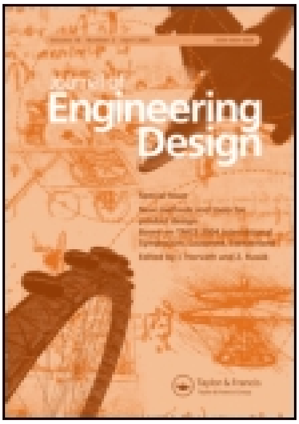

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The customer experience is important for adding value to firms' offerings but two challenges arise: the customer experience is increasingly created through interactions with product–service systems (PSSs) and it is formed through all moments of interaction with multiple firms. Incorporating customer experience requirements (ERs) into the design of PSSs is therefore a complex task. To address this challenge, this paper presents an extension of the Kansei engineering method consisting of two components. First, the extension includes an in-depth study of the customer experience from a holistic perspective that informs the design process. Second, it involves the active participation of multidisciplinary experts from the different partner companies that together enable the PSS offering. An application of this new extension is presented for mid-distance bus trips, involving passengers, a vehicle manufacturing and a transport provider company. The research followed design-science guidelines using an action research approach to develop new public transportation PSS concepts by involving a multidisciplinary design team. The customer experience study enables the team adequately incorporate ERs along the development process, and the joint work of the intercompany team of experts enables integration of the different PSS elements into a solution that enhances the travel experience from a holistic perspective.

Keywords: travel experience; transportation vehicle; Kansei engineering; cognitive; emotional

1. Introduction

Customers buy or use goods and services not as an end but as a means to fulfil deeper affective, sensory and hedonic aspirations (Maklan and Klaus 2011). Nowadays these aspirations are mostly dependent on customer-focused combinations of goods, services, support, self-service and knowledge that usually involves more than one company. This trend has led to servitisation (Vandermerwe and Rada 1988, 316) as manufacturing companies add value to their core offerings through services. This has progressively led to the emergence of complex service systems and value networks, which should be designed from a holistic perspective to enhance the overall customer experience (Patrício et al. 2011). The resulting combination of products and services is a product–service system (PSS), defined as a 'marketable set of products and services capable of jointly fulfilling a user's need' (Goedkoop, Van Halen, and Te Riele 1999, 18).

Customer experience is increasingly important and can be defined as 'the internal and subjective response customers have to any direct or indirect contact with a company' (Meyer and

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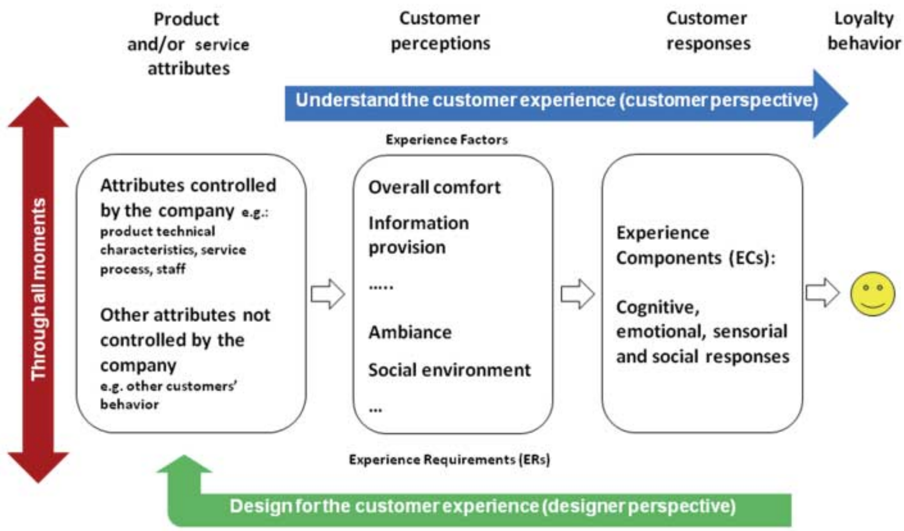

Figure 1. Customer experience creation framework with product(s) and/or service(s).

Schwager 2007, 118). The customer experience is holistic in nature because it results from all moments of contact with a company (see left side of Figure 1). The top of Figure 1 depicts the process of understanding the customer experience and how it is driven by a rich set of experience factors, which are customer perceptions of all product or service attributes such as atmosphere or comfort (Carreira et al. 2013). The top of the Figure also depicts customer experience, which comprised experience components (ECs) such as customer cognitive, social, sensorial or emotional internal responses (Gentile, Spiller, and Noci 2007; Hekkert 2006; Verhoef et al. 2009). The experience factors can be viewed as experience requirements (ERs) from the designer perspective (see the bottom of Figure 1), as they represent the customer needs that they aim to fulfil. As we adopt the design for the customer experience point of view in this article, we use the term ERs to designate the customer perceptions. ECs form the customer experience because they are the different customer internal responses to the interaction with the company offer. Customer perceptions or ERs (e.g. comfort or social environment) therefore influence the customer experience in its different components (i.e. ECs such as emotions and cognitive assessments). In this context, the designer acts upon ERs, designing customer offerings in such a way as to create positive customer perceptions, and therefore enable positive customer experience outcomes (e.g. loyalty behaviour).

In spite of the increasing importance of the customer experience, transportation studies have mostly addressed transit service quality by comparing passenger cognitive expectations and perceptions of transportation attributes that are controlled by the transport provider (e.g. dell'Olio, Ibeas, and Cecin 2011; Nathanail 2008). Public transport is a pertinent ground to study the customer experience, as previous research has shown that the travel experience is formed through all moments of contact between the customer and the firm, including interactions before and after the actual trip (Carreira et al. 2010). These studies have revealed that the travel experience is more complex than transit quality because it is influenced by a rich set of ERs, some of which go beyond the control of transport providers such as social environment or ambience (see Figure 1). These ERs in turn influence the travel experience that comprises a holistic set of customer cognitive, sensorial and emotional responses. Transportation is also a rich setting for the study of PSSs, as transport solutions usually involve various partners providing a transport solution that combines products and services, such as the core transportation service, the vehicle, the ticketing service, the on-board entertainment or the physical facilities in waiting areas (Carreira et al. 2013).

From the customer point of view, a PSS is an integrated offering, even though it results from a combination of product and service elements. These product and service elements are usually separately designed by different companies, while the other uncontrolled attributes are dependent on external aspects, such as other customers' behaviour. Several methods have been proposed for PSS development, but designing PSSs to enhance the customer experience is still a complex task. Existing methods specifically lack incorporation of a holistic view of the customer experience and active involvement of the various partners in the development process of result-oriented PSSs (Vasantha et al. 2012).

To address the aforementioned challenges, this article extends the Kansei engineering method to incorporate a holistic set of ERs into the design of PSSs and to involve different partners of the value network. These extensions are illustrated with an application to the design of new bus interior and bus transportation service concepts.

1.1. *Outline*

Research on the incorporation of customer ERs into PSSs is scarce and as such Section 2 covers existing literature on customer experience, PSSs and methods traditionally used in New Product Development, New Service Development, New PSS Development and the Kansei engineering method. Section 3 presents the research methodology and Section 4 explains the extended Kansei engineering method, focusing on the two extensions presented in this article: the in-depth study of the customer experience from a holistic view and the involvement of an intercompany multidisciplinary team along the different stages of the Kansei process. Section 5 describes the application of the extended Kansei engineering to mid-distance bus trips and is followed by discussion in Section 6.

2. Literature review

2.1. *Customer experience*

The customer experience is holistic in nature as it is (1) extended from the first until the last moment of customer contact with the firm; it is (2) driven by various ERs, some of which are not controlled by the company (e.g. the influence of other people) (Pullman and Gross 2004; Verhoef et al. 2009) and it (3) comprises diverse ECs such as cognitive and emotional responses (e.g. Gentile, Spiller, and Noci 2007). The complexity of the customer experience process through all moments of customer interaction with various product and service attributes is a challenge to the incorporation of ERs in the development of PSS offerings (e.g. Vasantha et al. 2012). Moreover, an experience can be more effective and memorable when it engages more senses (Pine and Gilmore 1998) such as sensory perceptions of an object or environment related to aesthetics (Hekkert and Leder 2008). Aesthetic factors are not limited to the visual domain; things can also be aesthetic or pleasant to listen to, to touch, to smell or to taste. In short, new holistic approaches should take into account that the customer experience is significantly influenced by aspects which are usually beyond the provider control and originate a wide set of customer ECs, including affective and sensorial responses.

