AN APPROACH TO ACHIEVE DESIGN RECOMMENDATIONS FOR INTERIOR ELEMENTS OF
URBAN RAILWAY TRANSPORT
WITH REGARD TO USER PERCEPTION OF SEMANTIC DIMENSIONS

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ABSTRACT

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Although, the literature reveals that coach interior designs have been emphasized as an important factor determining their competitiveness in the market and the quality of an interior design can be effectively improved by using information about passenger expectations, few practical studies exist to assess the urban railway transport interiors from the passengers' perspective. Consequently, designers lack reliable criteria to guide their decisions which would satisfy users. In this study, it is intended to develop a procedure to create interior design alternatives of urban railway transportation vehicles with regard to subjective needs and preferences of users. In order to acquire design criteria and recommendations for such interiors, the design alternatives are then evaluated quantitatively through the medium of semantic assessment tools. The thesis is supported with the arguments collected from literature and with the data from three empirical studies.

Keywords: coach design, user needs and preferences, semantic evaluation tools, semantic dimensions

ÖZ

KULLANICININ ALGILADIĞI SEMANTİK ÖLÇÜTLERE GÖRE
ŞEHİRİÇİ RAYLI TAŞIMA ARACININ İÇ ÖĞELERİNE İLİŞKİN
TASARIM ÖNERİLERİ ELDE ETMEYE YÖNELİK BİR YAKLAŞIM

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Literatürde, raylı araçların kompartıman tasarımlarının, bu araçların pazardaki rekabet yeteneğini etkileyen önemli faktörlerden birisi olduğu ve bu tür tasarımların kullanıcı beklentileri kullanılarak geliştirilebileceği vurgulansa da, şehiriçi raylı taşıma araçlarının iç tasarımlarında kullanıcı beklentilerine ilişkin sadece birkaç uygulanabilir çalışma yapıldığı görülmektedir. Bu nedenle tasarımcılar, kullanıcıları memnun etmesi beklenen tasarım kararlarını verirken güvenilir ölçütlerden yoksundur. Bu çalışmada, şehiriçi toplu taşımada kullanılabilecek raylı araçlar için kullanıcı ihtiyaç ve tercihlerine göre alternatifler oluşturabilecek, semantik araçlar yardımıyla da bu tasarımların nicel değerlendirmesini sağlayabilecek bir yöntemin geliştirilmesi ve edinilen verilerle de benzer araçlar için iç tasarım ölçütlerinin açığa çıkartılması amaçlanmıştır. Tez, literatürden derlenen görüşler ve üç ampirik çalışmanın sonuçları ile desteklenmiştir.

Anahtar Kelimeler: kompartıman tasarımı, kullanıcı ihtiyaçları ve tercihleri, semantik değerlendirme araçları, semantik ölçütler

ACKNOWLEDGEMENTS

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CHAPTER 1

INTRODUCTION

1.1. Problem Definition

A few decades ago, developing a new railway vehicle was simpler than today. Engineers of railroads worked together with engineers of manufacturers. As both sides spoke the same language, their discussions and compromises were based on the proven technical solutions using technical drawings. If industrial designers or artists were called in the development process, they were consulted on colors, textiles or some minor visual details (Neumeister, 2000). However, today, the development of modern trains is a multi-disciplinary task which should involve management, marketing and design as well as engineering. Numerous specialists for interior and exterior details and in some cases, representatives of potential passengers should be included to the design and manufacturing processes.

This is because today's trains are meant not only to transport passengers safely from point A to point B, but also are being designed to attract new passengers in competition with rivaling means of transport, such as private cars, airplanes or buses. Therefore, designing better looking interiors and exteriors; and developing alternatives, creating innovative solutions for better service and better comfort have become necessities for the manufacturers.

