain calm / await instructions	Remain calm and transmit a feeling of control to the passengers.	Always collaborate with the crew.
Internal temperature	Create the optimal environment by distributing hot/cold drinks and blankets if needed	Await instructions		
Presence of injured/fatalities			Notify superiors about any injuries or deaths and their location on the train	Inform crew members about any injuries or fatalities.
Proximity of the injured/deceased to the interviewee			Avoid contact between fatalities and other injured passengers to avoid distress to passengers.	Inform crew members about any injuries or fatalities.

As can be seen in the table presented above, the response protocol is the same in the case of accidents resulting from collisions as in the cases of fire. The influential variables provided by the FG were used to establish a series of responses or action guidelines that should be followed by both passengers and crew in case of an incident/accident.

If a stoppage is of short duration the crew should communicate this fact to the passengers through the on-board speaker system at regular, short intervals, nevertheless, if the stoppage is for a long duration, the crew should also provide this information in person at regular, longer intervals. The crew should also provide the passengers with information about the exact location of the train at the time of the incident. The crew should have a positive attitude which transfers a feeling of calm to the passengers. If the internal temperature of the train is uncomfortable (too hot or too cold) then the crew should offer drinks (cold/hot) or blankets to the passengers. The protocol that passengers should follow in the case of a stoppage is to await instructions from the crew and always to remain calm.

In the case of a collision (with/without derailment) and fire (with/without explosion) as well as using the speaker system to inform the passengers, the crew should also provide information in person in the affected part of the train. This information will be provided regularly at short intervals to keep the passengers calm. The crew, meanwhile, should be guiding the passengers towards a safer area (on-board or outside the train). In order to keep the situation under control the crew members should show a positive attitude in order to transmit an atmosphere of calm. If there are injuries or fatalities in the accident then the crew should immediately notify the exact position to their superiors and at the same time avoid contact between victims and the rest of the passengers in order to prevent panic spreading.

In the case of an accident the protocol that passengers should follow states that they should await instructions and try to stay calm while helping anybody worse affected.

They should exit the train in an orderly manner, avoid impeding others and collaborate with the evacuation of those worse affected. Passengers will also be obliged to inform the crew members about any injured passengers or fatalities in their immediate surroundings.

3.8.CONCLUSIONS

This research has shown the need to anticipate the behaviour of both users and crew on board trains as a key element for correctly managing and resolving an emergency situation. This article has described the design of a methodology for studying human behaviour within the field of railway safety. The state of the art section showed the existence of a great deal of research on railway safety which has concentrated exclusively on the causes of incidents without hardly looking at passenger and crew behaviour during their development, a logit model review of similar applications is also presented.

The innovative nature of the research presented here concentrates on the scientific evaluation of how the people involved react and behave during these events and the development of methodologies to improve these situations and the use of logit models to describe human behaviour during emergencies. Models presented here show how to quantify quality of behaviour variables. The use of a methodology based on logit models is new to the study human behaviour during railway emergencies. The qualitative research carried out was used to create a classification of incidents based on the reactions of passengers and crew, a typology of behaviour of both groups depending on each type of incident (negative and positive conduct), and to establish the variables governing each type of conduct in the passengers and crew.

This qualitative research has provided the basis for designing a Stated Preferences Pilot Survey. The methodology using focus groups in the design of the SP survey is presented here as a novel contribution to research predicting human behaviour when reacting to emergency situations on board trains. Furthermore, this methodology can be applied to propose new policies for dealing with unexpected situations in order to minimize both the economic and human risks.

This research has established the most important variables influencing how passengers react and behave during railway emergencies. These variables depend on the type of emergency (its degree and seriousness), on the type of passengers (grouped into various segments according to a series of fundamental variables like gender, age, state of health, personality traits), reasons for journey (demands on time), the information received (with/without information, how the information was provided, and the frequency it was

provided), relationship of the members of staff with the passengers, duration of the incident, conditions during the stoppage (air conditioning/heating, availability of water, train occupancy), nearness to the destination station, and finally, the external weather conditions. The results show that the information variable should be considered to be of vital importance and fundamental in the development of future research.

All these variables carry with them a series of associated types of behaviour which depend on the type of incident (stoppage, collision and derailment, and fire and explosion) and which are demonstrated with irritation, chaos, unease, confusion, anger, etc. as well as by a whole series of positive reactions which can help in managing these unexpected events when they occur on board trains.

The results of this research form the basis for the development of probabilistic simulation models which will be able to simulate individual behaviour as a function of user characteristics.

CAPÍTULO 4

MODELING PUBLIC BIKE PERCEPTION OF QUALITY CONSIDERING USERS HETEROGENEIT

MODELING PUBLIC BIKE PERCEPTION OF QUALITY CONSIDERING USERS HETEROGENEITY.

4.1. RESUMEN

El presente artículo propone una metodología de estudio de la calidad percibida por los usuarios del servicio de bicicletas públicas. La participación ciudadana es notoria desde las primeras fases de la investigación con la realización de grupos focales (GF) en los que se han identificado las variables relevantes. Se han calibrado modelos Ordered Probit considerando variaciones sistemáticas en los gustos y parámetros aleatorios. Los resultados destacan la importancia de la seguridad y la información disponible, por encima de las variables de nivel de servicio, además de resaltar las diferencias de percepción motivadas por la reflexión sobre los atributos, tal y como aquí se propone. Los resultados obtenidos son de gran interés para el logro de una gestión eficiente de la oferta pública de transporte en bicicleta.

4.2. PROMOTING SUSTAINABLE MOBILITY PATTERNS: PUBLIC BICYCLE SCHEMES

The excessive use of private cars is causing many urban areas to suffer from problems such as congestion, and noise and air pollution, which are not only unsustainable and harmful to the environment, but they also have a direct negative effect on the population's health. Further progress must be made towards new and more environmentally friendly urban mobility practices which will avoid the damage and inconvenience generated by existing traffic rates. In order to achieve this goal, a multimodal framework comprised of a wider range of alternative modes of transport is agreed to help promote sustainable mobility: "Sustainable mobility has a central role to play in the future of sustainable cities, but it is only through the understanding and acceptance by the people that it will succeed" (Banister, 2008).

The bicycle's specific competitive characteristics under certain journey conditions, coupled with its guarantee of sustainability, makes it the leading transport mode in the change towards new mobility patterns. One of the most widespread strategies for promoting this mode of transport in urban areas is the setting up of public bicycle sharing

schemes. The demand for this alternative form of public transport has shown growth in many cities, and it becomes essential to efficiently adapt these systems to the requirements of their users.

This research provides further knowledge on traveller behaviour and it is specifically aimed at understanding how users perceive the quality of bicycle sharing systems. The ordered scale defined to mark the quality of the overall service and its attributes suitably holds the assumptions of the proposed modelling framework: Random Ordered Probit. The results of the model show the aspects that should be prioritised to generate the highest impact on user satisfaction and, thus, encourage use of the public bicycle service.

Furthermore, the existence of heterogeneity has been addressed by allowing the parameters to distribute randomly across the population and by including the systematic variations in the perception of quality caused by different socioeconomic and trip circumstances. The trustworthiness of the models resides in the important role given to the users and potential users of the system, who have taken part from the initial experimental design and data collection phases.

Section 2 reviews the international scientific literature addressing the bicycle as a mode of transport and the modelling of quality provided by public transport services. Section 3 describes the methodology, which is comprised of several consecutive phases: the first steps focus on determining the situation and concerns around this particular transit system to ensure the suitability and quality of the data that is used in the last stages to calibrate the discrete choice models. Section 4 presents the results of the practical application, including the relevant variables, the management of the survey data and the calibrated models. A discussion about the results of the modelling is presented in section 5, and finally, section 6 contains the most important conclusions drawn from this research.

4.3. PREVIOUS CONTRIBUTIONS TO THE INTERNATIONAL LITERATURE

The scientific community has been working on defining the conditions that more efficiently lead to citizens' shift to more sustainable mobility patterns. The bicycle is a mode of transport that has been extensively analysed from many diverse angles over

Downloaded by recent decades. The promotion of this alternative requires knowledge about user behaviour in relation to the factors that traveller's consider when deciding to travel by bicycle (Pucher and Buehler, 2008; Xing et al., 2010; Ngoduy et al., 2013).

There are specific profiles of people whose behaviour with respect to the bicycle has been addressed in detail: commuters and women. On the one hand, the commuters represent an interesting study group due to the high number of journeys they make going to and from their work places and the particular requirements of this type of journey. This explains why certain research has specifically focused on determining the influential variables on mobility patterns related to trips to work (Wardman et al., 2007; Gatersleben, and Appleton, 2007; Heinen and Handy, 2012). On the other hand, the preferences of women with respect to the bicycle have been researched by Bernhoft and Carstensen (2008), and Garrard et al. (2008). The double viewpoint of Bonham and Wilson (2012) is interesting; they studied the factors that influence women to both start and stop cycling. Akar et al. (2013) discovered the different demands of men and women with reference to safety and feasibility. Safety is a factor which is generally perceived to have a close relationship with the availability of specific bicycle infrastructure. This aspect has shown to have an important effect on women's behaviour (Garrard et al., 2008; Akar et al., 2013), but also in general among the population. In fact, the literature has highlighted infrastructure as one of the decisive factors in the promotion of the bicycle as a mode of transport (Dill and Carr, 2003; Akar and Clifton, 2009; Dill, 2009). However, the installation of such infrastructure requires the use of economic resources meaning that their design needs to be justified and should guarantee the positive impact predicted by the potential demand.

The suitability of the bicycle as a complementary mode to the railway was highlighted by Reploge (1993) and Rietveld (2000) and it is being considered when determining the optimum location of facilities, along with other aspects (Larsen et al., 2013).

In terms of bicycle rental systems, various authors have analysed journey patterns and flows depending on time of day and day of the week in particular towns or regions such as Lyon (Borgnat et al., 2011), Barcelona (Froehlich et al., 2008) and Paris (Nair et al., 2012). This information is interesting given that such systems respond to public demand and count on a limited number of bicycles and docking stations. The literature also

analyses aspects relative to the introduction of new for rent systems (Monzon et al., 2010; dell'Olio et al., 2011b). Several methodologies have also been proposed for calculating the number and location of these stations (Romero et al., 2012) as well as the routes between origin and destination pairs (Lin and Yang, 2011).

An analysis of the state of the art in the research of quality in transport leads to the conclusion that a large amount has already been done in this field. One line of work opts for the creation of quality indexes. Some authors have set up satisfaction and quality indexes from indicators associated with aspects related to diverse transport systems (Eboli and Mazzula, 2009; Del Castillo and Benitez, 2012), while others have introduced satisfaction data from surveys into regression models (Givoni and Rietveld, 2007).

Debrezion et al. (2009) introduced a quality index based on data with specific transport characteristics such as time and distance into a hierarchical discrete choice model. In the Downloaded by latter two references the bicycle participates as an alternative mode of transport in the modal split models but it has scarcely been addressed from the quality point of view.