An experience is inherent to every customer interaction with a company. Nevertheless there is still an incomplete understanding of the customer experience creation process from a holistic perspective, in particular associated to public transportation research, which has essentially addressed transit quality. Research on customer experience has been mostly conceptual, and research on the translation of ERs into PSS development (Vasantha et al. 2012) is still scarce.

2.2. *Product–service systems*

Designing for the customer experience is crucial for developing new offerings, but providing new products or services alone is no longer enough (e.g. Baines et al. 2007; Doultsinou et al. 2009; Maklan and Klaus 2011). More than product ownership or service provision, customers always look for desired outcomes and value-in-use (e.g. Maklan and Klaus 2011; Shehab and Roy 2006). The importance of adding services to manufactured goods has been increasingly noted since Vandermerwe and Rada (1988) published their study on the servitisation of businesses. However, due to the different nature of products and services, their combination requires adequate integration in order to be coherent and to adequately meet customer requirements (Morelli 2002). Additionally, incorporating ERs into the development of PSSs to enhance the customer experience is especially complex when the combined offering involves various partner organisations (Vasantha et al. 2012). This requires early participation of the customer and of the providers of the different product and service elements that constitute the PSS (Baines et al. 2007). These authors have synthesised prior research to identify three types of PSSs:

(1) Product-oriented PSSs involve a manufacturing company selling the product(s) in a traditional manner, while adding supplementary services (e.g. computer hardware after-sales service), which may be provided internally or by other companies;
(2) Use-oriented PSSs are provided by a firm who sells the use or availability of a product instead of its ownership (e.g. leasing or sharing a car) and it is usually manufactured by another company;
(3) Result-oriented PSSs involve various companies selling the result or capability of a combined offering, instead of using a specific product or service (e.g. catering, web information replacing directories or public transportation).

Companies have considered products separately from services for a long time. However, in the last two decades ‘servitisation’ of products has grown in the economy, while in recent years the ‘productisation’ of services has also become relevant as well (Vandermerwe and Rada 1988). According to Tukker (2004), compared with the other types, result-oriented PSSs reveal the highest uncertainty in the evaluation of user value characteristics (e.g. intangible or subjective value and percentage of value captured) and also disclose high risk premium and transition costs for PSS providers. Within this paradigm, companies try to provide more complex combinations of products and services, developing systems that allow customers to co-create their experience without owning the products that enable it (Normann and Ramírez 1993; Vargo and Lusch 2004). Similar to result-oriented PSSs, in public transportation the customer pays for the provision of agreed results, i.e. being transported to a destination. These types of PSSs are least studied, and therefore deserve further research (Tukker 2004). The challenge is then for companies to form value networks to provide PSSs that customers will readily pay for, because they offer more complete solutions to their needs.

2.3. *Design methods*

Traditionally, New Product Development methods have focused on product design and are therefore centred on requirements associated to product functionality. Quality Function Deployment (Hauser and Clausing 1988) is a widely used New Product Development management approach in industries around the globe, having many variations (e.g. Kuo, Wu, and Shieh 2009; Kwong et al.

2010; Kwong, Wong, and Chan 2009). This approach consists of gathering the 'voice of the customer' in logical groups and in trading-off between those customer requirements according to their relative importance. Moreover, it involves performing concurrent analysis, choosing the adequate technical specifications and how they relate to the customer requirements and finally assessing the correlation between each of the specifications. The house of quality is a conceptual map that provides the means for interfunctional planning and communication. Ulrich and Eppinger's (2007) needs-metrics and competitive benchmark matrices constitute a simpler approach when compared to the house of quality, which starts with the list of customer requirements and results in the elaboration of a list of correspondent metrics or technical specifications, each having ideal and marginally acceptable values. Axiomatic design (Suh 2001) is more concerned with mapping and maintaining the independence of functional requirements while converting them into design parameters in order to minimise the information content of the design artefact. This method aims at optimising product design to eliminate design attributes, which are not related with any function. More recently, Chan, Kwong, and Wong (2009) proposed a method based on genetic programming to generate models for relating customer satisfaction to design attributes. Genetic programming is used to construct branches of a tree representing structures of a model where interaction and higher order terms can be addressed to relate satisfaction to attributes. In spite of the diversity of New Product Development methods for translation of requirements into specifications, they are usually adapted from the ones described here, which essentially translate customer functional requirements into product technical specifications, focusing on incorporating functionality in physical goods.

Despite the fact that some of the methods just described are also applied in the New Service Development context (e.g. Quality Function Deployment applications by Miyoung and Haemoon 1998 or by Herrmann, Huber, and Braunstein 2000), the specificities of services, such as intangibility, inseparability of 'production' and 'consumption' or variability, in the service performance require different approaches (Menor, Tatikonda, and Sampson 2002). Mapping the customer journey using Service Blueprinting (Shostack 1984) is a process-based method used in the New Service Development context, which has been extended and applied to PSSs (Shimomura, Hara, and Arai 2009) and to collaborative networks (Lelah et al. 2011). Service Experience Blueprinting (Patrício, Fisk, and Cunha 2008) also integrates Service Blueprinting with Goal-Oriented Analysis (Mylopoulos, Chung, and Yu 1999). Additionally Multilevel Service Design (Patrício et al. 2011) offers a more holistic approach to the incorporation of the customer ERs in the design of new-technology-enabled multi-channel service systems. However, these methods take a process approach and have not been applied to design of customer experiences with PSSs.

The product design literature has followed the trend towards PSSs, evolving from developing isolated products to developing products with supplementary services, and more recently to designing systemic solutions combining product(s) and service(s) (e.g. Maussang, Zwolinski, and Brissaud 2009). Servitisation extends the traditional functionality of a product by incorporating additional services and by adding value to the tangible goods provided (Vandermerwe and Rada 1988). Miles (2008) considers that the addition of services to a physical product is an increasingly important innovation element from the customer point of view. For that purpose, some specific New PSS Development methods have been developed, which are essentially based on the definition of alternative PSS use scenarios. Maussang, Zwolinski, and Brissaud's (2009) method evolved from New Product Development to address services and PSSs also. This method enables the detailed specification of physical products, the interactions with the service units of the PSS and the other objects or services outside the PSS. Nevertheless, the method only specifies the product properties and uses an external functional analysis to explore the different scenarios of the service provision process. Even though the use of predictable scenarios enables an understanding of the PSS use process, it has not been specifically adapted for complex customer experience incorporation involving different companies.

The methods proposed by van Halen, Vezzoli, and Wimmer (2005) and Morelli (2003) also consist of using hypothetical alternative scenarios to understand what the customer would do in each stage of the PSS 'service provision' while interacting with the physical product(s) involved. van Halen, Vezzoli, and Wimmer's (2005) method consists of several steps, such as (1) strategic analysis, (2) exploration of opportunities, (3) PSS idea development, (4) PSS development and (5) preparation for implementation. Morelli's (2003) approach enables developing a PSS on the basis of product and service functional performance requirements selected by the designer in association with predefined scenarios. This method takes into account that the customer interaction with a PSS is not just mediated by the physical product but also considers the organisational and social aspects associated with each scenario. Van Halen, Vezzoli, and Wimmer's (2005) and Morelli's (2003) methods enable the definitions of a PSS's general requirements but do not provide enough detail to inform subsequent stages of the development process and have not been used to incorporate the customer experience. Therefore, these methods are more tailored for use-oriented PSSs because they are focused on the service process and specifications, but do not address the PSS solution and usage outcomes as a whole nor the intercompany nature of emerging PSSs.

Other more collaborative methods concentrate on involving different partners through the discussion phases of PSSs. Krucken and Meroni (2006) have developed a solution-oriented partnership method which offers proactive tools for communication based on a general framework with specified steps for structured discussions: benchmarking, analysis, key content identification, discussion, refinement and result valuation. Meroni's (2004) methodology framework defines collaborative matrices to organise the data from diverse partners in the different phases of PSS exploration and development. Lindsay and Rocchi's (2004) context-of-use Co-research method takes a multidisciplinary perspective to understand user behaviours and preferences, in order for that information to be fully shared with the other partners. These methods are especially adapted to integrate and synthesise the different points of view and sources of information from diverse partners. These methods focus on creating a collaborative environment to facilitate strategic conversations among the partners, but they do not provide specific guidance for the actual incorporation of customer ERs in PSS specification.