However, most interiors of today's railway coaches are assessed unattractive when compared to the other types of transportation vehicles' interiors mentioned above (Neumeister, 2000). When interiors of other public spaces are included into this comparison, like small restaurants or cafes, hotel lobbies, shops, reception areas of

companies or modern office environments, this discrepancy becomes more evident. In spite of their different functions and use environments; most of them have similar combinations of materials, have design consistency from the overall layout up to the smallest details. However, the vision and creativity of the railway companies, engineers, designers and their clients are often restricted by an old-fashioned idea of a characteristic 'train image' (Neumeister, 2000). Consequently, this is combined with the desire to create vandalism-safe interiors, using vandalism-resistant materials; instead of gathering data from passengers and using their needs as guidelines to develop better travel environments. Additionally, because rail is seen as a business evolved slowly and where things appear to run relatively slowly, rail human factors research has been the forgotten branch of transport ergonomics at least in comparison to aviation and road driving (Wilson and Norris, 2005). Even in many sectors, such as consumer electronics or automotive, user needs and preferences have been assessed as an increasingly important part of new product development; few practical studies exist for the behalf of railway industry.

Therefore, the literature lacks a coherent understanding to assess the attractiveness of coach interiors from passengers' perspective, despite the fact that interior designs have been emphasized as an important factor determining the competitiveness of coaches in the market and the quality of an interior design can be effectively improved by using information about passengers' expectations. Consequently, designers lack reliable indicators about design criteria of coach interiors, therefore it is necessary to analyze users' needs and preferences in order to guide design decisions which would satisfy the users.

1.2. Scope of the Study

The study presents an insight to passengers' expectations and perceptions of semantic dimensions with regard to the coaches used in urban transportation like trams,

subways or monorails; in order to achieve design criteria and recommendations for such interiors. In the following chapters; with user needs and factors affecting preferences, semantic evaluation and development methods to evaluate the subjective opinions will be identified according to the related literature. Later, measurable specifications of coach interior elements and their features with regard to their influence and effect levels on the overall perception of an interior will be determined and discussed with the data acquired from empirical studies.

The primary research question of the thesis is:

- What are the design criteria for railway coach interiors in terms of user needs and preferences?

Throughout the study, the issue will be investigated with the secondary questions below:

- How can user needs and preferences contribute to new product development process?
- What are semantic evaluation and development tools to assess and compare the subjective preference data? Which methods are more suitable to use in such a study?
- What are the most influential design factors for coach interiors according to the passenger perception of semantic dimensions?
- Which elements and features affect and contribute to the overall impression of a coach interior most?

1.3. Structure of the Thesis

The thesis starts with a chapter on user needs and factors affecting user preferences in which a general approach and formulation of needs are given. Multidimensional psychological constructs - composed of cognitive, affective, and behavioral dimensions

- towards product perception are also defined in this chapter together with the presented models in the literature.

The next chapter elaborates on the related literature in order to convey the available design evaluation and development tools offering quantitative assessments with regard to users' expectations. In this chapter, different methods are defined, discussed and compared according to their strengths and weaknesses.

The fourth chapter has the purpose of comparing and evaluating users' semantic needs and preferences in order to achieve design criteria for coach interiors. Regarding with the elements and their features consisting the coach interior, the most influential design factors and their effects on the overall perception of interior are investigated within the framework of three empirical studies.

The fifth and the final chapter evaluates and summarizes the outputs of preceding chapters. Limitations of the study with suggestions for further research are conveyed in the closing section.

CHAPTER 2

USER NEEDS AND FACTORS AFFECTING PREFERENCES

This chapter deals with the transition from objective to subjective aspects of products. In order to have a wider perspective, the chapter is composed of three sections. The first part points out the historical background and the importance of subjective needs and preferences. The second part concentrates on the issue of user responses to physical appearance of products which are supported with the models of perception and communication processes, while the last part focuses on the formulation of user needs according to the broad range of literature in the subject of response to the visual domain and in the subject of user needs and preferences for product design.

2.1. General Approach to User Needs and Preferences

People have always needed objects for different purposes. However, throughout the history, it is not only personal preferences affecting purchasing decisions but also production capabilities and strategies of the time. For example, manufacturing quality revolution which began with Taylor around 1920, has made the manufacturing as the dominant force in the world (Saleh, 2002). Therefore manufacturers started to concentrate on the 'product-out' strategy which means a production by a manufacturer based on its own design strategy regardless of users' demands and preferences. Through 1970's this strategy was in use, therefore manufacturers designed and produced the products through their own concept with pure functionality and people bought them (Nagamachi, 1999).