Another line of work is based on discrete choice models which have been shown to be suitable for research into transit system quality. Two approaches have therefore been proposed: Mixed Logit (ML) models based on Stated Preference (SP) surveys and Ordered Probit (OP) and Logit (OL) models calibrated with data collected by the Revealed Preferences (RP) technique. The first approach was used by Hensher (2001), Eboli and Mazzulla (2008, 2009), dell'Olio et al. (2011a), Cirillo et al. (2011). SP surveys test hypothetical conditions using previously defined quality standards in quantitative measures that vary across the scenarios presented to the individuals making their choice. However, data gathered from RP surveys provide the travellers' behaviour based on the actual status of a transit system since the individuals are asked about their experience on their last trip. Since the dependent variable in Ordered models is specified on a discrete and ordered scale where the responses are correlated, representing different grades, this methodology can be rigorously adapted to the study of user perception of quality based on the actual performance of the service. Ordered models are applied by Hensher et al. (2010) and dell'Olio et al. (2010), for instance, but no applications have been found dealing with public bicycle systems.

Many of the previously mentioned studies have also taken into account the heterogeneity in the perception of quality. Discrete choice models, both Mixed Logit and Ordered, allow the consideration of systematic variations around the mean as well as the existence of unobserved heterogeneity. The former is achieved by introducing specific factors that may affect the perceptions (Hensher, 2001; dell'Olio et al., 2011a) and the latter by unrestricting the parameters allowing them to be randomly distributed across the population (Hensher, 2001; Eboli and Mazzulla, 2008, 2009; Hensher et al., 2010; Cirillo et al., 2011). In this respect, the comparison of the effect of various distributions has been discussed in Hensher (2001) and Cirillo et al. (2011).

4.4. PHASES OF THE PROPOSED METHODOLOGY

The aim of this research is to characterise the quality perceived by users of a public bicycle hiring service, recently introduced in numerous Spanish towns and cities and generally of a similar nature to that found in the particular town being studied (Santander). Three points can be highlighted in the methodology followed in this research: the important role of the citizens involved in the first stages through their participation in focus groups and in the data collection procedure, the consideration of different causes of heterogeneity in preferences, and the application of the modelling to a recently installed public bicycle system. The different phases assure the reliability of the results and their inference to the overall population. This information is of great value for the efficient design of improvements to public bicycle systems which will result in a positive impact on the public's perception of service quality.

Figure 13 shows the proposed methodology. Details about citizen involvement can be found in phases 2 and 3, following the bibliographic review (phase 1). The results from this process are used to address the sampling phases (phases 4, 5 and 6) and later proceed to the mathematical modelling of the perception of quality in the public bicycle service, thereby endowing a scientific nature on this research and contributing to our knowledge about public perceptions, sensitivity and willingness to use public bicycle services.

- Literature and Citizen Involvement.

The first step in the process of characterising cycling mobility consists of establishing the current state of scientific knowledge and the aspects that still need to be addressed. Therefore, phase 1 (Figure 13) includes a thorough bibliographic review of the most relevant work with the aim of finding the variables with the potential for influencing cycling mobility as well as analysing potential methodologies for application and/or innovation, in accordance with the objectives of this research.

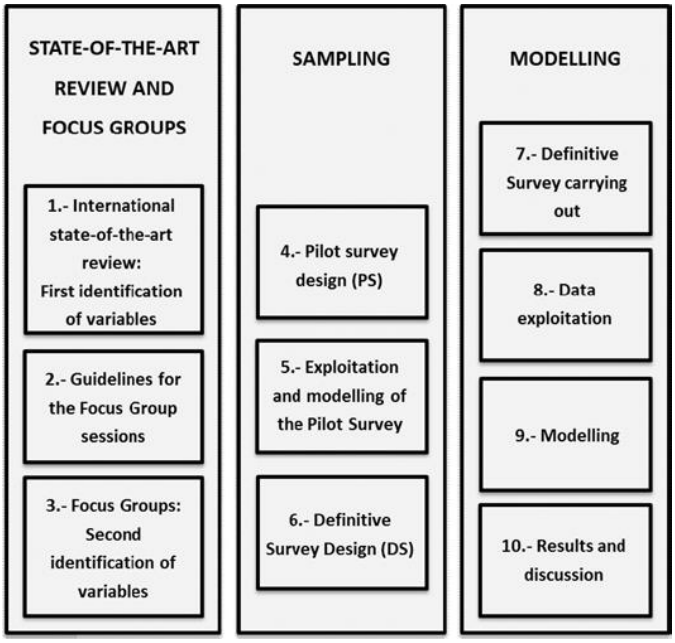

Figura. 13 Methodology for public involvement and the proposed modelling.

The bibliographic review carried out in the first phase was used as the basis for the design of a series of guidelines which "led" the meetings (focus groups) held with the public bicycle users. Focus groups (FG) represent one of the main qualitative tools used in social research. Their usefulness has been widely demonstrated in evaluating new initiatives and developing questionnaires (Fern, 2001; Krueger and Casey, 2000; Newman, 2002; Patton, 2002). Research on a new service, such as the recently introduced bicycle for rent systems, must not only evaluate previous work on the subject but Focus Group (FG) sessions should also be held to take into account user opinion from the very beginning of the process for the efficient design of survey questionnaires and to understand the political implications. "*A focus group is a research method designed to explore a particular topic by gathering the experiences and perceptions of selected target populations*" (Ward and Atkins, 2002). Krueger (1991) also defines a FG as a carefully designed discussion to

obtain perceptions about a particular field of interest (Ibeas et al., 2011). In order to conceptually determine a theoretical framework for defining a FG as accurately as possible an overview will be made of the various theories established by specialist authors in this field.

Focus groups are meetings made up of people with certain characteristics and interests in common; they provide qualitative data and information by participating in a discussion focused around a determined subject, in this case the demand of the cycling community for a public bicycle hiring service. These sessions correspond to Phase 3 (Figure 13) and represent the initial exploratory research of a qualitative nature aimed at determining the most relevant variables to be included in the pilot survey.

Two FG were held, one was made up of 8 frequent bicycle users and the other had 9 members who were not frequent users. The members of the first group were recruited randomly in the street, and the others were recruited through Santander neighbourhood associations. All the participants were contacted by telephone and instructed to meet at the Transport Department of the University of Cantabria Civil Engineering School. They were explained the reasons for the meeting followed by a brief presentation to explain the current state of affairs in Santander and the individual and collective benefits coming from bicycle use. All the discussions were recorded both on video and in sound.

The guidelines established in phase two were put into practice in the focus groups. The sessions started by giving the members an exercise about how they perceived the public bicycle system in Santander in terms of its "quality". At the end of this exercise the participants took part in a debate lasting about 45-60 minutes. Finally, an explanatory video was shown about bicycle use in other European or American cities: "Cycling Friendly Cities". The exercise was closed with the observation of how the FG members reacted when they saw that there were other cities with similar geographical characteristics to Santander where the citizens used the bicycle frequently (Ibeas et. al, 2011).

The FG were also used to stimulate debate amongst the participants about sustainable modes of transport and, in particular, public bicycle for rent systems. The knowledge acquired from the literature and the results of the focus groups provided the background

for phase 4 (Figure 13) in which the pilot survey was designed. The design of the survey was defined by the goal of characterising the quality of service perceived by users of public bicycle systems.

With this goal in mind a Revealed Preferences (RP) survey was proposed to study the current standards provided by the system. The interviews were held at the docking stations and asked to the cyclists returning the bicycle. The user is encouraged to score the standards of diverse aspects of the service they received on their most recent journey, in other words they were asked about real past experiences. After the pilot data was collected it needed to be analysed in the models so that any necessary changes could be made to assure the accuracy of the definitive survey (phase 6).

The survey was divided into two parts in order to characterise both the users and their journey patterns as well as understand their behaviour. The first part of the survey provided the individual's socioeconomic characteristics (Ortúzar and Willumsen, 2011) as well as data on origin and destination, journey purpose, frequency of journey and other data. The analysis of this data (phase 8) provides useful information about different types of service users and their characteristics which help explain the different perceptions or behaviour of the users. The second and last section of the survey provide the data required in the following stages of the methodology to determine the influential variables on user perception of quality.

The first and the last of these questions are actually the same one and refer to the overall quality perceived by the user. Each of these responses will be the dependent variable in two separate models. In between both responses, the interviewees are asked to evaluate the quality of the characteristics of the service, one by one. These ratings (the quality given to each attribute of the service) will be introduced as explanatory variables of the dependent one (the overall quality) in each model. This sampling experiment was studied by dell'Olio et al. (2010) in the city's bus service, concluding that the overall quality of service is perceived differently by the user after having evaluated certain specific aspects than it was at the beginning of the survey. The potential for explaining the choice mechanisms occurring in these different moments during the survey is the reason why the perception of the system as a whole is asked twice: when the user rates the overall quality for the first time, several aspects influence their perception, whereas after the interviewer

verbally names the characteristics making up the system and the user scores them individually, their perception changes. The stages of the methodology determine this change and provide in-depth knowledge about user behaviour.

- Theoretical Framework

Phase 9 deals with modelling the data collected in the definitive survey. This data is introduced into the mathematical structure which studies user behaviour and their perceptions. The disaggregate modelling (Ortúzar and Willumsen, 2011) and, specifically, the discrete choice models have proved their ability to explain choice processes between alternatives; processes where each registered answer corresponds to an individual faced with a choice from a limited number of possibilities subjected to specific conditions and constraints. These models are based on random utility theory, where the individual *q* chooses the alternative *i* which provides the most benefits or utility U_{iq}, following the expression:

$$U_{iq} = V_{iq} + \varepsilon_{iq} \quad (1)$$

Where the utility is made up of the terms: Viq, or systematic utility, and εq, random component represents the likes and dislikes of each person which are not explained in the group of attributes, as well as any possible mistakes made in measuring or during data collection, thereby endowing the model with realism. This leads to the conclusion that it is not possible to know user behaviour with absolute certainty and, therefore, we turn to calculating the probability that a specific individual will choose one of the available alternatives. The systematic utility *Viq* is explained by a set of variables which are affected by their corresponding coefficients in the following way:

$$V_{iq} = \sum_k \theta \cdot X_{kiq} \quad (2)$$

Where X_{kiq} represents the value of the variable k of the alternative *i* for an individual *q*, and each parameter θ_{ki} represents the weight placed on the variable *k* of the alternative *i*. In turn, these parameters rank the variables by importance within the utility, which in this case is the overall perception of quality.

The perceptions collected about the service quality and their attributes are qualitative by nature, with five possibilities ranging from "very bad" to "very good". The model in this research is based on the specification proposed by McKelvey and Zavoina (1975), who defined the Ordered model as a latent regression adapted to ordinal outcomes. In this case study, the semantic and qualitative responses of the scale defining the overall service are converted into discrete but ordinal numeric values and introduced as the dependent variable following the expressions 3 and 4 below (Greene and Hensher, 2010):

$$y_i^* = \theta_{ki} \cdot x_i + \varepsilon_i \qquad \varepsilon_i \sim F(E[\varepsilon_i]\,|Var\,[\varepsilon_i]), \qquad E[\varepsilon_i] = 0,\ Var[\varepsilon_i] = 1, \qquad (3)$$

$$y_i = \text{j} \text{ if } \mu_{j-1} < y_i\,^* \leq \mu_j \quad (4)$$

Where j represents each of the responses comprising the numeric scale. The expressions 3 and 4 imply that the unobservable, dependent and continuous variable, y^* is transformed to an ordinal and discrete variable y that contains the observed responses. In the Ordered Probit model, the error term $i\,\varepsilon$ in (3) is assumed to be normally distributed.