2.4. *Kansei engineering method*

Kansei is a Japanese word which translated into English means 'consumer's psychological feeling and image' (Nagamachi 1995, 4). The Kansei engineering (Kansei) or emotional engineering method (Nagamachi 1995) is different from the previous methods because it concentrates on incorporating user hedonic requirements in new products or services. To this aim, the method associates Kansei or emotional words to specific product or service properties, usually involving a group of experts, engineers or designers of a company. This method therefore accommodates the involvement of the different interested parties (i.e. customers, product manufacturers or service providers) in the actual design process, focusing on the customer point of view instead of focusing on a process or scenario perspective. The Kansei method has been successfully used in the development of different products such as cars (Jindo and Hirasago 1997), bottles (Barnes and Lillford 2009) or mobile phones (Kuang and Jiang 2009). However, studies conducted on internet services showed that Kansei is applicable well beyond tangible artefacts (Nishino et al. 1999). Therefore, in Kansei the term product should hereafter be understood in its broadest sense, involving not only artefacts/ goods but also services (Schütte et al. 2004).

The main phases of the Kansei method are the (1) choice of domain, (2a) semantic description, (2b) description of properties, (3) synthesis and (4) test of validity. Kansei has different variants that go from pure qualitative data analysis to complex computational modelling approaches (Schütte et al. 2004). Frequently, category classification and computer aided system variants are combined to define which product attributes to test, and then to specify what variations of those attributes to include in the final model. Different tools and statistical methods support the use of Kansei to test a set of variations of the product. This is performed through carefully designed experiments to identify their contributions to the overall affective quality of the product.

2.4.1. *Choice of domain*

In the choice of domain stage, the group of experts, who usually belong to the same organisation, defines ad hoc the Kansei domain or the boundaries of the analysis. The experts collect images, possible concepts or even innovative ideas that cover the domain as much as possible (e.g. Roy, Goatman, and Khangura 2009). Various sources can be used such as magazines, reviews and user opinions.

2.4.2. *Semantic description*

After the choice of domain, the experts brainstorm it in the semantic description. In this stage, the team identifies and writes down Kansei or emotional adjectives, verbs or small expressions on cards, focusing on the customer perspective. These words are associated not only with existing solutions, but ideally to new ideas and visions related with customer impressions of the product or service. Even though this stage represents a critical step, it is usually performed with no systematic or predefined approach, and without the involvement of potential customers or other companies that may be relevant for the final product or service being offered. This means that any idea that is not elicited and written down by the team might not be explored in further analysis. These low-level Kansei words or expressions can then be grouped into high-level categories using tools such as the Affinity diagram (Bergman and Klefsjo 1994).

2.4.3. *Description of properties*

In the description of properties stage, the experts identify existing and innovative product properties, as well as company image properties associated with the chosen domain (see Figure 2). This process takes into consideration the relative importance for each existing property from the customer perspective and the expert assessment of the innovative and company image properties. To foster the generation of novel offerings, the selection of properties should reflect as many innovative attributes as possible, which is symbolised by the thicker arrow in Figure 2. After the identification process, the experts evaluate, select and order the properties in three groups, creating a single list using tools such as Pareto diagrams (Bergman and Klefsjo 1994).

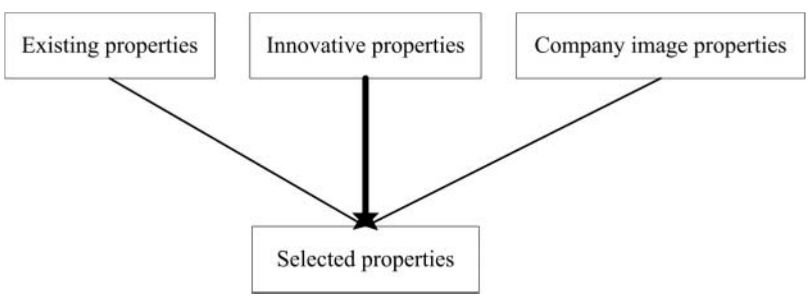

Figure 2. Selection of the most relevant product or service properties.
Source: Adapted from Schütte et al. (2008).

2.4.4. *Synthesis*

In the synthesis stage, the selected product or service properties are connected to the high-level Kansei words to define which properties evoke which semantic impact using Nagamachi's (1997) category identification technique. In this stage, the experts additionally identify each Kansei word's most relevant sensorial impact taking into consideration that the term Kansei is the multisensorial impression somebody gets from a certain artefact, environment or situation (Schütte et al. 2008).

2.4.5. *Test of validity*

The validation phase involves the choice of representations (e.g. images) that symbolise different combinations of the most relevant product or service properties described in the previous stage. The representations are then shown to customers in order for them to evaluate each one on a semantic differential scale associated with each of the Kansei words. Hayashi's quantification theory type I (Ishihara et al. 1995) is used to analyse the customer evaluation of representations to find Kansei word–property relations. Depending on the significance of the results obtained in this step, the description of the semantic and property spaces may need to be updated and the synthesis stage run again until the results from this iteration process are satisfactory.

Kansei engineering engages the experts and brings in the customer perspective through the whole design process, offering an approach to associate ERs with product or service properties. However, it does not yet address the development of new PSSs from a systemic perspective. As the method is traditionally used within a single product or organisation, it makes it difficult to develop PSSs, because that would require the involvement of an intercompany team. Moreover, to effectively incorporate a holistic view of the customer experience, strong involvement and validation with customers is also needed. However, this method relies mainly on experts to explore ad hoc the Kansei domain and properties as well as the customer sensorial and affective impacts. In summary, Kansei provides a useful method to incorporate the emotional components in product development, but new evolutions are needed to incorporate a holistic perspective of the customer experience into an integrated development of result-oriented PSSs, with the participation of the different partners involved.

2.5. ***Literature review summary***

From the customer point of view, the experience is developed from the first until the last contact with a company and it is driven by a rich set of ERs that originate cognitive, sensorial or emotional responses. Customers perceive a PSS as a whole offering, although it may result from a complex combination of products and services that involve more than one company.

Traditional New Product Development methods are structured and essentially focused on the association of requirements to specifications, while New Service Development methodologies focus on visual representations of the service process phases. Some New PSS Development approaches already enabled designers and engineers to understand the systemic product and service integration, but they still focus on either product specification or service process without an effective integration of all the different PSS elements, namely the case of the different types of PSSs (Vasantha et al. 2012). More collaborative methods facilitate strategic conversations and discussion among the partners, but they are also not adapted to incorporate ERs that involve both instrumental and hedonic attributes.

A semi-structured method like Kansei engineering has the potential to incorporate ERs in new result-oriented PSS development because it is performed from the customer perspective.

However, the choice of domain as well as the description of semantic and properties space are usually performed ad hoc by experts that belong to a single company. This paper contributes to fulfil these gaps by extending Kansei engineering with (1) a prior structured study of customer ERs in order to incorporate a holistic perspective of the customer experience into PSS specification and (2) the involvement of an intercompany team of experts along all stages of the development process for a collaborative design of the different PSS elements.

3. Research methodology

The research process followed design-science guidelines according to Hevner et al. (2004). Those guidelines are intimately associated with problem solving procedures and have their roots in engineering and the sciences of the artificial (Simon 1996). Hevner et al. (2004) propose a design-science approach whenever research is related with the creation of innovations that define the ideas, practices, technical capabilities or artefacts, which are not a result of natural laws or behavioural theories.

Taking a design-science approach into account, this article developed an extension of the Kansei engineering method, by incorporating a diverse set of ERs in the design of new PSS, and by combining product (e.g. vehicles, physical facilities) and service (e.g. the actual transport provision or the off-board services) elements of the companies involved. According to these guidelines, the extended Kansei engineering method was developed in two phases: (1) the initial exploration and understanding of the customer experience process from a holistic perspective, in particular ERs and ECs during all moments of contact between the customers and the firms and (2) the incorporation of ERs into new integrated PSS solutions.

The first phase was the study of the customer experience that consisted of an extensive literature review and also qualitative (Neuman 2006; Strauss and Corbin 1998) and quantitative (Churchill 1979; Gerbing and Anderson 1988) approaches. This study provided an in-depth understanding of the customer experience affective realm and of the product or service properties, providing the basis for thorough incorporation of ERs into the design of the PSS. Observations and semi-structured interviews (Pawson 1996) offered qualitative in-depth information that was used to develop a survey questionnaire, which was self-administered to bus passengers in a quantitative approach.