However in later phases, people's demands have focused on more than functionality. Besides objects' primary work, they have turned into living objects with communicating abilities like usability or aesthetics. Users have started to be interested in the objects with expanded features and have become more careful while choosing them in terms of their expectations (Lin et al., 1996) and the trend in product design has shifted from functionalism to product semantics (Krippendorff, 1995). According to this trend, users' needs and preferences are primary concerns in product development within a highly competitive market. In order to meet these needs and also to improve attractiveness, a well-designed product should not only satisfy requirements, defined objectively, but should also satisfy consumers' psychological needs (Aoussat et al., 2000).

Therefore in the market, developing new products that meet consumers' needs and tastes is a crucial issue for product design and the industrial age has changed from a 'product-out' concept to a 'market-in' concept which means a production by a manufacturer based on the current consumer's desire and preference, regarding new product development (Kwon, 1999).

In addition to the shifted production strategy which has a more consumer-oriented attitude, technological improvements shape the product development as well (Nagamachi, 1999). Along with the industrial designers' contributions, new products are enhancing in terms of better communication facilities, material qualities and some other added values. The proper design of these new products is perhaps the most critical factor that determines whether or not the product, and in turn the developing company, thrives or fails. While satisfying some user needs and following user preference are priorities, many other factors are involved in product development, such as availability of materials, resources, and available manufacturing capabilities as well as technologies (Tarasewich, 1996). Therefore, product design become a multi-dimensional process including marketing, manufacturing, engineering, and human factors perspectives; thus highlights the need for collaboration among market researchers, engineers, ergonomists and designers.

Baber and Wankling (1992) defined design as a process to create a system or a product with functions meeting human being's needs. In this process, some social, economic, technological, psychological, anthropological, artistic and aesthetic factors should be considered in order to satisfy the psychological and physical demands of human beings.

Today, people use products not just for their functions, but also for their symbolic meanings and feelings that are evoked. Besides the physical expectations, people take into consideration the psychological expectations while assessing the products. Even, there are products that users have a very limited chance to prefer one to another such as public transportation vehicles, subjective evaluations have great impact on their satisfaction. It is well documented that users have composite needs that affect their choices (Elliott and Wright, 1999). However it is not clearly understood that how users perceive a form and how the meaning of the product form can be effectively transmitted to them (Lundquist, 2001 in Khalid and Helander, 2004). Also trends in product development indicate that users will find it hard to distinguish between many products due to their functional equivalency. Users' decisions, therefore, are based on more subjective factors (Hsu et al., 2000).

As a fact, engineering and marketing models of product design and the product design process emphasize the importance of customer needs first. Ideally, companies that develop products ought to understand customer needs so that they can develop products that will sell. Assessments of customer needs are then used to specify the functional requirements of the product. The functional requirements in turn are used to determine product design parameters. These three steps are common for many established design methods (Suh, 1990) and all variables whether they are directly or indirectly related with human beings, compose the input of the industrial design process. The development of any product should, therefore, first understand and evaluate customer needs addressing several issues, including: utility, functionality, aesthetics, prestige, usability and pleasure. This is the first step in the life cycle of product development (Chapanis, 1995).