The maximum likelihood method (ML) is applied to estimate the parameters θ_{ki} and μ in discrete choice models. This method produces the most probable answer for each individual according to the responses given to the explanatory variables, the socioeconomic characteristics and their mobility constraints. The series of probability functions associated with each outcome j is given by the following expression:

The log likelihood is the logarithm of the probability expression in (5):

$$Prob\,[y_i = j|x_i] = F(\mu_i - \theta_{ki} \cdot x_i) - F\left(\mu_{j-1} - \theta_{ki} \cdot x_i\right) > 0, j = 0,1, \ldots\ldots, J \quad (5)$$

$$\log L = \sum_{i=1}^{n} \sum_{j=0}^{J} m_{ij}\, log\left[F\left(\mu_j - \theta_{ki} \cdot x_i\right) - F\left(\mu_{j-1} - \theta_{ki} \cdot x_i\right)\right] \qquad (6)$$

Where $m_{ij}=1$ *if* $y_i=j$, and 0 in other cases.

In the case of the ordered model, μ is directly related to the probability, within the population, of choosing each specific choice score *j* on the ordered scale as the perceived quality. The generalisation of the ordered models means that the parameters θ_{ki} are not constants that have been estimated from the average of the collected data but rather they

are random variables. This means that the coefficients of the different explanatory variables of the model are different from one individual to another, assuming variability in preferences and possible correlation between variables.

The random coefficients respond to the following definition:

$$\theta_{ki} = \theta^{*}_{ki} + \Delta z_i + \Gamma v_{ki} \quad (7)$$

Where θ^{*}_{ki} is the average value of the parameter in the population and the systematic heterogeneity in the mean is induced by the variables z_i which are normally socioeconomic in nature or journey restrictions. The variability across the population in the perception of each explanatory variable k of the alternative i is taken into account through the unobservable random component v_{ki}, which will present the distribution which best fits the existing heterogeneity. The mean of the parameters for a specific individual characterised by z_i is:

$$E[\theta_{KI}|x_i, z_i] = \theta^{*}_{ki} + \Delta z_i \quad (8)$$

The variance of the parameters is:

$$Var[\theta_{KI}|x_i, z_i] = \Gamma\Gamma' = \Omega \quad (9)$$

Where Γ is the lower triangular matrix which introduces the correlation between the random parameters. Similarly, in the Ordered model, the variability in the parameter thresholds μ may be studied taking different values for each individual. In the Ordered model, the final conclusions about the choice mechanism are derived from the partial effects (Greene and Hensher, 2010), which report on the impact of a variable's variation on the choice probability of a specific result of y (5). The values of these effects may be both positive and negative representing an increase or decrease on the probability. The estimated parameters do not report on the final result; they provide an overall vision about how users feel. The parameters are interpreted by using partial effects which are based on the probabilities of the choice model:

$$\delta_j(x_i) = \frac{\partial \text{Prob (y=j}|x_i)}{\partial x_i} = \left[f\left(\mu_{j-1} - \theta_{ki} \cdot x_i\right) - \left(\mu_j - \theta_{ki} \cdot x_i\right]\theta^{*}_{ki} \quad (10)$$

The partial effects report on the effect a variation in a variable has on the probability of a specific result of *y*. The values of these effects may be both positive and negative in accordance with an increase or a decrease in the probability of choosing each alternative *y*. The accumulated value of the partial effects of all the variables is also of interest:

$$\frac{\partial \text{Prob (y} \leq \text{j}|x_i)}{\partial x_i} = \sum_{m=0}^{j}[f(\mu_{m-1} - \theta_{ki} \cdot x_i) - f(\mu_m - \theta_{ki} \cdot x_i)]\theta_{ki}^* = -f(\mu_m - \theta_{ki} \cdot x_i)\theta_{ki}^* \quad (11)$$

4.5. PUBLIC BIKES IN SANTANDER: APPLICATION OF THE METHODOLOGY

The methodology conducted in this research has been put into practice in Santander (Spain), capital of the Autonomous Community of Cantabria, one of 17 in Spain and located on the north coast. Santander is a medium sized city, covering 36 km2 with a population of about 200,000. North-south mobility is restricted because the steep slopes (greater than 15o) of parallel hills and valleys running northeast to southwest meant few of the important city routes were built in that direction.

Public transport in Santander has historically been provided by a network of bus lines serving 97% of the municipal territory with bus stops located at less than 300 metres apart. Santander currently counts on a public bicycle service provided by a fleet of 200 bicycles distributed between 14 recently installed docking stations and with further plans for expansion. This service was conceived to work in tandem with the bus service but in competition with the private car with the aim of increasing the supply of public transport and extending its coverage. The results of the focus group (FG) session, which is phase 3 of the methodology shown in Figure 13, are presented first. The participants agree that the service is, in general, known about by bicycle users, it counts on overall acceptance and is seen as a good initiative to encourage the use of the bicycle by the public. Nevertheless, the start of the service was limited in opening times and number of docking stations, meaning it wasn't used as a mode of transport; rather it just encouraged bicycle use for leisure purposes. The results show that, before the modifications were made to the service, users saw this hiring system as a pastime for the following reasons: the times it was available limited its use as a mode of transport, the "pick up and drop off points" were few and not suitable for using the bicycle as a mode of transport and there was too

little cycling infrastructure. It was thought that the initial distribution of the docking stations favoured tourists rather than residents:

"…the three "pick up and drop off points" are at tourist locations, they are no use to us, they are for tourists … who goes to work at the Piquío Gardens or the Magdalena Park? They are beach areas" "What's more, there aren't enough of them, there are only three…"

Users' willingness to pay was viewed positively, at start-up the service was free although some members disagreed and thought that there should have been a minimum cost involved.

"…because it is free people don't value it as they should …", "…the service should have a cost, at least something symbolic which gives it a tangible value, that would make people use it in a more continuous way…"

The analysis of the FG session found out what the public thought about the improvements being made to the service (when they were just starting). Regarding the characteristics of the service, action needed to be taken such as setting up more docking stations and longer opening hours for using the service as well as solutions for topographical barriers ("…in Scandinavian countries there are special systems whereby you arrive with your bike, you hook it on and it takes the bike up the hill leaving you at the top").

To summarise, this initiative at setting up a public bicycle hiring system has a whole series of pros and contras that have been arranged in the following SWOT matrix (Strengths, Weaknesses, Opportunities, Threats) in Table 11.

Tabla 11 SWOT matrix on the use of public bicycles in Santander (Ibeas et al., 2011)

STRENGTHS	**WEAKNESSES**
It encourages the use of bicycles in the community.	The service is less well known by none bicycle users.
The service is known by bicycle users.	The service is aimed at tourists and day trippers; it is mainly used for leisure.
It is very adaptable.	Restricted possibilities of being used as a mode of transport because:
	- Limited opening times.
	- Few docking stations
	- Santander does not have the necessary infrastructure
OPPORTUNITIES	**THREATS**
Support changing habits and activities in favour of the bicycle.	The service encourages bicycle use as a leisure activity and not as a mode of transport.
Provide a more complete service, with payment:	Incorrect use of the bikes by some service users.
- Longer opening times.	
- More availability of parking.	
- Payment for certain standards of quality.	

The participants in the FG considered that more docking stations should be installed at the entrances to the city, both for private car users and public transport users (park and ride installations at bus and train stations). In this respect, it is essential that more places to park bicycles are installed throughout the city at: shopping centres, financial and business districts, public services, education establishments, etc. Businesses should be encouraged and have incentives to provide their workers with good installations related to bicycle use (showers, secure parking areas, etc.). Suitable bike lanes also need to be built for accessing the city which are well signposted and exclusively for bicycle use. The members of the focus group affirmed that these changes would encourage modal change in favour of the bicycle with a corresponding reduction in private car use for making everyday trips.

As explained in the methodology, the ideas that arose in the focus groups were introduced into a pilot survey and the results were evaluated, modelled and corrected leading to the

design of the final survey on perceived quality in a public bicycle hiring service. Taking into account the continued little use of the bicycle in Santander and the conclusion drawn for this city in Monzon et al. (2010) that the climate is one of the most important aspects influencing this mode of transport, the final survey was administered in July-August 2011 to users returning the bicycles to the docking stations. The sampling method used consists of surveying a ratio of users proportional to the demand at each station at different intervals of peak and off peak times. The questionnaire provided the following information: socioeconomic characteristics, origin, destination, journey purpose, frequency of journey, access, journey, and egress time, and ratings to evaluate the quality of the various attributes and the whole service. 195 interviews were used, with around 500 daily rentals in that period (considering all the uses, where many of them are made by the same users, on a trip chain basis).

The results of the user and journey characterisations (Figure 14) are presented below and provide some very interesting information about the main uses of the service. Improvement measures can, therefore, target attracting new types of customers or these insights may simply assist in deciding where to make improvements to increase the usage of current users.