In the second phase, the Kansei engineering steps were applied using the action research approach (Harris 2007; Herr and Anderson 2005) through which the researchers were also practitioners within the organisations involved. Harris (2007) defines action research as an informed investigation about a concrete issue in an organisation by a participating researcher, which originates new knowledge both to the organisational members and to the research community. The participating research team led a group of experts in the application of Kansei, and thus had reasonable control over the other participant activities in relation to its implementation. An additional quantitative analysis (e.g. Hair et al. 2009) was performed to validate the extended method after testing its results with the customers during a survey administration.

The extended method was evaluated taking Hevner et al.'s (2004) design-science generic guidelines into consideration and its contribution to new design methods assessed according to Forlizzi, Zimmerman, and Evenson's (2008) criteria, which are process detail, invention, relevance and extensibility. First, the extended Kansei is described in detail so that the design process can be replicated and the rationale for method selection can be understood. Second, the specific application of the method demonstrates that it addresses a novel approach for incorporating ERs into PSSs, which was not offered by other design methods. Finally, the application of extended Kansei to the development of public transportation result-oriented PSSs, involving bus manufacturers and transport providers, demonstrates its relevance and suggests that it can be extended to other transport settings or even other PSS contexts.

The extension to the Kansei method is described in the next section and is followed by the concrete application to mid-distance bus transportation. This application shows how the method can be used for incorporating the customer experience into New PSS Development, with a more specific application to the incorporation of the travel experience.

4. Extended Kansei engineering method

With the research objectives in mind, the Kansei engineering method was enhanced by extending it with two new aspects, as shown in Figure 3. First, the extended model involves an in-depth study of the customer experience to elicit a holistic set of ERs and to enable their incorporation in the design of a PSS. Second, the extension involves sharing and discussing the study results with a team representing the companies involved in the development of a new PSS so they understand the customer experience creation process and are able to better incorporate it into the design process. This multidisciplinary intercompany team actively participates along the different stages of the extended Kansei application which provides two main contributions when compared with traditional Kansei engineering: (1) the in-depth study provides a more complete understanding of the customer experience realm from a holistic perspective, especially regarding hedonic attributes, and takes into account all moments of the customer experience; (2) the involvement of intercompany team members through all method stages enables the alignment between product and service elements of the PSS, as the in-depth understanding of the customer experience is better acknowledged and the different companies' inputs are brought together to inform design decisions.

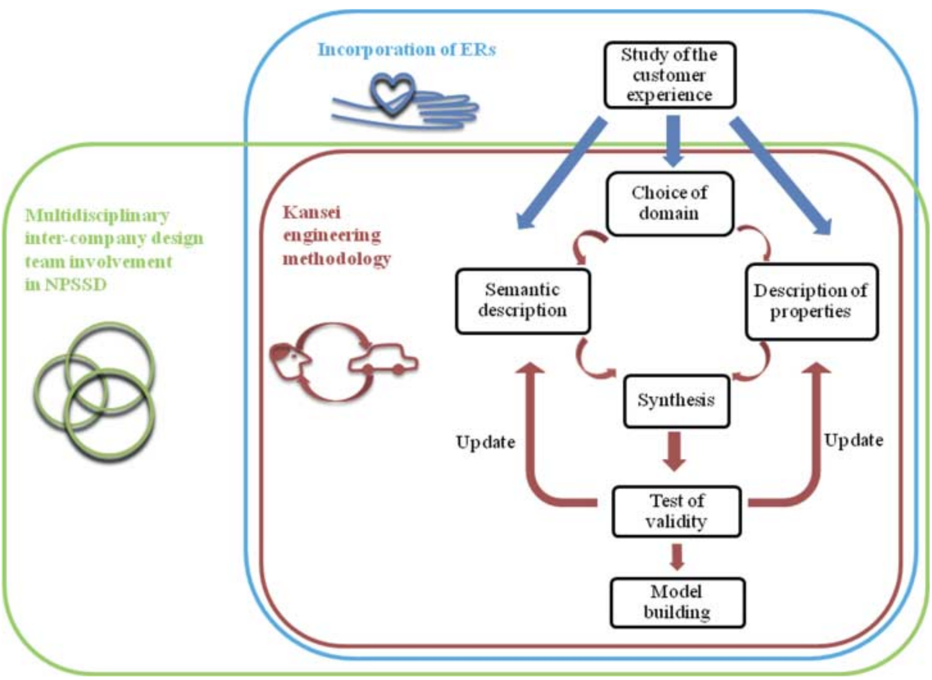

Figure 3. Extended Kansei experience development model.

4.1. *Extension 1: study of the customer experience*

To achieve an in-depth understanding of the customer experience, the extended Kansei method consists of both qualitative and quantitative approaches. The first stage of the study uses qualitative methods (e.g. Neuman 2006), which involve both interviews and observations in a complementary way. Interviews are considered more adequate for identifying requirements that customers are able to verbalise, whereas observations are considered moreappropriate for discovering customer latent needs (e.g. Dahan and Hauser 2001; Sandén, Matthing, and Edvardsson 2006). The proposed extended Kansei engineering method involves the elaboration of specific protocols with open-ended questions for the qualitative activities undertaken, which provide guidance for the identification of a holistic set of customer ERs and ECs. All the process of qualitative data preparation and collection contributes to a thorough understanding of customer actions and verbal comments because it facilitates their content analysis (Neuman 2006).

Based on the qualitative results, a questionnaire is developed in the second stage of the study involving a sequence of steps in a scale development approach (Churchill 1979; Gerbing and Anderson 1988). This questionnaire is administered to customers who are asked to evaluate the importance of each ER item (e.g. on a seven-point Likert scale) as well as its respective performance and are also asked to assess ECs (e.g. emotional or cognitive evaluation). Survey data are then subjected to quantitative analysis to identify the most relevant customer ERs needing further improvements.

On the one hand, qualitative methods are a powerful tool to understand the complexities of phenomena that are considered insufficiently studied (Parasuraman and Zinkhan 2002), as their more open nature allows the researcher to explore unexpected patterns and issues. On the other hand, the quantitative approach enables the identification of customer ERs following scale development guidelines (Hair et al. 2009). These scale development procedures include exploratory and confirmatory factor analysis to identify the dimensions of ERs and ECs and are followed by structural equation modelling to analyse the impact of the different ERs on each EC. After this process, Martilla and James‘s (1977) importance–performance analysis is used to assess the relative importance and performance of the ERs' dimensions to identify the main PSS areas for potential improvements. Together, these qualitative and quantitative studies provide in-depth information that may be related to the semantic and property domain and also enables a thorough data analysis in the following development phases. The multidisciplinary team is involved in this initial study, contributing to the elaboration of the qualitative protocols and of the questionnaire for the quantitative study, as well as providing continuous feedback on study results.

4.2. *Extension 2: Kansei engineering method with an intercompany team of experts*

After the first extension involving the customer experience study, the method continues with the regular stages of Kansei engineering described in Section 2 and depicted in the inner square of Figure 3. However, differently from the typical Kansei approach, which usually involves engineers and designers from a single product manufacturer or from a service provider, the current extension engages experts from more than one organisation. These experts work in the companies that are involved in the different product and service elements of the result-oriented PSS, but they are asked to take on the 'systemic' customer perspective as they collaborate in the multidisciplinary team. The preliminary qualitative and quantitative study results are shown and discussed with the team of experts and provided to them a more holistic perspective of the customer experience, based on the elicitation of the expressed or latent customer ERs. In order to enable the use of the qualitative and quantitative experience data, this extension combines category classification and computer aided system Kansei variants, due to their wide applicability and proven success in industrial and service case studies.

During this intercompany collaborative phase, it is crucial that all team members are strongly committed and actively involved in analysing the data and interpreting the results of the Kansei domain under study through each step of the method. Based on the importance–performance analysis of the survey data, the choice of domain is the first formal step of extension 2. While brainstorming on the semantic and property spaces, the experts should be open minded and should try not to be influenced by current manufacturing or technological limitations, in order to facilitate the future development of breakthrough PSS solutions. Taking into consideration that the semantic description is a critical step in implementing this method, the Kansei word generation for each domain is performed until there are no more word suggestions from any of the team members. The qualitative and quantitative information obtained during the travel experience study is discussed with the Kansei team and is used throughout the Kansei stages. This is very valuable during the phase of Description of properties, specifically in assessing the passenger perceptions of relative importance of existing trip properties. The active collaboration of experts enables integrated PSS design at this stage, taking into account the interconnections between the different parts to improve the overall solution, instead of focusing only on the product or on the service part(s) of the PSS. With this approach, the extended Kansei method enables the incorporation of customer ERs by establishing relationships between specific innovative PSS properties, Kansei words, and customer sensorial responses. In the Synthesis stage, each Kansei word or expression is selected, and then the properties and sensorial impacts related to each one are identified. Finally the results of the team analysis are shown to the customers for validation of the relationships established. Further multivariate data analysis are performed at this stage such as quantification theory type I (Ishihara et al. 1995). This analysis provides assessment of method rigour and reliability, by quantifying the impact of PSS property dummy variables (i.e. predictor variables, which are binary variables that take the values 0 or 1 and are used to incorporate qualitative variables in a regression analysis such as the PSS properties) on each Kansei word as a predicted variable. Through the process described above, these two extensions enable more holistic incorporation of the customer experience into a collaborative process of PSS development, involving both product and service companies in all phases of the process. In the next section, a concrete application of the generic extension to Kansei engineering is presented in detail.