Khalid and Helander (2004) propose a framework for conceptualization of customer needs through product design features. According to this model, there are three major features of a product like holistic features, functionality and styling (or design details). These features are ordered in an abstraction hierarchy. Therefore holistic impression followed by functionality and design details (styling) are perceived according to the consumer needs for a product and form the overall consumer response towards it (Figure 2.1).
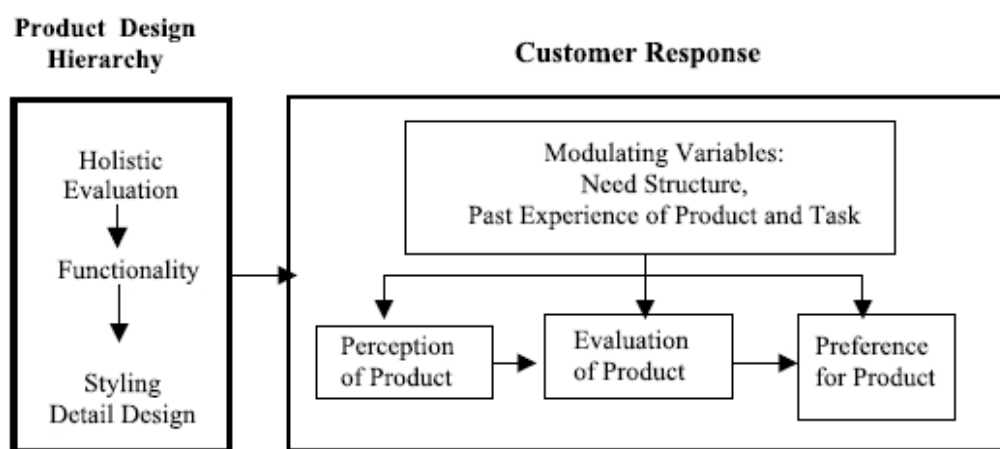

Figure 2.1 A framework for conceptualization of customer needs (Khalid and Helander, 2004)

However, the importance of the three levels will vary depending on the customer's experience of the product and the task environment in which it is used. For example, a customer who is inexperienced with a product may focus primarily on the holistic impression and the styling of the product. The reason is that he or she has not yet understood how to use the product and would, therefore, not be able to comment on functionality. With increased experience gained while using a product and the task environment there will be more opinions. A driver cannot look much at a car radio. Therefore, features related to its functions and usability such as search and identification of stations become more important rather than its styling (Khalid and Helander, 2004).

In this respect, it can be said that, need to be in the process of design is becoming more important for users with their expanding needs and preferences which contain more subjective values than ever. Therefore all aspects of user responses to product form should be well understood and evaluated, because the visual appearance of products becomes a critical determinant of product success in the market (Bloch, 1995).

2.2. User Responses to Physical Appearance

User's preference is largely affected by the fact that how he/she perceives the visual attributes of a product (Crilly et al., 2004). Design as a facilitator and communicator, creates the form that meets the preferences of consumers (Hayes, 1990). Hence, the choices are often made on the elegance, functionality and social significance of products based on visual information rather than needs and requirements (Monö, 1997).

Maslow's hierarchy of needs (referred in Bloch, 1995) has been compared to users' requirements of designed products. Lewalski (1988) suggests that when issues of utility, safety and comfort have been satisfied, emphasis of user shifts towards the decorative, emotional any symbolic attributes of products. Thus, a product's perceived attributes may have greater importance than its tangible properties and may contribute to product's success (Esslinger, 1999 In Crilly et al., 2004).

Bloch (1995) identifies four major ways of how product form may play a role in this success. First, it is a means to gain consumer notice, in markets with high a number of product design variation. Secondly, it is a way to communicate information to the consumers. It creates the first impression and this impression generates inferences the attributes of the product such as functionality, strength or ease of use. Thirdly, it is significant in influencing the quality of consumer's lives in larger sense. They may gain pleasure or stimulation when they perceive and use a beautifully designed product.

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Lastly, it can also have enduring effects, where the aesthetic characteristics may have impacts for years.

Although visual information frequently dominates our culture and environment, it is accepted that the full range of human senses influence response to design (Macdonald, 2000). Wells et al. (1995) define perception as the process of receiving information through senses and giving meaning to it. Their study focuses on the sense of sight, what consumer sees on the product form and how she/he gives meaning and response to it. Therefore, it is important that a product's appearance is convenient with other sensory aspects of design mentioned above as 'the product form that the eye sees creates in the observer expectation of what the other senses will perceive' (Monö, 1997).