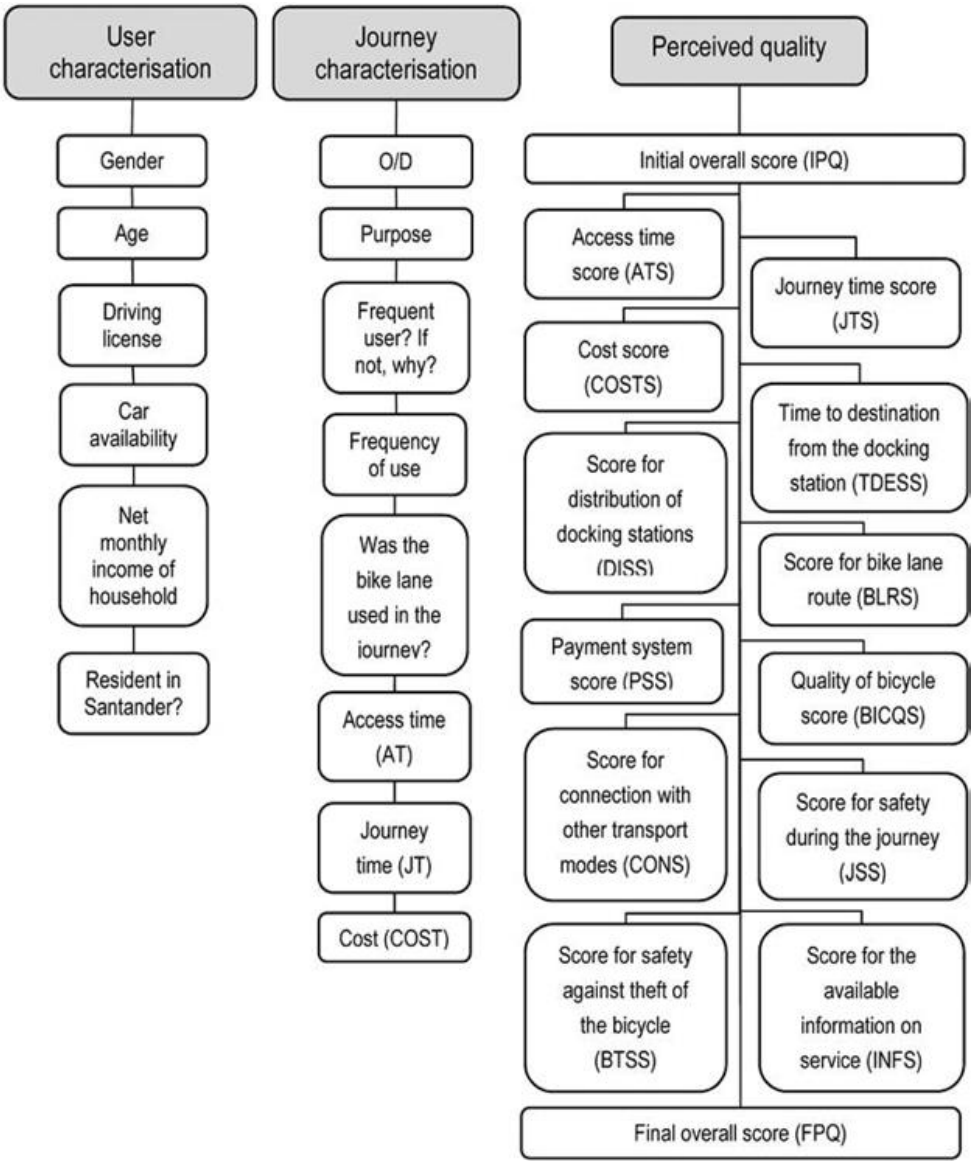

Figura. 14 Variables collected in the survey.

The analysis of the collected data reveals that 51% of users are women and 49% are men.

It is noteworthy that more than half of those surveyed (56%) are under 25 years old, 15% are between 35 and 44, 13% are aged 45 to 54, 12% from 55 to 64 and 4% are over 64 years old.

While 85% confirmed that they had a driving license, only 67% had access to a private car. In terms of household income, 3% stated under 900€ per month, 17% between 900 and 1,500€, 30% between 1,500 and 2,500€ and 23% replied their income was over 2,500€.

However, 28% did not know or did not answer that question. 74% of the interviewees were residents in Santander.

The journeys were mainly made for leisure (44%), 37% were travelling home, 1% for education, 3% for work, 2% for health purposes, 3% for shopping and 11% were travelling for other reasons. The service is used on a daily basis by 42%, weekly by 31%, monthly by 2% and sometimes by 25% of the interviewees.

Finally, regarding the use of the bike lane during the journey, 58% said they had used it, 9% said they had not used it and 33% said they had used it in certain sections (because it didn't exist or they had taken an alternative route).

The data collected in the second part of the survey deal with the perceived quality of the public bicycle service and are used to calibrate the models. Users were asked to mark the overall quality of the service twice: at the beginning and at the end of the survey. Each of these scores are the data used in the dependent variable of one of the two separate models that will provide insights into the users' perception in those two moments: the initial and the final perceived quality (IPQ and FPQ).

The explanatory variables in both models are the ratings regarding the quality of the specific features of the public bike system. The outcomes of the modelling phases are therefore the consequence of the consecutive phases in the presented methodology. The scale to mark the quality is semantically defined: Very bad; Bad; Not good, not bad; Good; Very good. An ordered and numeric scale has been used to analyse the data, going from 1 to 5. The average score turned out to be over 4, meaning that the quality of the service is perceived to be in between good and very good. The highest scores were given to the cost and the travel time and, on the contrary, the bike lane design and the quality of the bicycle itself received the poorest ratings.

After analysing the data, the next step in this research is the calibration of models (Figure 14). The variables that have been tested to explain the overall perception of quality are those collected in the survey (Figure 14): the scores given to the different attributes of the system have been introduced either on their own or as new variables regarding the interaction between them and the socioeconomic or journey characteristics. A key

consideration that has been taken into account in the discrete choice models presented in this research is the presence of heterogeneity in the perceptions. The causes of heterogeneity have been studied through both the variability in the perception across the population and the systematic variations in preference existing among users characterised by a particular socioeconomic or trip circumstance. The former is achieved by unrestricting the parameters of the model by allowing them to distribute randomly across the population.

Different distributions have been tested (normal, logarithmic, uniform, triangular) to represent the variation around the mean of the parameters affecting the explanatory variables. To consider the latter type of heterogeneity, the systematic variations in preference are introduced by the interaction between the score given to an attribute and a "dummy variable" representing whether or not each individual is characterised by the various socioeconomic aspects and trip conditions stated in the survey (Figure 14). The resulting interaction term is a new variable containing the evaluation of the selected attribute, responded only by the group of users categorised by the socioeconomic feature. Very diverse causes of interaction have been tested accounting for the profile features of each individual collected in the survey: gender, age, net monthly household income, residence in Santander, frequency of use of the service, trip purpose, use of the bike lane during the journey and whether a desire for more infrastructure has been stated, or for the improvement of the existing facilities.

During the interview, users were also asked about quantitative aspects of their trip: the access time to the docking station, the travel time and the cost. As with any mode of transport making up an urban mobility system, it is helpful, even necessary, to know what influence these variables have on the travellers' behaviour. They were not only introduced into the models just as they were collected in the survey (AT, JT and COST), but also through the use of dummy variables characterising different time and cost ranges. In the latter case, each of these variables (access time, journey time and cost) was subdivided into three different categories so that the journey was characterized more specifically according to the purpose of the journey (given that 44% travelled for leisure purposes) in accordance with the classification presented in Table 12.

Tabla 12 Percentage of users from each journey purpose as a function of access time (AT) and journey time (JT)

	Dummy Variables	Purpose: Leisure	Other Purposes
AT <= 5 mins	AT5	80	88
5 < AT<=10 mins	AT0510	13	11
AT > 10 mins	AT10	7	1
JT <= 25 mins	JT25	43	73
25 < JT <= 50 mins	JT2550	42	21
JT > 50 mins	JT50	15	6

Table 12 shows the percentages dividing cyclists who make their journeys either for reasons of leisure or for any other purpose (home, education, work, health, shopping and other purposes) with respect to the categories in which access time (AT) and journey time (JT) have been defined. The cost of the service is defined by the type of ticket acquired by the user: day-ticket, week-ticket or annual ticket.

Each of the two different evaluations of the overall quality has been introduced in different models as the dependent variable. As a result, the first model (Table 13) shows the variables influencing the perception of the quality at the beginning of the interview (IPQ) and the second model (Table 14) presents the attributes explaining the overall score at the end of the interview (FPQ), after each user was asked to score the individual attributes making up the system.

The variables that have resulted explanatory of the perceived quality are the following:

- ATQ: Quality perceived regarding the access time
- COSTQ: Quality perceived regarding the cost of the service.
- BICQQ: Quality perceived regarding the quality of the bicycle.
- PSQ: Quality perceived regarding the payment system.
- DISQ: Quality perceived regarding the distribution of the docking stations.
- INFQ: Quality perceived regarding the available information.
- JSQ: Quality perceived regarding the journey safety.
- The dummy variables that lead to systematic variations in preference:
- AT5: Access time less or equal to 5 minutes.

- JT25: Journey time less or equal to 25 minutes.
- G: Gender (female=1; male=0).
- ESPP: Specific trip purpose (work, study, health care, shopping or other reasons).
- JT2550: Journey time from 25 to 50 minutes.
- AT10: Access time longer than 10 minutes.
- Y: Young people (younger than 34 years old).
- M: Middle-aged users (34 to 54 years old).

For the models to be estimated, every alternative or available response of the ordinal scale has to be represented in the sample so that the calibrated model can reproduce a similar share of responses for all the scores and, thereby, reproduce the reality. Given the small representation of the two lowest scores of the dependent variables (initial and final overall perceived quality), the models were calibrated by aggregating the "Very Bad" and "Bad" responses from the survey into a single category regarding negative perceptions.

Tabla 13 Initial perceived quality estimation model

INITIAL PERCEIVED QUALITY (IPQ)		
Variables	**Coefficient**	**b/St.Er**
Non-random parameters		
Constant	-1.19	-1.83
ATQ	0.04	0.23
COSTQ	1.25	4.93
BICQQ	0.32	2.24
PSQ	0.45	3.55
AT5·COSTQ	-0.41	-2.68
JT25·BICQQ	0.56	3.92
G·COSTQ	-0.19	-2.07
ESPP·ATQ	0.39	2.5
Means for random parameters		
DISQ	0.71	5.17
Scale parameters for random parameters		
DISQ	0.29	4.57
Thres hold parameters for probabilities		
MU(1)	1.56	3.38
MU(2)	4.91	8.35

Tabla 14 Final perceived quality estimation model.

FINAL PERCEIVED QUALITY (FPQ)		
Variables	**Coefficient**	**b/St.Er**
Non-random parameters		
Constant	-3.03	-3.41
BICQQ	1.02	3.60
PSQ	1.00	4.48
INFQ	1.60	4.92
JT2550·ATQ	-0.70	-3.79
AT10·ATQ	2.82	4.38
Y·JSQ	-1.14	-3.73
M·INFQ	-1.07	-3.38
G·INFQ	-0.49	-2.58
Means for random parameters		
ATQ	1.02	4.56
JSQ	2.38	5.12
DISQ	0.66	3.12
Scale parameters for random parameters		
ATQ	0.41	4.71
JSQ	0.60	4.99
DISQ	0.34	3.52
Thres hold parameters for probabilities		
MU(1)	350	4.22
MU(2)	11.41	6.77
Number of observations 195		
Log likelihood function -77.63		

4.6. DISCUSSION OF THE RESULTS

The parameters of the models explaining the initial (IPQ) and the final (FPQ) perceived quality of the public bike system are set out in Tables 13 and 14. The calibrated models inform about different sources of heterogeneity in the perception of the quality across the population of users. To begin with, Table 13 shows that the initial overall evaluation is heterogeneously explained by the perception of the distribution of the docking stations (DISQ). However, the model determining the users' perception of quality at the end of the survey (Table 14) reports on the presence of three attributes that heterogeneously explain the final valuation of the service: the distribution of the docking stations (DISQ), the perception of the access time (ATQ) and journey safety (JSQ). In all cases, the Normal distribution was found to yield the best fit of the parameter.

The positive sign of the parameters needs to be assured so that the higher the system attributes are marked, the higher the value of the coefficients are. In the present research it also has to be noted that since all the independent variables are defined on the same scale, a higher weight or value of a coefficient directly affecting a variable leads to a higher partial effect. The most important findings based on the obtained parameters are exhibited, followed by a presentation of the partial effects which quantify the impact that improvements made to diverse individual attributes have on the overall perception of quality.

The comparison of the two models reveals the adjustment in the perception before and after the characteristics of the service have been explicitly listed and rated: the quality mark given to the cost of the public bicycle service (*COSTQ*) only influences the overall quality perceived at the beginning of the interview (*IPQ*) (Table 13). On the other hand, there are two variables influencing the perception of service quality at the end of the interview which didn't do so in the initial model: the satisfaction on the safety during the journey (*JSQ*) and the evaluation of the available information (*INFQ*) (Table 14).