5. Application of the extended Kansei engineering method to mid-distance bus transportation

The extended Kansei method was applied to the development of new bus transportation concepts, involving a bus body manufacturer and a regional transport provider. The regional transport provider was interested in enhancing the customer experience to improve its competitive position. This service provider had been a regular client of the bus body manufacturer, but had no structured collaboration for the development of new buses or transport services. On the other hand, the manufacturer was interested in developing its buses to better satisfy end user needs, but had no direct access to passengers and had not involved transport companies in the bus body development process. The application of the extended Kansei engineering method was therefore seen by both companies as a way to get in-depth inputs from end customers to incorporate a more holistic view of their experience, enabling the two companies to collaborate for an integrated design of the PSS they both wanted to improve.

The new concepts were developed from a PSS perspective, taking in consideration that mid-distance bus transportation involves product elements such as the vehicle or the bus terminal facilities, and also service elements such as transportation itself or on-board entertainment. The application included the formation of a Kansei team which engaged members from both manufacturer and transportation companies, comprising bus body engineers and designers as

Figure 4. Images of the multidisciplinary team meetings.

well as mid-distance transport managers. The multidisciplinary team comprised four permanent experts and three additional experts who participated in regular meetings, also contributing to the vehicle and transportation service development. The two companies did not use formal methods respectively, in their New Product Development and New Service Development processes. Therefore, the research team offered a detailed explanation of the overall Kansei method, its specific techniques and objectives to all the team members. The research team conducted the customer experience study, presented the results, and facilitated the regular meetings and workshops involved in the extended Kansei engineering application. Finally, the research team also performed the validation test with end customers.

Following the extended Kansei engineering approach described in the previous section, the application started with an in-depth study of the customer experience, and the results were shared with the Kansei team. Sharing these results was important for the team to analyse the interconnections between vehicle and service properties related with the chosen domain of ERs as well as properties' impact on passenger cognitive, sensorial and emotional responses.

The travel experience study results were used for applying all the principles of Kansei engineering in 2h weekly meetings and in several workshops, some of them involving bus trips (see Figure 4). These meetings and workshops were performed during three months and were moderated by the research team, with the objective of enhancing the public transportation in the Kansei domain(s) chosen. Finally, the passengers were again involved through administration of a questionnaire to validate specific associations between bus trip properties and Kansei words, which resulted from the Kansei team meetings.

5.1. *Extension 1: study of the travel experience*

This study aimed at gathering a rich understanding of the passenger experience, with a comprehensive identification of travel ERs to inform the design of the PSS. The passengers under study were travelling between different Portuguese cities in bus trips that took 2 h on average. During the qualitative phase, passengers were observed inside buses and in bus terminals, and 27 of them were interviewed (see Carreira et al. (2013) for further details of the qualitative phase). The qualitative study allowed for an in-depth understanding of the passenger experience from a holistic perspective, both in terms of ERs and ECs. This phase showed that an integrated development and management of the overall trip is important for passengers, as they spontaneously mentioned both product aspects, such as the vehicle or the individual seat, and service aspects, like the information provided or the staff's professionalism during all moments of transportation.

Building upon the qualitative study and literature review, a survey questionnaire was designed and administered to bus passengers to develop and validate a scale to measure the travel experience. After several pretests, the survey was administered to 116 passengers, who were randomly selected in similar mid-distance bus trips to assess their specific journeys by evaluating the importance and performance of each ER, as well as passenger emotions (i.e. emotional ECs), travel satisfaction and overall value (i.e. cognitive ECs), and loyalty intentions in relation to the transportation provider. The factor analysis of the survey data allowed for the aggregation of the questionnaire items into eight dimensions of travel ERs (see Carreira, Natal, and Magee (2012) for further details of the factor analysis performed to the sample of respondents):

- *Overall comfort* (e.g. comfortable interior temperature and sound, being able to sleep, aesthetic appeal of the bus trip),
- *Body comfort* (e.g. individual space and body seating support),
- *Safety* (e.g. access to and from the bus, easy-to-use seatbelts, bus maintenance and knowledge of the safety procedures),
- *Social environment* (e.g. ability to talk to other passengers or knowing new people),
- *Staff's skills* (e.g. friendliness, professionalism or driving ability),
- *Information provision* (e.g. pertinent information availability, adequate identification of the bus and stops, departure times),
- *On-board entertainment* (e.g. having good conditions to read, use a laptop or hearing music) and
- *Waiting time* (e.g. punctuality, available schedules, fast trip).

The results showed that these requirements were related to both product components, such as vehicles or off-board facilities, and service components, such as information provision or on-board entertainment. The requirements also covered the different stages of the customer travel experience such as searching for information before a trip, waiting in the bus terminals or actually travelling during a trip.

Following Martilla and James's (1977) importance–performance analysis, each point on Figure 5 displays the mean value for the importance (horizontal axis) and performance (vertical axis) for the questionnaire items of the eight ERs. The horizontal and vertical black bold lines represent the overall mean for all the items in terms of importance (vertical line) and performance (horizontal line). These lines help to visualise the ERs' relative position to the overall mean in terms of importance and performance, and the lines divide the figure in four quadrants. The lower-right quadrant depicts the attributes that have relatively high importance and low performance. The upper-right quadrant depicts the attributes that have relatively high importance and high performance. Taking this analysis into consideration, improvement efforts on ER *overall comfort* were considered a priority, as this dimension was positioned in the lower-right quadrant, meaning that it was highly important for customers and the current trip service performance was of relatively low importance. Efforts on upper-right and lower-left quadrants could also produce interesting results in terms of enhancing the customer experience: ERs that had both high importance and performance, such as *waiting time* or *safety*, should still be managed in order to maintain their current performance. Nevertheless ERs with low importance and performance for

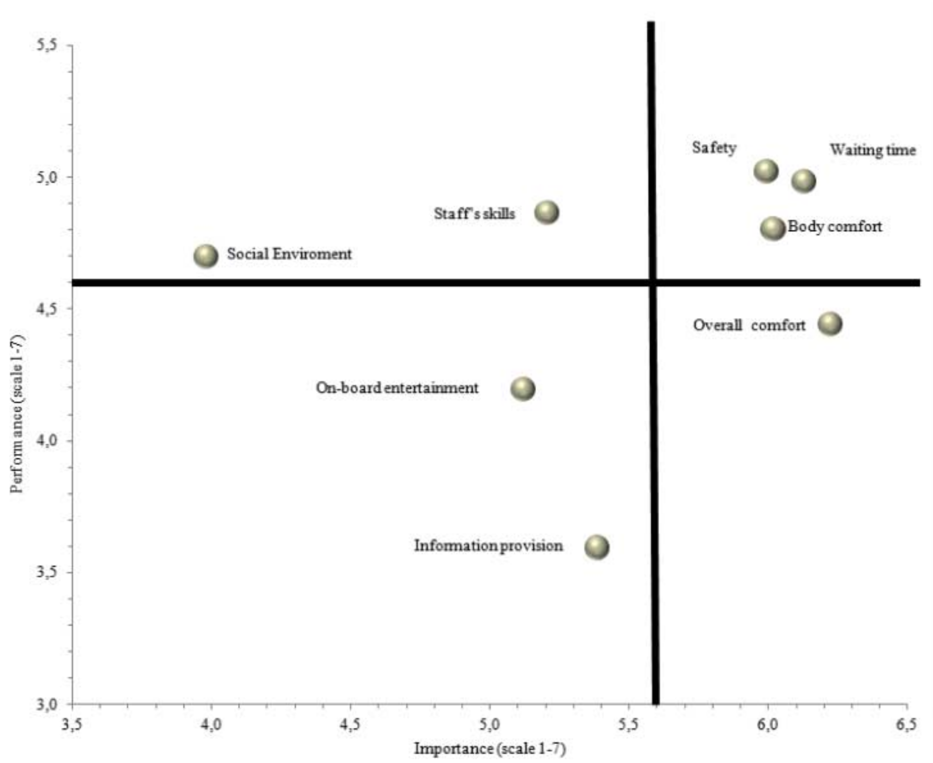

Figure 5. Importance–performance analysis for travel ERs.

the global passengers, such as *on-board entertainment*, might have the potential to enhance the travel experience for specific passenger profiles, e.g. passengers of longer trips. In addition, the ERs for which the division between importance and performance means is higher should be taken into consideration. Taking these criteria into account, improvements in *overall comfort* ER were considered a priority.