In general, users have no access to the designers of the products they interact with. Thus, the users' interpretation of the design is based dominantly on their interaction with the product. This semiotic perspective on design focuses on viewing products as signs capable of representation (Vihma, 1995 in Crilly et al., 2004). If products are to be considered as signs that are interpreted by users, it is useful to consider user response to product appearance as one stage in a process of communication (Monö, 1997).

Shannon (1948) described a basic process of communication with a model covering five elements: source, transmitter, channel, receiver and destination. According to this model, the information source produces a message which is encoded into a signal and transmitted across a channel. The receiver decodes the signal and the message arrives at the destination (Figure 2.2).
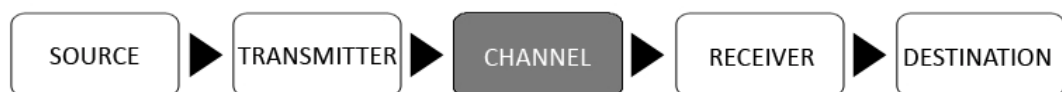

Figure 2.2 Basic model of communication (Adopted from Shannon, 1948)

Monö (1997) has applied this basic model of communication to the study of product design. The producer is responsible for design and manufacturing processes of product in that model. The designer acts as the *source* of the message. The product itself may be viewed as *the transmitter* of the message, and the environment in which the consumer interacts with the product may be regarded as the *channel*. The consumer is involved in both the perception of products and response to them. Consequently, the consumer's perceptual senses may be regarded as the *receiver* and the sensations for response may be regarded as the *destination*.

On the other hand, the traditional view of consumer behavior presents response to products as comprising cognition and affect, which are followed by behavior (Bloch, 1995). According to Bloch (1995), once the product is developed, variety of responses is evoked from consumers. These include cognitive and affective responses, which may interact and influence each other and may occur simultaneously (Figure 2.3). The product form affects consumer's belief about the product. It may create or influence beliefs related to characteristics like durability, ease of use and prestige. Categorization is another type of cognitive response where the appearance of a product influences the ease with which a product is categorized and the category to which it will be assigned.
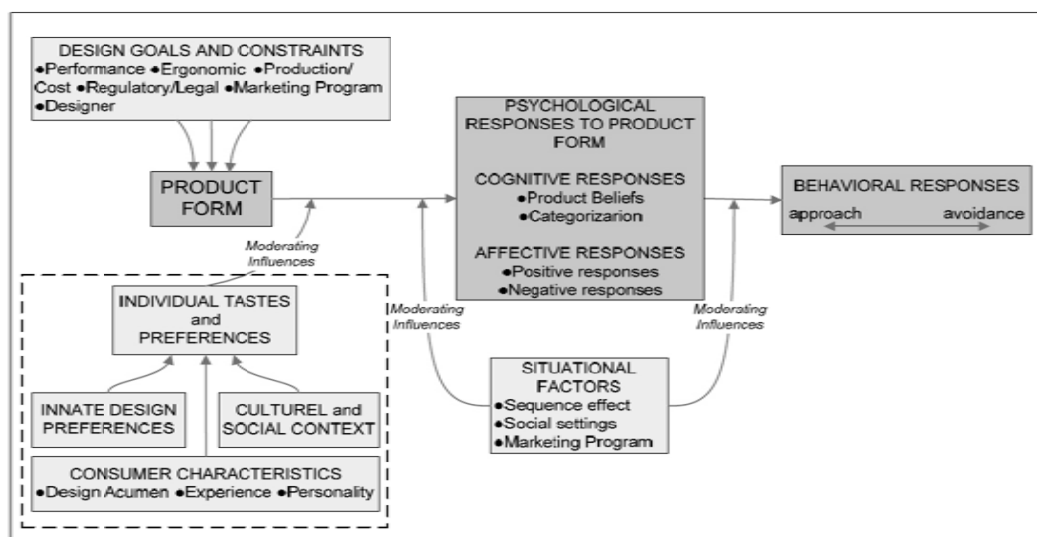

Figure 2.3 A model of consumer responses to product form (Bloch, 1995)

Perception of a product's form may lead to affective responses as well. It may evoke - aesthetic - positive responses that range from simple liking to stronger affection, or negative responses such as dislike. Aesthetic responses are based on the design and sensory properties of the product rather than its performance or functional attributes. The psychological responses lead to behavioral responses that can be described as either approach or avoidance. While approach indicates an attraction to a design, avoidance represents the opposite (Bloch, 1995).