Therefore, although initially the cost of the service is considered in the overall perception of the quality, once the individual service attributes have been thought about, the cost ceases to have any influence and other factors show to be of importance in the final

evaluation of the overall service, factors which had not even been considered at the start of the interview.

The model also reveals the existence of systematic variations in preference, which are studied through the interaction variables created by multiplying different factors. The categories of users showing this systematic variation in variable perception are affected by both parameters: that of the variable itself and that of the interaction term. Therefore, when evaluating the overall service at the beginning of the interview (Table 13), the perception of those users that have experienced journey times of less than 25 minutes is the sum of the interaction parameters for *JT25·BICQQ* and the variable *BICQQ*.

Similarly, in the first model, those users whose journeys have been made for specific purposes (ESPP: work, education, health, shopping or other purposes) perceive the access time (ATQ) differently than the other users, who travel for leisure or to get home.

Considering the systematic variations in preference that have been found significant in the second model (Table 14), it is worth pointing out that, the access time is again not homogeneously perceived across the population: those users who perceive an access time of over 10 minutes (AT10) are not only affected by the parameter ATQ but also by AT10·ATQ. Other systematic variations found in the model regarding the final valuation of the quality (Table 14) indicate the specific perception of the time accessing the station in the case that the trip lasts between 25 and 50 minutes (JT2550) and, the quality of the safety during the journey perceived by users younger than 34 years old (Y). The same explanatory variables have been introduced into both the initial and final models, yielding the significant parameters in tables 13 and 14, in each case. The dependant variable of the IPQ model is the overall service quality scored at the start of the interview, whereas in the FPQ model it is the quality score provided at the end of the interview. In the FPQ model, the parameters show a confidence level of greater than

99%. However, on the contrary, the coefficients of the IPQ model have a lower significance and the log likelihood value also indicates a poorer fit. The significance of the parameters indicates the possibility of transferring these results onto the overall population. As the quality perceived at the end of the interview (FPQ) is explained by more significant parameters, it is possible to state that the individual's behaviour is known

with greater precision in this case. For this reason, the partial effects of the FPQ model are analysed and discussed (Table 14). This uncovering of the difference between the overall service quality scores provided at the start and at the end of the interviews is interpreted as the effect of having previously considered the quality of each individual attribute before providing a final score for the overall service quality (dell'Olio et al., 2010). Therefore, the partial effects of the model explaining the final perceived quality (FPQ) are shown in Table 14. The partial effects quantify the unit increase or decrease (positive or negative sign) in the probability of choosing each response available in the scale (Very Bad/Bad; Not good, not bad; Good; Very Good) to score the overall quality as a result of a unit improvement on the satisfaction mark given to each influential variable.

The scale defined to score quality, as well as the amplitude of the intervals determined by the parameters μ of the model (Table 13), affect the probability of choosing from Very bad or Bad, Not good, not bad, Good or Very good to score the overall service quality. It is important to point out that the improvement of the performance of any of the attributes and, thus, the increase in satisfaction regarding that service characteristic will result in an increase in the maximum valuation ("Very Good"), as the partial effects shown in Table 14 reveal. Since the average score of the overall valuation turned out to be in between "Good" and "Very good", any improvement accomplished in the system would result in an increased probability of a "Very good" response to rate the overall quality and, therefore, a similar reduction in the probability of perceiving the quality as "Good".

As the coefficients suggest, the greatest impact results from a successful unit increase in the satisfaction regarding firstly, the safety during the journey (*JSQ*) and, secondly, the available information about the service (*INFQ*). Measures designed to achieve these improvements would cause an increased probability of 2.49% and 1.67% respectively, representing an accumulated increased probability of 4.16% of rating the service quality with the maximum score. After these two attributes, the greatest positive impacts on the perception of quality would come from actions directed at service improvements regarding access time (1.07%), bicycle quality (1.06%), payment system (1.04%) and the distribution of docking stations across the city (0.69%). Likewise, the partial effects accounting for the interactions should be added to the effect of the variable alone (in a

similar way to the interpretation of the parameters). In this respect, it is worth pointing out that users with access times over 10 minutes (*AT10*) place much more importance on this aspect than the general population of users do, as can be confirmed by adding 2.94% (*AT10·ATQ*) to the 1.07% (*ATQ*) that for the general population increases the probability of responding with the highest score to rate the overall quality when that particular aspect (*ATQ*) is improved.

Table 14 also shows that the user categories involved in the remaining interaction terms will experience a lower positive impact compared to the expected effect on the general population's perception. Such is the case of perceived quality in relation to access time for those users whose journeys last between 25 and 50 minutes (-0.73%), in the case of the valuation of the safety perceived during the journey by consumers aged under 35 (-1.19%), and among females (-0.51%) and users aged between 35 and 54 (-1.12%) regarding the quality relative to the available information about the service. The direction of these effects was previously revealed by the negative signs of their corresponding parameters (Table 13), which remove weight from the importance placed on the corresponding variables by the general population. In summary, the interactions indicate several circumstances under which the impact of the quality of some attributes on the overall quality systematically variates.

The quality perceived regarding the access time has been found to be less important when the trip lasts between 25 and 50 minutes, whereas it has a higher impact on the overall quality when more than 10 minutes are required to access the nearest station. On the other hand, safety is less important among users younger than 35, and women and users aged between 35 and 54 tend to reduce the importance of the quality of the information provided about the service.

4.7. CONCLUSIONS

The bicycle clearly has to play an active part in the current search into more sustainable mobility systems. Numerous urban areas have introduced public bicycle systems as complementary to their existing supply of public transport. Aimed at improving the efficiency of managing this kind of service, this article proposes a process for evaluating the quality of service that users perceive they are experiencing from the actual performance of the system. This research emphasises the importance of citizen involvement and the need to consider variability in perceptions in order to assure the realism of the results reported by the models on public bicycle user preferences. The main conclusions coming from this work are presented below.

Firstly, the proposed methodology involves the citizens from the very first phases to guarantee a reliable representation of reality during the modelling process. The collected data is the result of successive phases involved with identifying variables and survey design which have later been loaded into Ordered Probit models to understand the perception of quality of service as a function of the characteristics which define it. Secondly, the modal split model of any town should include the corresponding explanatory perceived quality variable in the utility function of each alternative for a given mode, as the modelling developed in this research does for the "bicycle" alternative.

The scientific process described in this research can be applied to any town or city in a similar way to its application to Santander. The modelling provides interesting results on various aspects. Firstly, the research once again shows the difference in the perception of service quality before and after the interviewee has had time to reflect about and score different aspects of it. Variables such as safety during the journey and the available information go unmentioned in the initial evaluation of overall quality while they turn out to be of greatest weight at the end of the interview.

The opposite occurs with the cost, with the highest a priori score, but which ceased to be of importance for the users after considering each and every characteristic of the service. This and the scarce presence of the level-of-service variables lead to the conclusion that this type of attribute has a certain influence on the perception of service quality, but they are not decisive. This could also be a result of the still low modal share of the bicycle

within urban mobility as a whole and that its use is still mainly for recreational purposes. The proposed models represent a tool which has great potential as an aid in the management of public bicycle services because not only does it report on the different service variables and their degree of importance on quality, but it also provides information on population variability and the systematic differences in perceptions resulting from different socioeconomic and journey characteristics.

Heterogeneity in the population appears in the scores given for the distribution of bicycle docking stations while among the causes of systematic variation in the perceptions of different attributes are gender, age, purpose of journey, type of ticket purchased and the access and journey times. Specifically, access time presents the greatest weight for those users who feel it takes longer than 10 minutes to access the system. As a result, reflected in the accumulated value of the corresponding partial effects, the improvement of this attribute is the one which generates the most noteworthy impact on the overall perception of quality among this group of users.

Finally, this article concludes by stressing the need to encourage users to evaluate each of the characteristics of a service to make their overall perception of quality more complete as, in this way the model is loaded with more realism. It is recommended that improvements made to the service are disseminated to guarantee their maximum impact on the overall quality of service that users feel they are receiving.

CAPÍTULO 5

CONCLUSIONES FINALES DE LA TESIS

CONCLUSIONES FINALES

En este apartado de la Tesis Doctoral se va a efectuar una exposición de los principales resultados obtenidos en la investigación.

Para ello, en primer lugar se presenta una discusión estructurada en diversos puntos que contienen los principales resultados de la investigación.

Seguidamente, se realiza un repaso de las principales líneas de investigación tratadas e igualmente se hace especial hincapié en la importancia y aplicabilidad de los resultados obtenidos, las futuras líneas de investigación, y por último, las posibles limitaciones y problemáticas que no han quedado resueltas.

Finalmente se exponen todas aquellas actividades de interés científico que han sido efectuadas en la trayectoria académica del doctorando y que han servido de apoyo para el desarrollo de esta investigación.

5.1. PRINCIPALES RESULTADOS DE LA INVESTIGACIÓN.

En esta Tesis se ha construido una metodología aplicable a cualquier campo del transporte y cuyos cimientos residen en la elaboración de una investigación de tipo cualitativa con base participativa (a través de la realización de mega grupos focales, grupos focales y entrevistas en profundidad) para la posterior obtención de las variables determinantes en el diseño y realización de diversas tipologías de encuestas (de preferencias declaradas y preferencias reveladas).

Los tres artículos que componen esta tesis se han centrado en el conocimiento del comportamiento de los agentes involucrados en diferentes ámbitos del transporte, para la posterior modelización del mismo. De esta manera, la combinación de los métodos cualitativo y cuantitativo se aborda como aristas de la metodología de investigación desarrollada.

El fin último de la investigación, se corresponde con el hecho de servir como pilar base para el diseño de posibles políticas y estrategias de mejora, en base a un proceso de participación ciudadana (de tipo consultivo) de los grupos de interés en cada caso y a través de las técnicas anteriormente citadas.

Las presentes conclusiones se articulan en 3 ejes principales:

- La importancia y complementariedad de los métodos de investigación cualitativa y cuantitativa.
- El aumento de la calidad de la información obtenida a priori que determinará un diseño más eficaz de encuestas.
- La importancia de los procesos participativos, a través de la consulta a los agentes implicados, en la correcta planificación de políticas de transporte. Para ello se han tratado 3 pilares fundamentales como ejemplo y caso práctico:
    a) Políticas para el fomento de la movilidad sostenible en un ámbito urbano.
    b) Políticas para hacer frente a situaciones inesperadas en trenes de pasajeros.
    c) Políticas de mejora de la Calidad Percibida en el caso particular de los usuarios de bicicletas públicas.

A continuación se desarrollan cada uno de los puntos anteriormente expuestos.

- Conclusiones acerca de la importancia y complementariedad de los métodos de investigación cualitativo y cuantitativo.

El método presentado se ha centrado en el empleo de técnicas cualitativas (MGF, GF y Entrevistas en Profundidad) que han servido como base para la extracción de las variables determinantes para el posterior diseño de una encuesta y la consecuente modelización de los datos obtenidos en la misma.