Overall, the Kansei extension with the studies of the customer experience enabled the project team to gain a deeper understanding of ERs and of how they influenced the customer experience. The importance–performance analysis also enabled the identification of priority improvement areas, and therefore facilitated the incorporation of ERs into the development of new bus interiors and transportation service concepts, as integrated and collaborative PSSs.

5.2. *Extension 2: Kansei engineering method with an intercompany team of experts*

The results obtained in the travel experience study served as input for the application of Kansei engineering involving an intercompany team of experts with both bus designers and transport managers.

5.2.1. *Choice of domain*

In the choice of domain stage, all the Kansei team members reflected on the significance of the travel experience study results. Based on this discussion, the team chose the ER dimension *overall comfort* as the one to be further analysed. After several brainstorming sessions, it was

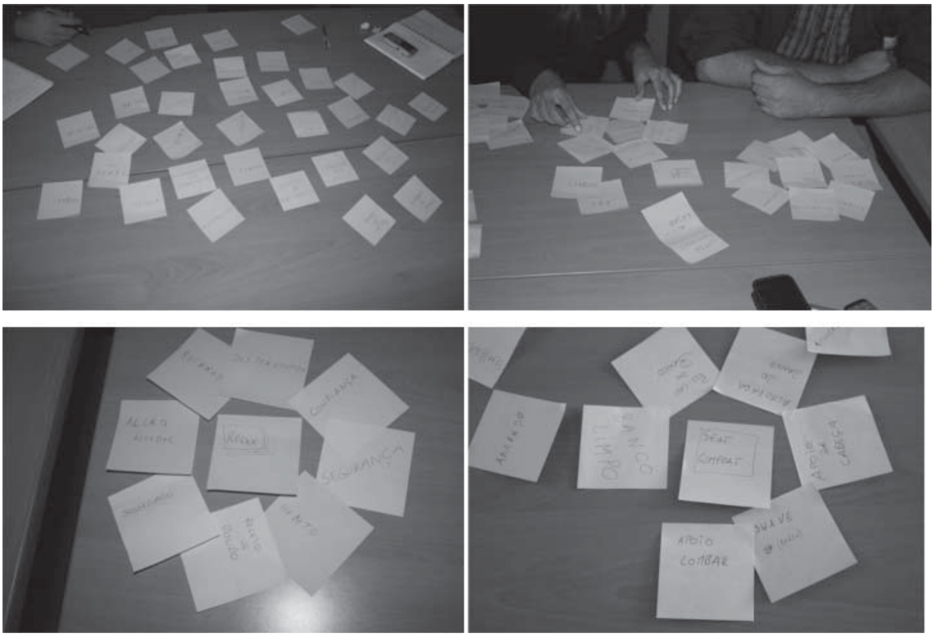

Figure 6. Kansei word generation and aggregation examples.

acknowledged that *overall comfort* involved many product and service attributes, and it was a domain too broad to be analysed without decomposing it. Therefore, taking into account the companies' strategic priorities, the questionnaire item *aesthetic appeal of the bus trip*, which was associated to the ER dimension *overall comfort*, was chosen as the specific domain for applying Kansei engineering. From a PSS perspective, the multisensory *aesthetic appeal of the bus trip* was considered interesting for the extended method application, as it involved overall comfort conditions related with both product and service elements of transportation, such as the ones associated with the vehicle and with the transport provision.

5.2.2. *Semantic description*

The Kansei or emotional words and expressions were generated through brainstorming sessions with the multidisciplinary team for the chosen domain. These Kansei words reflected the passenger affective response associated with the ERs identified in the travel experience study. Taking into consideration that this is a critical step in implementing this method, the Kansei word generation for the domain was performed until there were no more word suggestions from any of the team members. In the first step, words were written down on post-it cards, and in the second step they were aggregated into logical groups (see Figure 6).

In the semantic description approach, more than 40 Kansei words were associated with the domain *aesthetic appeal of the bus trip*, which were then aggregated in four high-level emotional words that were *functional layout*, *visual aesthetics*, *well-being*, and *overall sensorial perceptions*. These words were organised in multiple, hierarchical levels as can be seen in the Kansei word columns in Table 1.

5.2.3. *Description of trip properties*

The identification of the emotional expressions related with the Kansei domain in the previous step was followed by the description of trip properties. This stage dealt with the identification of the

Table 1. Synthesis results for domain aesthetic appeal of the bus trip.

Kansei words				
Level 0	Level 1	Level 2	Senses	Trip properties
Pleasant sensorial perceptions	Safety perception		Vision, audition	Driving ability; driver not speaking at the mobile phone while driving; luggage-rack design and finishing; characteristics of decency-screens
	Tactile perception		Touch, vision	Materials' finishing, coatings and colours
	Sound perception	Silence	Audition, vision	Luggage-rack design and finishing; other passengers' conversations or noise; music on the sound system
	Smell perception		Smell, vision	Other passengers' food; shapes; coatings and colours overall coherence (e.g. bus garbage bin)
Functional layout	Quality of the materials		All	Materials' finishing, coatings and colours; characteristics of decency-screens (e.g. soft, robust); seats' softness; 'hidden' bus interior mechanical parts
	Design		All	All
		Ergonomics		
		Accessibility		
		Functionality		
		Organised		
		Stowage		
		Minimalist		
		Simplicity (less is more)		
		Space		
		Involvement		
		Wideness perception		

(*Continued*)

Table 1. Continued.

Level 0	Level 1	Level 2	Level 3		
Visual aesthetics	Visual feelings			Vision	Material coating and colour overall combinations; shapes; luminosity control; indirect illumination; clear and reflective colours of the bus roof interior; illuminated bus roof interior; staff's appearance
	Aesthetic coherence			All	Material coating and colour overall combinations; Shapes
	Modern	Shapes		Vision, touch	Rounded shapes
		Patterns		Vision, touch	Material coating and colour overall combinations; shapes
		Colour combinations	Warm	Vision	Material coating and colour overall combinations; shapes
			Neutral	Vision	Material coating and colour overall combinations; shapes
			Cold	Vision	Material coating and colour overall combinations; shapes
				All (especially vision and touch)	Material coating and colour overall combinations; shapes (e.g. rounded shapes); other types of curtains or alternative ways of reducing outdoors luminosity
	Nice illumination (sources of light)			Vision	Clear, indirect illumination; Illuminated bus roof interior and gangway; daylight transmittance of the windows; not being sun blinded
	Luminous (materials)			Vision	Material coating and colour overall combinations; shapes; reflective colours of the bus roof interior
Well being	Nice ambiance			All	Material coating and colour overall combinations (e.g. soft seats); shapes; luminosity control; illuminated bus roof interior and gangway; staff's awareness and control of the passengers' comfort; pleasant and relaxing music
	Airy			Vision, smell	Rounded shapes; high-roof buses; luminosity control; fresh air renovation (but not cold air flow)
	Pleasant	Inviting		All	Material coating and colour overall combinations; shapes; accessibility (e.g. stairs' low height, few stairs, telescopic stairway); stairway and bus interior luminosity; staff's friendliness and professionalism
	Tranquillity	Attractive		All	Material coating and colour overall combinations (e.g. materials' finishing); Shapes
		Cosy		Touch, vision, smell	Soft seats' appearance; luminosity control; materials' finishing; right air flow (not too cold nor too hot)
				Audition	Insonorisation (possibility of choosing the level of noise); separation from other passengers to some extent; pleasant and relaxing music
	Beauty			Vision	Material coating and colour overall combinations (e.g. bus interior luminosity); shapes

most relevant trip properties (see the Trip properties column in Table 1) associated with the domain *aesthetic appeal of the bus trip* that potentially had an impact on the Kansei words. These properties were identified from existing transportation solutions, new ideas or corporate image. Additionally, the participation of the transport company's managers in the team provided further information about the passenger perspective (e.g. associated to hedonic or affective trip requirements) and about the service within which the bus would be used. This service transportation perspective was very important for a systemic approach to the design of the PSS, since vehicle designers tended to focus on the physical elements inside the bus.