Crilly et al. (2004), referring to Bloch (1995), suggest a representation of the design communication process where designers have intentions for how a product should appear, the product is manufactured, placed in an environment, perceived by the consumer and finally responded to. Thus, on their paper providing a comprehensive view of these responses as it aims to review and combine the related literature on product form perception and consumer response, the destination (response) is divided into three aspects as *cognitive*, *affective* and *behavioral* (Figure 2.4). Each of these classes of response will be discussed below.
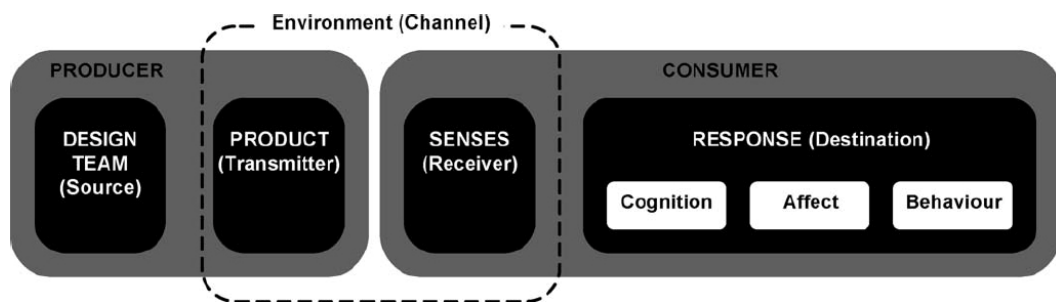

Figure 2.4 Basic framework of design as a communication process (Crilly et al., 2004)

2.2.1. Cognitive Responses

Crilly et al. (2004) define the cognitive responses as the judgments that the user or consumer makes about the product based on the information perceived by the senses. These judgments include evaluation of the products' perceived qualities and cognitive

response is an intellectual process based on knowledge and experience integrated with social and cultural heritage.

In relation to the literature review they have conducted, Crilly et al. (2004) have identified three categories in describing cognitive response to product appearance as follows:

> **Aesthetic impression** may be defined as the sensation that results from the perception of attractiveness (or unattractiveness) in products.

> **Semantic interpretation** may be defined as what a product is seen to say about its function, mode-of-use and qualities.

> **Symbolic association** may be defined as the perception of what a product says about its owner or user: the personal and social significance attached to the design.

Crilly et al. (2004) also stated that these categories of response are not presented as objective qualities of the product; instead they are classifications for different aspects of cognitive response to product form. Although it is often suitable, it is not entirely accurate to describe products as being aesthetic, having semantic attributes or possessing symbolic qualities. Instead, these are all aspects of cognition driven by both the perception and pre-existing knowledge. Although there is often consensus, viewers in different circumstances may make different judgments about products (Khalid and Helander, 2004).

2.2.2. Affective Responses

It has been well established that products take out emotional responses and consumers may experience a variety of potentially contradictory feelings towards an object, such as admiration, disappointment, amusement and disgust (Desmet, 2003). The word 'affect' is commonly used as a general term to describe these emotions, moods and feelings (Norman, 2002). Therefore, unlike Bloch's (1995), the study of Crilly et al.

(2004) refers affective responses from a broader spectrum of emotional responses other than positive and negative responses.

Their study, by referring to Desmet (2003), proposes five categories for the emotional responses that products may elicit. These are instrumental, aesthetic, social, surprise, and interest emotions.

> **Instrumental emotions** (such as disappointment or satisfaction) stem from perceptions of whether a product will assist the user in achieving their objectives.
>
> **Aesthetic emotions** (such as disgust or attraction) relate to the potential for products to 'delight and offend our senses'.
>
> **Social emotions** (such as indignation or admiration) result from the extent to which products are seen to comply with socially determined standards.
>
> **Surprise emotions** (such as amazement) are driven by the perception of novelty in a design.
>
> **Interest emotions** (such as boredom or fascination) are elicited by the perception of 'challenge combined with promise'.