Tradicionalmente al efectuar un análisis social de la demanda del transporte se han venido utilizando modelos econométricos basados en modelos teóricos para el acercamiento al conocimiento del comportamiento de los usuarios del transporte. Es por ello, que la presente Tesis plantea la utilización de un método mixto de investigación cualitativa (técnicas participativas) y cuantitativa (modelos econométricos) para el análisis comportamental de la población objeto de estudio en cada caso.

La presente tesis ha demostrado la importancia que tiene la incorporación y convergencia de técnicas cualitativas con base participativa, dentro de la fase previa al análisis

econométrico tradicional, para una correcta gestión y planificación del transporte en diversos ámbitos (movilidad sostenible, seguridad y calidad).

En referencia a ello, el autor Yanetsys Sarduy (2007) expresa de manera sistemática a través del siguiente esquema cómo en el análisis de la información convergen los métodos cualitativos y cuantitativos.

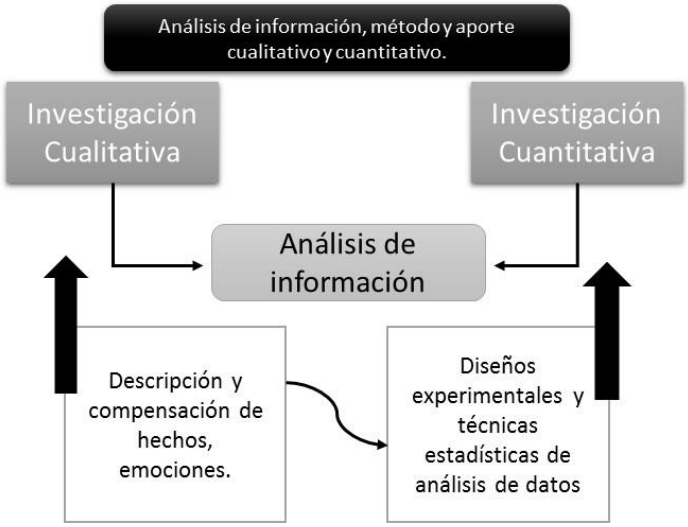

Figura. 15 Análisis de información, métodos y aporte de cada uno.

La existencia de dos enfoques que se complementan y se dan paso dentro de esta investigación (cualitativo y cuantitativo) ha contribuido a un mejor conocimiento de la población objeto de estudio, habiéndose planteado soluciones más eficaces ante las diversas problemáticas.

Ya hace décadas, autores como Fals afirmaban que los modelos econométricos son necesarios en la caracterización de cualquier problemática de carácter social, pero no obstante debe de tenerse en consideración "la sabiduría popular" que en numerosas ocasiones no se encuentra involucrada en el desarrollo de modelos econométricos.

- Conclusiones sobre el aumento de la calidad de información obtenida a priori que determinará el diseño de un cuestionario.

Dentro de la investigación cualitativa pueden distinguirse diversidad de técnicas para la obtención de datos que posteriormente se consolidarán como base para la generación de datos cuantitativos. Entre estas técnicas destacan la observación directa, la entrevista, el

análisis documental del estado del arte, el estudio de caso, los grupos focales y las encuestas, entre otros.

Esta Tesis ha cubierto parte de éstas técnicas y ha añadido otras (MGF) configurando finalmente una metodología específica para su desarrollo. En ella se aporta un nuevo concepto que se corresponde con el de Mega Grupo Focal (MGF) para el caso del tratamiento de temáticas genéricas que requieren representación de grandes colectivos (asociaciones de vecinos, asociaciones de comerciantes, asociaciones de transportistas, asociaciones de ciclistas, etc.).

Cabe destacar que en los grupos focales (GF) la información resultante dispone de más detalle que en caso de los MGF, por lo cual la calidad de la misma aumenta en cuanto a concreción con respecto a los grupos de mayor tamaño. En el caso de las entrevistas, los grupos focales (GF) y los megos grupos focales (MGF), el investigador tiene la oportunidad única de obtener información muy valiosa y de alta calidad, que en otros casos no se logra y que puede influir directamente en los resultados finales de la investigación. Esto se debe, a que a menudo las personas emiten gestos o presentan actitudes que van en contra de lo que están diciendo o que enfatizan en mayor medida sus opiniones.

A través de estas técnicas grupales el investigador, al seleccionar un grupo objetivo de personas que cumplen las características que desea para el cumplimiento de sus objetivos, puede dirigir el tema de discusión por la vía más conveniente para el estudio sin que se presenten muchos problemas de discordancia.

Además al estar todos los integrantes del grupo expuestos, se puede lograr que las personas interactúen entre sí y expongan un mayor abanico y diversidad de opiniones y percepciones.

- Conclusiones acerca de la importancia de las técnicas participativas, a través de la consulta a los agentes implicados, en la correcta planificación de políticas de transporte.

La finalidad de la planificación es la de unir el conocimiento científico y técnico a los procesos de orientación y transformación de las sociedades. El correcto análisis de la

información ayuda en la toma de decisiones tratándose de una tarea que requiere una metodología sólida de carácter científico para su correcto desenvolvimiento.

En sintonía con ello y debido a los grandes cambios que se están experimentando en los ámbitos urbanos, los poderes públicos y los agentes involucrados en el proceso, se ven ante la necesidad de tener a su disposición herramientas de gestión que les avalen y apoyen en la toma de decisiones para una correcta planificación del sistema de transporte.

Es por ello, que los mecanismos de participación ciudadana se presentan como una herramienta que fortalece la gestión administrativa y puede ayudar en el logro de la eficacia y eficiencia de las políticas públicas (Brugué y Gallego, 2001).

En los siguientes párrafos, se efectúan las conclusiones a través de la aplicación de la metodología expuesta en la tesis, referida al desarrollo de diversas políticas de gestión del transporte.

a) Políticas para el fomento de la movilidad sostenible en un ámbito urbano.

En la primera fase de la metodología presentada en esta Tesis aplicándose al caso del artículo "Citizen involvement in promoting sustainable mobility", se efectúa un proceso de participación ciudadana basada en la realización de mega grupos focales (MGF) y grupos focales (GF), para el conocimiento de las opiniones y percepciones de los ciudadanos acerca de la movilidad sostenible en un ámbito urbano.

Los mega grupos focales (MGF) se utilizan para que todos los segmentos de la población tengan representación en este proceso y no exista ninguna discriminación. Se pueden ver como una estrategia política de atracción de la ciudadanía a través de temas de carácter genérico y de interés ciudadano (problemáticas del transporte público y privado), para el logro posterior de un objetivo más específico: la realización de grupos focales (GF) a través de los cuales se obtienen las variables necesarias para el diseño y realización de una encuesta piloto de movilidad.

En ellos interactúa una pequeña muestra de la población objeto de estudio y son ideales para tratar temas de especial relevancia e interés (ejemplo: transporte en bicicleta).

En definitiva, se puede afirmar que el desarrollo de esta metodología constituye una herramienta fundamental para el planificador ya que le permite acercarse a la realidad percibida pudiéndose estudiar diversas posibilidades de mejora. Además, el objetivo principal en la realización de los grupos focales (GF) y los mega grupos focales (MGF) es el de ayudar al planificador en el correcto diseño de encuestas de movilidad, de gran utilidad para el conocimiento de la demanda de transporte y la posterior formulación, seguimiento y actualización de Planes de Movilidad sostenible.

b) Políticas para hacer frente a situaciones inesperadas en trenes de pasajeros.

El segundo artículo "Passenger behavior in trains during emergency situations" propone, al igual que en el caso anterior, una metodología para el análisis del comportamiento humano, en este caso de pasajeros y tripulación ante una situación de emergencia en trenes de pasajeros.

Esta herramienta metodológica gira en torno a un estudio de carácter cualitativo efectuado a través de grupos focales (GF) y entrevistas en profundidad, para posteriormente extraer las variables que son determinantes en el comportamiento de los pasajeros y la tripulación, cuando se enfrentan a determinadas situaciones inusuales a bordo de un tren.

Esta investigación de índole cualitativa ha servido como base para el diseño de una encuesta piloto de preferencias declaradas (PD). De esta manera, cabe destacar que la metodología a través de grupos focales (GF) para el diseño de encuestas de preferencias declaradas (PD), se presenta en este caso como una aportación novedosa a la investigación, con el objeto de predecir el comportamiento humano y las reacciones ante situaciones de emergencia a bordo de trenes.

El estudio cualitativo se ha utilizado como base para la posterior modelización de los datos de preferencias declaradas (PD) utilizando modelos de elección discreta de tipo logit para caracterizar y cuantificar el comportamiento.

La investigación cualitativa que se ha llevado a cabo se ha planteado para crear una clasificación de los incidentes en base a las reacciones de los pasajeros y de la tripulación, una tipología de comportamiento de ambos grupos en función de cada tipo de incidente

(conducta negativa y positiva) y para el establecimiento de las variables que rigen cada tipo de conducta de los pasajeros y de la tripulación.

Las causas de los accidentes han sido objeto de estudio en numerosas investigaciones, pero sin embargo nunca se ha hecho hincapié sobre las mismas y su influencia sobre el afectado. Hasta el momento se habían tenido en cuenta el entorno, la sucesión de los eventos, la duración, la resolución del mismo, pero sin embargo nunca se había tenido en cuenta de manera detallada cuales son las percepciones y reacciones de los usuarios ante una situación de emergencia de este tipo.

Los resultados obtenidos tras la aplicación de la presente metodología de investigación, forman la base para el desarrollo de modelos probabilísticos que son capaces de simular el comportamiento individual como una función de las características del usuario. Además al igual que en el caso anterior, la aplicación de la metodología es determinante a la hora de proponer nuevas políticas que hagan frente a situaciones inesperadas, con el fin de minimizar tanto los riesgos económicos como los riesgos humanos.

c) Políticas de mejora de la Calidad Percibida por los usuarios en el caso particular de servicios de préstamos de bicicletas públicas.

El tercer artículo "Modeling public bike perception of quality considereing users heterogeneity" propone una metodología de estudio de la calidad percibida por los usuarios del servicio de bicicletas públicas en Santander, de aplicación adaptable a cualquier lugar con esta oferta de transporte.

La participación ciudadana es notoria desde las primeras fases de la investigación con la realización de grupos focales (GF), de los que se han identificado las variables relevantes para el posterior diseño de una encuesta. Se han calibrado modelos ordered probit considerando variaciones sistemáticas en los gustos y parámetros aleatorios.

En primer lugar, cabe destacar que la metodología expuesta aporta todo un proceso metodológico de participación ciudadana desde las primeras fases, para asegurar una fehaciente representación de la realidad en el proceso de modelización. Los datos recogidos en este proceso, son el resultado de las fases consecutivas de identificación de variables y diseño del cuestionario, y han sido introducidos en modelos ordered probit

para conocer la percepción de la calidad del servicio, en función de las características que lo definen.

Los modelos expuestos constituyen una herramienta de gran potencial en la gestión del servicio de préstamo de bicicletas, ya que no sólo informan de las variables y el grado en el que influyen en la calidad, sino que también aportan información sobre la variabilidad poblacional y las variaciones sistemáticas en las percepciones debido a características socioeconómicas y del propio viaje.