The relative importance given to the innovative trip properties, which were still unavailable in the current trips, was mostly based on the Kansei team experts' knowledge and vision. The importance given to existing properties was based on the passengers' feedback from the quantitative study of the travel experience. Regarding company-image-related properties, the brainstorming sessions revealed that there were no trip properties that reflected the bus manufacturer and transport provider brands and as such they were not included in the selected trip properties. After this analysis and discussion, the experts selected and ranked the most relevant trip properties, which essentially reflected existing and innovative public transportation properties associated with the tangible elements during the trip or with the transportation service provision. After several sessions, the three most significant properties chosen were (1) *shapes*, (2) *material coating and colour combinations* and (3) *gangway lighting*. In the following stage, the overall selected trip properties were synthesised with the Kansei words associated with the domain *aesthetic appeal of the bus trip*.

5.2.4. *Synthesis*

The association of the Kansei words to each of the trip properties and to sensorial perceptions was thoroughly performed by the multidisciplinary team in a word by word synthesis with the selected trip properties and senses, which is represented in Table 1. Since aesthetics is also related to the different senses, the team elements had a slightly diverse perspective of the passenger sensorial responses to the bus interior environment. As in previous stages of the method, the collaboration of vehicle and transportation experts enabled a PSS perspective of the synthesis performed, instead of focusing only on the vehicle or on the transportation service. For example, when working on the sound sensations, service managers were more concerned about the sound comfort provided to the passengers, while vehicle experts were more focused on the perceived safety associated with the absence of mechanical noises. The synthesis stage enabled the understanding of the association between trip properties and semantic and sensorial impacts. These relationships were tested with the passengers in the following stage.

5.2.5. *Test of validity*

The previous Kansei steps led to the identification of the trip properties that potentially influenced the passenger affective response. Taking into consideration the three most relevant trip properties that were previously selected, i.e. *shapes*, *material coating and colour combinations* and *gangway lighting*, the team identified the Kansei words that were more frequently associated with those properties of the bus interior environment: *nice ambiance, attractive*, *sensorially pleasant*, *high-quality materials, modern* and *luminous*. For the validation stage that followed, the team chose public transportation visual representations that were associated with different combinations of the three most relevant trip properties. Considering that the Kansei team members included bus body design experts and transport managers, and also that the vehicle is a key product component of transportation, several bus interior photographs were selected as PSS

Table 2. Trip properties and respective categories associated with each regression explanatory variable.

Trip property	Category	Regression dummy variable: Name	Regression dummy variable: Value
Shapes	Rounded	Shapes	1
	Straight		0
Material coating and colour combinations	Warm	CC_Warm	1
	Neutral		0
	Cold		0
	Warm		0
	Neutral	CC_Neutral	1
	Cold		0
Gangway lighting	Yes	Gang_light	1
	No		0

Table 3. Combination of the trip properties associated by the Kansei team to each photograph.

Variables:	1	2	3	4	5	6	7	8
Shapes	0	0	0	1	1	0	1	1
CC_Warm	1	0	0	0	0	0	0	1
CC_Neutral	0	1	1	1	0	0	0	0
Gang_light	0	0	1	0	0	0	1	1

Note: As an example, images 5 through 7 are perceived by the team as having a cold combination of material coating and colour (because CC_ Warm = 0 and CC_ Neutral = 0).

Table 4. Semantic differential scales used to evaluate each image on each Kansei.

Nasty ambiance	1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7	Nice ambiance
Not attractive	1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7	Attractive
Unpleasant sensorial perceptions	1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7	Pleasant sensorial perceptions
Low-quality materials	1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7	High-quality materials
Old	1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7	Modern
Not luminous	1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7	Luminous

representations that combined the selected trip properties. This stage included the generation of dummy variables for each of the trip properties and categories, which are listed in Table 2. Given the four dummy variables involved in the analysis, a high variety of possible combinations might be obtained. To overcome combinatorial explosion, the orthogonal experiments were designed using the Orthogonal Design Tool provided by SPSS (Statistical Package for the Social Sciences, which consists of predictive analytic tools for multivariate data) software as depicted in Table 3.

To test the association of trip properties with Kansei words performed by the team of experts in the previous stage, the photographs in Table 3 were shown to 73 customers in the same type of mid-distance bus trips as in the travel experience study. Customers then answered the question 'How does the interior look to you?' to evaluate each of the eight bus interior images on each Kansei word using the seven-point semantic differential scale represented in Table 4.

Taking into consideration that 68 valid questionnaires were obtained, and that each one had 8 parts (i.e. one part for each bus interior image) consisting of the same 6 questions, a total sample of $68 * 8 = 544$ cases were obtained.

Table 5. Kansei words Analysis of variance (ANOVA).

Kansei words	Model	Sum of Squares	Df	Mean Square	F
Nice ambiance	Regression	145.199	2	72.599	31.543
	Residual	1245.153	541	2.302	
	Total	1390.351	543		
Attractive	Regression	258.640	2	129.320	53.309
	Residual	1312.388	541	2.426	
	Total	1571.028	543		
Pleasant sensorial perceptions	Regression	168.194	2	84.097	42.221
	Residual	1077.584	541	1.992	
	Total	1245.778	543		
High-quality materials	Regression	192.934	2	96.467	51.561
	Residual	1012.176	541	1.871	
	Total	1205.110	543		
Modern	Regression	330.105	2	165.053	71.838
	Residual	1242.981	541	2.298	
	Total	1573.086	543		
Luminous	Regression	169.785	4	42.446	18.955
	Residual	1206.972	539	2.239	
	Total	1376.757	543		

Note: Statistical significances < 0.001.

The ANOVA represented in Table 5 tested the acceptability of the model from a statistical perspective. The F-statistics in the six models are significant to the 0.001 level, which means that the variation in the Kansei words explained with these models is not due to chance. In the last row of Table 6, R^2 stands for the coefficient of determination, that is, the squared value of the multiple correlation coefficient, which is the linear correlation between the observed and model-predicted values of the dependent variable. If there is no linear relation between the independent variables (i.e. product properties) and each dependent variable (i.e. Kansei word), R^2 will be very low. Otherwise, if all the values fall on the regression line, R^2 will be high. The adjusted R^2 is especially considered because it is a better measure of the correlation between independent and dependent variables since it not only reflects over fitting, but also takes into consideration the addition of variables that do not contribute significantly to predictive accuracy. The regression revealed statistical power (significant at the 0.01 level for all but two variables, which are significant at the 0.05 level) and the adjusted R^2 were above 3%, which was considered significant based on the number of cases obtained (Hair et al. 2009). Therefore, the experts' association of trip properties to Kansei words performed in the previous stage was statistically validated.

The regression results presented in Table 6 showed that the trip properties *shapes* and *gangway lighting* had a stronger impact on all of the Kansei words. The results presented for the Kansei word *luminous* revealed differences when compared with the other ones, since the existence of *gangway lighting* had the strongest impact, followed by *warm combination of material coating and colour*. The *shapes* had only a residual impact, while the *neutral combination of material coating and colour* caused a negative impact on that Kansei word. These results were important for the development of new bus interior concepts for both the bus manufacturer and the transport service provider, as they showed that the selected bus interior properties had a significant impact on Kansei words, thus validating this connection. Through this extended Kansei engineering approach, the team of experts was able to identify and evaluate different types of bus aesthetic environments, understanding how product and service properties influenced passenger sensorial and emotional assessments implicit in the Kansei words. The application presented in this paper focused on the trip aesthetic component, but the customer experience study allowed for the identification of other

Table 6. Standardised regression coefficients, coefficients of determination and adjusted coefficients of determination.