Each of these categories of emotion results from an appraisal of the product. With regard to visual perception, this appraisal is based on the aesthetic impressions, semantic interpretations and symbolic associations that comprise cognitive response. However, while aesthetic emotions are directly related to aesthetic impressions, in general, the full range of cognitive responses may contribute to the full range of affective responses (Crilly et al., 2004).

2.2.3. Behavioral Responses

As in Bloch (1995), Crilly et al. (2004) claim that behavioral responses follow the psychological responses (cognitive and affect) and are in between approach and avoidance towards a product.

According to Bloch (1995), marketers frequently use the terms *approach* or *avoid* to distinguish the behavioral responses of an interested and a disinterested consumer. Approach responses may be associated with further investigation of the product, product purchase and product use, they reflect an attraction to a design and include spending time to explore it. On the other hand, avoid responses may be associated with ignoring the product, failure to purchase, product abuse and even hiding the product, they represent the opposite of approach responses.

However, according to Crilly et al. (2004), they are not only cognitive, affective or behavioral responses when interpreting a product's visual appearance, but also they are *visual references* helping the user to understand the product by reflecting generic designs, referring to other concepts or evoking comparison with living things. The consumer may compare the product with *stereotypes* of the product category or with *similar products* within the same category. Products may also make reference to other products, other entities or other styles, which can be detailed in terms of *metaphors*, *characters*, *conventions*, and *clichés* (Crilly et al., 2004). Therefore, these visual references also affect consumer responses (Figure 2.5).
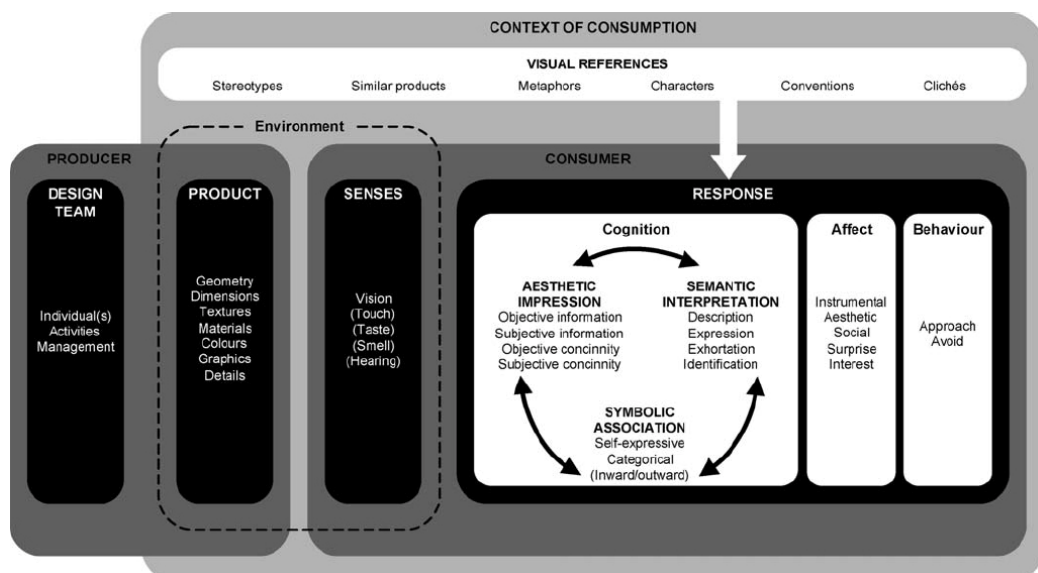

Figure 2.5 Expanded framework of design as a communication process

In brief, the visual appearance of products plays a significant role in determining user's responses and also in affecting his/her preferences. This response to this visual domain in product design is a part of communication process as the design team creates a message which is encoded in a product and the product is perceived by the consumer within an environment. This perception leads to cognitive, affective and behavioral responses, where cognitive response is composed of aesthetic, semantic and symbolic aspects and interpretation of product appearance may be assisted by reference to other products, concepts or entities.