La heterogeneidad en la población se presenta en la valoración de la distribución de los puntos de toma y deje de las bicicletas mientras que entre las causas de variación sistemática de las percepciones de diferentes atributos se encuentran el sexo, la edad, los motivos del viaje, el tipo de abono adquirido y los tiempos de acceso y de viaje. Concretamente, el tiempo de acceso presenta el máximo peso para los usuarios que han percibido más de diez minutos en acceder al sistema. En consecuencia, tal y como se refleja en el valor acumulado de los efectos parciales correspondientes, la mejora de este atributo es la que generaría un impacto más notorio en la percepción de la calidad global del sistema en este conjunto de usuarios.

Finalmente, a través de esta investigación se llega a la conclusión de la necesidad de motivar a los usuarios a valorar cada una de las características del servicio para que la percepción de la calidad del sistema sea más completa ya que el modelo de esta manera estará dotado de un mayor realismo. Para ello es recomendable informar sobre las mejoras en el servicio de modo que sea garantizado el impacto de dichos cambios en la calidad percibida global de los usuarios sobre el servicio.

5.2. PRINCIPALES LÍNEAS DE INVESTIGACIÓN TRATADAS EN LA TESIS

El eje de investigación seguido en la presente Tesis Doctoral se sustenta y toma como base (en los tres artículos que configuran la investigación) la aplicación de diversas técnicas de índole cualitativo como base para la posterior aplicación de técnicas de tipo cuantitativo a través del diseño y desarrollo de encuestas. A partir de los datos obtenidos de la muestra de población encuestada, posteriormente se realiza la modelización del comportamiento humano en diversas vertientes del transporte.

En términos genéricos, cabe constatar que se ha conseguido diseñar una metodología de carácter participativo que se muestra esencial e imprescindible dentro de la planificación del transporte y que puede ser aplicada en diversas vertientes del mismo.

Tomando como partida estas premisas, resaltar que han sido diversas las áreas de investigación que han sido objeto de estudio en la presente Tesis Doctoral.

Dentro del área de la participación ciudadana, se han investigado una gran diversidad de técnicas que han servido de base para el desarrollo de la investigación presentada. Dentro de estas técnicas destacan los grupos focales (GF), los mega grupos focales (MGF), las entrevistas en profundidad, e igualmente, las Encuestas de Preferencias Declaradas (PD) y Encuestas de Preferencias Reveladas (PR).

Por otro lado, hay que destacar la importancia de la presencia del estudio detallado que se ha efectuado acerca de las percepciones y opiniones de los usuarios del transporte público, usuarios/no usuarios de sistema de bicicletas, pasajeros de trenes, tripulación de trenes, etc. Se ha efectuado un estudio del comportamiento y de la conducta humana ante diversos fenómenos relacionados con el transporte, que ha desembocado en la modelización del comportamiento humano dentro de diversas vertientes como la planificación del transporte urbano y la movilidad sostenible, la seguridad ferroviaria y la calidad y satisfacción con respecto al sistema de préstamo de bicicletas públicas. En cuanto a los modelos utilizados se han estudiado los modelos de elección discreta de tipo logit y por otro lado modelos ordered probit.

A continuación se muestran de manera más detallada las áreas de investigación tratadas en los diversos artículos que componen este compendio de Tesis Doctoral acompañada de algunas referencias del estado del arte.

Se resume, que las áreas de investigación tratadas son: planificación participativa, metodologías de participación ciudadana, desarrollo de modelos matemáticos de predicción (Modelos de Elección discreta), causalidad de incidentes ferroviarios, metodologías para la deducción del comportamiento en materia de seguridad ferroviaria, predicción de incidentes/accidentes ferroviarios, creación de índices de calidad, factores influyentes en el uso de la bicicleta, y por último, los sistemas de préstamo de bicicletas públicas.

En el ámbito del desarrollo de metodologías participativas para el estudio del comportamiento. Ward y Alkins (2002), Ward y Alkins (2002), Bruseberg y McDonagh (2002), Newman (2002), Patton (2002), Fern (2001), Krueger y Casey (2000), Krueger (1994), y por último Morgan (1996), definen y empelan diversas técnicas de carácter participativo como Grupos Focales y Entrevistas en Profundidad en numerosas investigaciones.

En el ámbito ferroviario, las principales líneas de investigación que han sido tenidas en cuenta en la presente Tesis Doctoral, se corresponden con:

- La causalidad o los motivos desencadenantes de los diversos fenómenos inusuales que pueden acontecer a bordo de un tres (incidentes/accidentes). En este sentido autores como Fukuda (2002) y Ugajin (1999), definen y tipifican las causas de un incidente/accidente dentro de ámbito ferroviario.
- Metodologías empleadas para la deducción del comportamiento humano referidas a la seguridad a bordo de trenes. En este caso ha sido estudiados autores como Miyachi (2008), Miyachi (2008), Shinomiya (2002), y Davey (2008) que han efectuado diversas investigaciones a través de cuestionarios y entrevistas a los agentes implicados (pasajeros y maquinistas).
- Predicción de incidentes/accidentes ferroviarios. Santos Reyesa y Beard (2009). Baysari y Mcintosh (2008). Radbo (2005). Efectúan numerosas investigaciones

acerca de la seguridad ferroviaria y metodologías la predicción de estos fenómenos.

Otra de las líneas de investigación tratadas en la presente Tesis Doctoral, es la de la creación de índices de calidad. En este sentido, destacan los trabajos efectuados por Eboli y Mazzula (2009), Givoni y Rietveld (2007), y Debrezion et al. (2009), donde se han tratados temas referidos a la creación de índices de satisfacción y calidad en el sistema de transporte, datos de satisfacción en encuestas con modelos de regresión y la introducción de un índice de calidad en modelos jerárquicos de elección discreta basado en características del transporte.

Igualmente se ha efectuado un análisis exhaustivo acerca de los factores que influyen en el uso de la bicicleta. En la bibliografía internacional, numerosos estudios analizan los factores que influyen en el uso de la bicicleta y en la elección de ruta (Wardman et al., 2007; Pucher y Buehler, 2008; Su et al., 2010), mientras que otros confirman que la infraestructura disponible y la seguridad derivada motivan la movilidad en bicicleta (Dill y Carr, 2003; Akar y Clifton, 2009; Dill, 2009).

En cuanto a la investigación referida a los sistemas de préstamo de bicicletas públicas, se ha seguido esta línea de investigación completando las investigaciones ya existentes en esta materia. Así, Froehlich et al. (2008) y Borgnat et al. (2011) analizaron los patrones de viaje y los flujos según la hora del día y el día de la semana en una ciudad o región en cuestión. Esta información resulta interesante ya que, dado que dichos sistemas responden a una oferta pública, cuentan con un número limitado de bicicletas y de estaciones. Igualmente, CEDEX (2007), dell'Olio et al. (2011), Reploge (1993), Rietveld (2000), analizan aspectos relativos a la implantación de nuevos sistemas de préstamo y su idoneidad como modo complementario al ferrocarril. Por último, Lin y Yang (2011), exponen diversas metodologías de cálculo del número y localización de las estaciones así como las rutas entre pares origen y destino.

Por otro lado, en el ámbito del desarrollo de modelos matemáticos de predicción del comportamiento humano. Esta supone otra de las principales líneas de investigación tratadas en la presente Tesis Doctoral.

- Aplicabilidad de los Modelos de elección discreta. Hensher et al. (2010) y dell'Olio et al. (2010). Afirman que en los modelos de elección discreta la variable dependiente se define de manera discreta y ordenada, como es habitual con el uso de escalas en encuestas de calidad de servicios públicos de transporte
- Utilización de los Modelos de tipo Logit. Waddel (1996), Guo y Bhat (2001), utilizan este tipo de modelos para el caso de la localización residencial, Mohammadian y kanaroglou (2003) en la planificación del transporte, y dell Olio et.al (2010) en la percepción de la calidad de los usuarios del servicio de transporte público y en 2009 el comportamiento de los usuarios de vehículo privado a lo hora de aparcar.

5.3. FUTURAS LÍNEAS DE INVESTIGACIÓN.

A partir de la construcción de esta metodología, basada en la participación ciudadana como instrumento de apoyo en la formulación de políticas de gestión y planificación del transporte, pueden establecerse futuras aplicaciones y líneas de investigación.

Como primera línea de investigación, se propone la complementariedad de este método presentado con técnicas participativas adaptadas a las nuevas tecnologías (e-participation) a través de la exploración e investigación de métodos de participación ciudadana vía online. Con ello se propone la investigación de la posible introducción y mejora del método presentado en esta Tesis a través de técnicas de participación vía online para el estudio del transporte y la movilidad.

Esta futura línea parte de la premisa de que los procesos comunes de participación consisten en la celebración de una serie de eventos a los que son invitados los vecinos y todas las partes interesadas que se puedan ver afectadas por un determinado proyecto o acción. Durante estas reuniones son presentados a los asistentes los escenarios que se van a emprender y por lo general es aquí donde éstos pueden obtener documentación e información de más fácil comprensión.

Sin embargo, el principal problema de este tipo de reuniones reside en que tan solo pueden celebrarse en un número reducido de ocasiones lo que imposibilita que todos agentes involucrados en el proceso puedan asistir.

Las formas clásicas de la participación ciudadana y, en particular, la organización de eventos de participación tienen algunos inconvenientes (Carver, 2003). Aunque este tipo de eventos a menudo se celebran en horarios cercanos a la noche, la mayoría de las personas y familias ven difícil participar, ya que entre semana suelen estar ocupados en sus actividades laborales y otras (cuidado de menores, cuidado de personas dependientes, labores del hogar, compras, etc.).

En consecuencia las personas que suelen acudir a estos eventos suelen ser personas mayores, jubiladas, o ciudadanos que se encuentran muy interesados o con los cuales ya se ha tratado.

Otro punto a destacar se corresponde con el hecho de que estos acontecimientos a menudo se limitan a la presentación de un conjunto de documentos disponibles relacionados con el proyecto que se va a desarrollar, y muchos de estos documentos ni siquiera pueden llevarse a los domicilios de los asistentes para un análisis más profundo. Además, el tiempo en el que se desarrollan estos eventos es limitado.

Esto quiere decir que, las discusiones van a detenerse en algún momento, por lo cual puede que, aunque se alcance el consenso entre los participantes, tal vez no hayan sido debatidas y contestadas todas las cuestiones que pretendían tratarse.

Esto supone un sesgo en las opiniones que no es representativo totalmente de la realidad de percepciones de la ciudadanía o del grupo concreto objeto de estudio. Una solución eficaz para contrarrestar estos tres problemas descritos anteriormente, se corresponde con la implementación de herramientas de e-planning para el desarrollo de dichos procesos.

Las herramientas de e-planning consisten en el desarrollo de un conjunto de herramientas online (o simplemente "páginas web") que apoyan la participación y el debate sobre ideas y proyectos de desarrollo urbano, aplicables en la etapa previa, así como en etapas posteriores de la planificación, y en este caso de la planificación del transporte.