Predictors	Nice ambiance	Sig.	Attractive	Sig.	Pleasant sensorial perceptions	Sig.	HQ materials	Sig.	Modern	Sig.	Luminous	Sig.
Constant term	4.099	.000	3.667	.000	3.887	.000	4.287	.000	3.910	.000	4.310	.000
Regression variables												
Shapes	.298	.000	.373	.000	.344	.000	.380	.000	.423	.000	.095	.024
CC_Warm											.117	.014
CC_Neutral											−.155	.001
Gang_light	.125	.000	.159	.000	.130	.010	.124	.020	.177	.000	.330	.000
R^2 (coeff. of determination)	.104		.165		.135		.160		.210		.123	
Adj. R^2	.101		.162		.132		.157		.207		.117	

Note: Sig. values represent the statistical significance of the regression coefficients, given all the other variables in each regression equation (i.e. associated to each regression predictor variate or Kansei word).

ERs that could be further explored in other applications, supporting the design of PSS attributes that enhance the travel experience from a holistic perspective.

6. Research and managerial implications

This paper presents an extension of the Kansei engineering method, with a detailed application to the development of result-oriented PSSs for mid-distance bus trips. The proposed approach contributes to an integrated design of PSSs to enhance the customer experience through two extensions, as previously depicted in Figure 3: (1) an in-depth study of the customer experience from a holistic perspective and (2) the involvement of a multidisciplinary and intercompany team in the New PSS Development process.

First, customer involvement in the initial study enables a rich understanding of the customer experience, which is useful along the subsequent stages of the Kansei method application. Previous research has developed methods for incorporating the voice of the customer into product or service design, such as Quality Function Deployment. However, these methods have not addressed the customer experience from a holistic perspective, and have mostly focused on aspects that are verbalised by the customers and are more easily controlled by providers, such as price or schedules. The study undertaken in the extended Kansei engineering method allowed for the elicitation of a thorough set of ERs, such as *overall comfort*, *staff's skills*, *information provision* or *safety*. The study also allowed the identification of different ECs, such as perceived value, which is more cognitive, but also of emotional responses to the PSS, such as excitement and joy on the positive side or annoyance on the negative side. The ERs identified in the study concerned all moments of service provision, such as the *information* provided in the bus terminals before the trip, the *on-board entertainment* during the actual trip or the *safe access* from the bus at the end of the trip. This holistic approach to the customer experience was therefore important to provide an extended understanding of the process of searching, acquiring, using or remembering companies' combined offers and to provide a comprehensive view of the customer ERs.

The initial study also facilitated the association of aesthetically appealing properties with various semantic and multisensorial perceptions by the multidisciplinary team of experts, helping them understand the Kansei domain and how the semantic and the property space were associated. With this extension, the voice of the customer experience was taken into consideration through all stages of the Kansei method and was grounded in thorough customer input, instead of leaving these tasks only to the team of experts, which is the traditional Kansei engineering approach. The results of the validity test showed that selected properties, e.g. *shapes* or *gangway lighting*, had a significant impact on Kansei words, such as *modern* or *luminous* bus interior environment. The extended Kansei engineering therefore enables a robust incorporation of ERs into New PSS Development, supporting the multidisciplinary team along the Kansei engineering process.

Second, the extended Kansei engineering approach presented in this article also contributes to the design of result-oriented PSSs, which are considered an under-researched area (e.g. Tukker 2004). The second extension enables a systemic approach to the development of new PSSs through the integrated design of its product and service components by involving an intercompany and multidisciplinary team in the process of creating result-oriented solutions. Product manufacturers and service providers are brought together in the various phases of New PSS Development to collaborate in an integrated design approach to enhance the customer experience. The application to the public transportation PSS showed that the team members possessed extensive knowledge related to vehicle specification and service processes. However, they lacked comprehension of the customer experience from a holistic perspective and systemic view of the transport PSS provision. Design experts were accustomed to think in product and service specification terms separately, but were not used to think of an integrated PSS with a strong customer focus. The extended Kansei engineering method contributed to address these challenges through the various meetings, workshops and bus trips that brought together the different team elements since the preliminary study of the customer experience and through the different stages of the method. The intercompany multidisciplinary team could therefore collaboratively incorporate the customer experience perspective into integrated development of the PSS, as opposed to existing methods (e.g. Maussang, Zwolinski, and Brissaud 2009) that usually focus either on product specification or on the service process methodologies. Compared with other collaborative methodologies (e.g. Krucken and Meroni 2006), this new Kansei extension provides specific support for incorporation of customer ERs into result-oriented PSS.

Even though previous Kansei engineering approaches enable the incorporation of affect and emotions in products and services, they traditionally contain too much subjectivity in dealing with customer perceptions and designer interpretations of data (Schütte et al. 2008). In previous Kansei approaches, the team members are usually experts either in a product or in a service. Moreover, the choice of domain, the description of semantic space and the description of the property space are usually performed by the team with no systematic guidance. The proposed extended method offers a balance between systematisation and flexibility and it is fairly semi-structured. As such, it provides a set of procedures and guidelines that can be adapted to facilitate the incorporation of instrumental and especially of hedonic requirements such as aesthetics, which are more subjective in nature. The New PSS Development process becomes more robust using extended Kansei engineering because the intercompany team of experts is engaged since the beginning in the development of the integrated offering, and is better informed by the structured and holistic study of the customer experience, when compared with other PSS design methods. The extension facilitates all the process of (1) experience understanding through the identification of ERs and ECs; (2) domain selection, based on the ERs' importance–performance analysis; (3) Kansei word generation, which is facilitated by the in-depth qualitative results; (4) description of properties, taking the multidisciplinary team practice and their customer perspective approach into consideration; (5) determination of the relative importance of properties, based on the passenger importance assessment of ERs in the survey and (6) association of properties to the Kansei words, because of the combined contribution of the teams' expertise and the experience study results.

The application presented in this article shows that the extended Kansei engineering method can be used in public transportation PSSs, but the insights gained can also be useful for other PSSs. The application to a real-world setting shows that the extended Kansei method can be applied with valuable results for the different companies involved. The study of the travel experience revealed that product and service trip elements should be consistent with each other to enhance the passenger experience. The discussion of qualitative and quantitative results provided customer feedback about the travel experience from a holistic perspective to engineers, designers and managers in the development team. The intercompany meetings and workshops contributed to a close collaboration between the companies involved in developing new PSSs.

This study also highlights the importance of looking beyond the firms' boundaries to adopt a solution orientation and discover new ways to innovate and create value for and with customers. The holistic view offered by the extended Kansei method supports companies to broaden their views during all the moments of interaction with customers. The study provided the companies rich information about the passenger generic ERs, and more concretely of *overall comfort* aspects such as multisensory aesthetic appeal. This article details the application of the later stages of the Kansei method to aesthetic appeal, but study results enabled the companies to improve their offerings in other ERs.

The study also shows that the intercompany collaboration along the development process offers insights on the connections between the different components of a result-oriented PSS that a single company cannot achieve. These results highlight the need for companies to adopt collaborative approaches that enable integrated PSS development involving the different partners of the value network to identify and incorporate ERs. These results also reveal that vehicle manufacturers and transport operators can gain from establishing long-term collaborations for the development of PSSs. By sharing their complementary perspectives they can understand the interconnections between product and design decisions, and can therefore design integrated PSSs to enhance the customer experience as a whole.

7. Conclusion and future research

Customer experience is increasingly important for companies, and more specifically for the ones involved in public transportation. Public transportation can be seen as a result-oriented Product-Service System (PSS) because it involves a complex set of elements such as vehicles, facilities and transportation services. The integrated development of PSSs requires innovative design methods that enable effective incorporation of a holistic set of customer ERs.

The extended Kansei engineering method presented in this paper contributes to addressing these challenges, by enabling in-depth understanding and incorporation of the customer experience along the development process, and by joining an intercompany and multidisciplinary team of experts that together provide a complete view of the different elements of the PSS. The application to the bus transportation PSS shows how both Kansei extensions bring new insights and help the team along the development process. Public transportation is a rich ground to study the development of result-oriented PSSs, providing insights that can be also useful for other types of PSSs. However, further studies are needed to expand this emergent research area.

The later stages of the application of the extended Kansei engineering presented in this paper focused on aesthetic ERs. Replicating the process to other travel ERs such as social environment or on-board entertainment can further contribute to a holistic incorporation of ERs in the PSS development. The extended Kansei method can also be further validated by building physical prototypes to represent how the semantic and the space of properties are associated and by testing them within the same type of bus trips. The extended Kansei method was applied to mid-distance bus trips, but further research can apply it to other types of public transportation settings such as aeroplanes or trains, in order to broaden its application.

Overall, this study contributes to a deeper understanding and incorporation of the customer experience in the design of PSSs using extended Kansei engineering. This study will hopefully motivate further research related to the design of PSSs to enhance the customer experience from a holistic perspective.

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