Esta supone una de las líneas de investigación futura fijando como laboratorio de experimentación la propia ciudad der Santander. Es por ello, que a partir de la presente Tesis Doctoral se plantea continuar esta línea de investigación aplicada al transporte a través del desarrollo e implementación de técnicas de participación ciudadana online utilizando como laboratorio la ciudad de Santander, haciendo visibles las diferencias, beneficios y problemáticas de ambos métodos, y su posible complementariedad.

Además, esta metodología igualmente podría ser empleada para efectuar un seguimiento y evaluación (Fase de Evaluación de Planes de Movilidad) a largo plazo de la evolución de las políticas que sean implementadas, pudiéndose efectuar comparativas con los resultados obtenidos en varios periodos, incluso pudiéndose estimar el grado de mejora con respecto a la situación anterior. El desarrollo de este punto, daría aún si cabe más validez y veracidad a la metodología propuesta.

Por otro lado, las posibles aplicaciones de las mismas y futuras líneas de aplicación podrían especificarse en el transporte de carga, movilidad eléctrica, Smart Cities, transporte aéreo, transporte marítimo, transporte portuario, entre otros.

5.4. IMPORTANCIA Y APLICABILIDAD DE LOS RESULTADOS OBTENIDOS

La metodología presentada a través de la tesis expuesta destaca por su rigor científico respaldado por tres publicaciones en revistas científicas indexadas incluidas en la relación de revistas del Journal of Citation Reports-Science Edition (JCR-SCE).

Ésta puede ser aplicada no solo a diversos ámbitos de la planificación del transporte, sino a cualquier campo que requiera una investigación de la demanda y de la conducta humana.

Igualmente, hay que destacar la enorme aplicabilidad de esta herramienta metodológica en cada uno de los casos presentados. Los resultados obtenidos para cada caso han sido muy satisfactorios y cuentan con una gran aplicabilidad, no quedándose en la mera teoría, sino funcionando como ejemplos y casos prácticos que abalan el rigor y la eficacia del método.
Se trata de una investigación que ofrece una gran aplicación práctica y ha sido apoyada en todos los casos presentados a través de un estudio real utilizando como laboratorio la ciudad de Santander en alguno de sus casos.

En línea con este aspecto referido a la importancia y aplicabilidad de los resultados obtenidos, a continuación se expone la importancia de cada uno de los casos prácticos que han sido presentados y que han servido de ejemplo para certificar la validez de la metodología expuesta en la presente Tesis Doctoral.

- Aplicación para el desarrollo de planes de movilidad urbana.

El desarrollo de esta metodología conduce a un proceso de fortalecimiento ciudadano. Además las opiniones recopiladas en los grupos focales (GF) y en los mega grupos focales (MGF) se han incorporado al Plan de Movilidad de la ciudad de Santander para la gestión del sistema de bicicletas públicas, el diseño de una red de carriles bici, el reajuste en las frecuencias de ciertas líneas de bus, la reagrupación de líneas de autobús y las modificaciones de ciertos recorridos.

En el ejemplo expuesto, el Plan de Movilidad de Santander ha tenido como objetivo principal mejorar la movilidad reduciendo la necesidad de movimientos en vehículo privado y optimizando las necesidades de movilidad con el transporte público colectivo,

a pie o en bicicleta. Aquí se encuentra la justificación de la presente investigación "Citizen Involvement in Promoting Sustainable Mobility" que sirve como base para la implantación y seguimiento de planes de movilidad sostenible.

- Desarrollo de planes y protocolos de actuación.

La metodología de investigación presentada en esta Tesis Doctoral constituye la base para el correcto desarrollo de protocolos de actuación en este caso a bordo de un tren de pasajeros.

Se han logrado determinar cuáles son las variables influyentes en el comportamiento y en las reacciones de los pasajeros ante una situación de emergencia a bordo de un tren. Todas estas variables llevan asociadas consigo una serie de comportamientos que dependen del tipo de incidente en cada caso (parón/ colisión/ descarrilamiento y fuego/explosión), que se corresponden con irritación, caos, inquietud, confusión, ira, etc.; así como una serie de reacciones positivas que pueden ayudar en la gestión de estos sucesos inesperados.

A través de esta metodología, se ha conseguido simular el comportamiento individual como una función de las características del usuario, y por ello se muestra como una herramienta de gran utilidad que puede ser aplicable al desarrollo y planificación de protocolos de actuación, en caso de darse una situación de emergencia.

Cabe destacar que el método mostrado podría aplicarse igualmente a protocolos aéreos, marítimos, de transporte público, en instalaciones o estaciones aeroportuarias, portuarias y ferroviarias.

- Diseño de cuestionarios de Preferencias Reveladas y Preferencias Declaradas.

En este caso cabe destacar que la actual investigación sirve de soporte o base para el diseño de cuestionarios de preferencias reveladas (PR) y preferencias declaradas (PD). En este caso se trata de cuestionario aplicados a la gestión del transporte en diversos ámbitos, pero hay que destacar que el método presentado podría aplicarse a cualquier ámbito de la planificación donde se precise de un estudio de demanda.

- Desarrollo criterios medibles e índices de calidad.

Se han extraído los criterios del usuario acerca de la calidad percibida y deseada para el futuro seguimiento y control de la evolución de la calidad del servicio (en este caso de préstamo de bicicletas). Por ello se han creado una serie de criterios medibles que servirán para calificar la calidad de cualquier sistema de préstamos de bicicletas dentro de un ámbito urbano.

5.5. LIMITACIONES A DE LA INVESTIGACIÓN

Actualmente la participación ciudadana de tipo consultivo e informativo se muestra como una parte esencial de la planificación de las ciudades modernas. La ciudadanía debe de hacerse partícipe en los procesos de planificación del transporte para así crear espacios urbanos de más fácil acceso y mayor calidad, bajo el principio de movilidad sostenible. Sin embargo, la problemática se manifiesta en que tales reuniones (MGF) transcurren en un espacio muy limitado, por lo cual no a todo el mundo le es posible asistir, no permitiéndose así un estudio a detalle de todos los comentarios, ideas y hechos desarrollados durante este tipo de eventos.

Igualmente en base a como se dirija la discusión, en este tipo de reuniones puede que suceda que algunas de las personas que la integran, por el hecho de ser demasiado tímidas y de evitar la confrontación con el resto de participantes, apenas se atrevan a hablar en público durante el evento, lo que supone un sesgo en las opiniones. Por otro lado, puede haber participantes que son demasiado extrovertidos y pueden hablar demasiado acaparando la reunión, hablando de manera excesiva y convincente pueden causar el efecto de que algunos argumentos (quizá importantes) se hagan invisibles ante los suyos. Por último, cuando las personas llegan a sus domicilios tras la celebración de estas reuniones comienzan a reflexionar nuevamente sobre lo que se ha dicho y lo que se les ha olvidado decir, etc. A través de la aplicación de técnicas de e-planning en las diversas fases anteriores y posteriores a la reunión, o incluso como complemento de la metodología expuesta en la presente Tesis Doctoral, puede ser capaz de hacer frente a estos problemas, al tratarse de herramientas que permiten la participación y el debate sobre el desarrollo de proyectos urbanos.

Del mismo modo, la aparición de las redes sociales durante la primera década del siglo XX facilita la comunicación en general y la discusión en particular entre amigos, vecinos y personas con intereses similares. De ahí que Internet ofrece una oportunidad para permitir la participación de los ciudadanos en formato online y para superar algunos de los inconvenientes descritos anteriormente, que vienen de la mano de los métodos clásicos de participación presencial.

Por otro lado en numerosas ocasiones las restricciones presupuestarias pueden ser otro gran hándicap que podría ser solventado con metodologías online de participación ciudadana, a través de la realización de debates online, encuestas online, etc., con las cuales podría alcanzarse a un mayor grupo objetivo de población.

5.6. ACTIVIDADES REALIZADAS DURANTE EL DESARROLLO DE LA TESIS DOCTORAL

Durante la elaboración de la presente Tesis Doctoral han sido efectuados diversas actividades relacionadas con la investigación, tales como asistencias y publicaciones en congresos, jornadas de transporte y formación específica e investigaciones complementarias.

Dentro de las contribuciones a Congresos, cabe destacar las siguientes ponencias y publicaciones:

- Priorización de inversiones en ciclo vías en redes regionales mediante el análisis multicriterio y SIG: aplicación a la Comunidad Autónoma de Cantabria. Ponencia y publicación en el VIII Congreso de Ingeniería del Transporte. La Coruña, 2008.
- Metodología para el estudio crono-geográfico de los espacios urbanos a partir de la movilidad de la población en transporte público y privado. Aplicación en la ciudad de Santander. Ponencia y publicación en el XI Congreso Nacional de la Población. Envejecimiento, despoblación y territorio. León, 2008.
- Metodología para el estudio de la desigualdad interurbana en la accesibilidad al transporte público. Ponencia y publicación en el XI Congreso Nacional de la Población. Envejecimiento, despoblación y territorio. León, 2008.
- Las desigualdades socio espaciales en la ciudad de Santander en relación en relación al bienestar y dotación de equipamientos sociales. Ponencia y publicación en el XI Congreso Nacional de la Población. Envejecimiento, despoblación y territorio. León, 2008.
- Prioritisation of investments in cycle lanes on regional road networks using multi-criteria analysis and Gis: application in Spain. Poster, TRB 88th Annual Meeting. Washington, 2009.
- Fomento de la Movilidad Sostenible en Campus Universitarios. Ponencia y publicación en el IX Congreso de Ingeniería del Transporte. Madrid, 2010.
- Modelización del comportamiento de los usuarios en trenes de alta velocidad en situaciones de emergencia. X Congreso de Ingeniería del Transporte, Granada, 2012.

Por otro lado, en cuanto a los documentos científico-técnicos, es decir, las publicaciones realizadas a lo largo de la trayectoria doctoral, se presentan (incluyendo las expuestas en la presente Tesis Doctoral) las siguientes:

- Citizen Involvement in Promoting Sustainable Mobility. Journal of TransportGeography, 2010.
- Metodología para el fomento de modos de transporte sostenibles en Campus universitarios. Estudios de Construcción y Transporte, 2010.
- Passenger behaviour in trains during emergency situations. Journal of Safety Research, 2013.
- Modelling the service quality of public bicycle schemes considering user heterogeneity. Bordagaray, M., dell'Olio, L., Ibeas, A., Barreda, R., & Alonso, B. International Journal of Sustainable Transportation, 2014.
- A Methodology to Promote Sustainable Mobility in College Campuses. Transportation Research Procedia 3, Euro Working Group on Transportation 2014.

Por otro lado, el doctorando ha completado su formación académica en materia de participación ciudadana a través de una estancia internacional en la Universidad Pontificia Católica de Chile, dentro del CEDEUS (Centro de Desarrollo Urbano sustentable) durante un periodo de 4 meses. Durante esta estancia internacional la doctoranda ha efectuado diversas investigaciones en colaboración con varios investigadores del Centro:

- Consulta ciudadana: Construyendo una opinión representativa. Aplicación a la Segregación Urbana.
- Hacia el e-planning: Instrumentos participativos online para la implicación de la ciudadanía en el desarrollo urbano.
- Desarrollo de investigación sobre participación ciudadana como elemento de planificación urbana sostenible.

CAPÍTULO 6

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