However, judgments which consist during communication process above include not only consideration of whether the product looks good, but also whether it appears functional and gives the right messages to the user. Therefore, user responses to product appearance have to be well understood and used to identify and formulate user preferences and needs during product design process.

2.3. The Formulation of User Needs

Crilly et al. (2004) have claimed that users' needs are largely affected by how visual attributes of a product is perceived while design tries to create the form that meets expectations of users. On the other hand, in their research Khalid and Helander (2004) have noted that users are unaware of exactly what directs their expectations therefore a product is usually assessed in its small and large details visually and these assessments are driven by user needs.

In this respect, to better understand user needs and factors affecting preferences, in the context of product design, types of needs are formulated, evaluated and discussed according to the broad range of literature into the subject of response to the visual domain and in the subject of user needs and preferences for product design.

2.3.1. Need for Aesthetics and Gestalt Features

Physical appearance of a product is an important determinant of users' preferences and choices (Bloch, 1995). Users may get the idea of the product just by a glance rather than using or observing its operation. The first impression is formed by the product's visual properties that affect the users' attitudes towards a product and become an evaluative factor while making judgments (Coates, 2003).

Throughout the history, people have been always fond of aesthetically attractive objects in which they have found pleasurable and meaningful aspects. It is a fact that the effect of the aesthetic properties is a determining factor on purchasing decisions for the products which belong to similar categories. When users ought to choose one of two products, which are equal in price and function, people prefer the one that they consider as more attractive (Bloch, 1995). Therefore, high performance and good qualities are not sufficient for successful product designs. Aesthetic considerations are becoming increasingly important as an additional dimension of product design preferences that should be integrated into the design process. In this respect, this positive aesthetic impression has drawn the interest of design researchers for decades, and art theorists and philosophers for centuries before them (Crilly et al., 2004).

Most early researchers of beauty claimed that attractive features resided in the object itself. Beauty was considered to be an objective property of the stimuli (Routio, 2002). Certain lines, proportions, shapes and colors were believed to be inherently attractive. This approach suggests that each object will have an ideal form, which once attained will tend to be considered attractive by everyone (Coates, 2003).

A great deal of historical art and architecture is based upon the notion of these pleasing proportions (such as the Golden Section), and strict geometric rules (Elam, 2001 in Crilly et al., 2004). The Bauhaus school pioneered the application of this approach to product design in the 1920s and 1930s. Products from the Bauhaus school were highly rational,

and reflected the work of the Gestalt psychologists, who identified the tendency to perceive or construct symmetry, regularity and harmony even when it is not actually present. These principles are commonly referred to as the Gestalt Rules. There are a large number of these rules which consists of an emphasis on symmetry, proximity, similarity, continuance, repetition and closure (Baxter, 1995).

Gestalt principles basically emphasize the holistic nature, where recognition is interpreted with the properties of an image as a whole, rather than parts, during visual perception (Jiang et al., 2006). A Gestalt is a 'whole', an organization of parts, whether these are design elements of a product, graphic elements, tones or colors. Towards achieving a gestalt, there is a strong tendency in perception to render a structure as simple as possible rather than complex (Elam, 2001 in Crilly et al., 2004). That is why; simple structures have characteristics such as unity, symmetry, regularity and harmony that complex ones have not (Crozier, 1994 in Khalid and Helander, 2004). Objects that are symmetrical and have an even weight distribution, are regarded as more 'balanced' and preferred over other objects (Margolin and Buchanan, 1995).

However, as Crozier (1994, in Khalid and Helander, 2004) has proposed, neither 'holistic impression' is the only element affecting subjective evaluations nor 'gestalt principles' is the only factor conducting design decisions. He suggests that the visual appeal of objects is also influenced by socio-cultural, socio-economic, historical and technological factors. As such, the ideals and standards to which one culture desires may not be appreciated by other cultures. This issue of cultural taste indicates that the objective properties of a design are insufficient to explain judgments of attractiveness.

Today, designers use their skill, training and experience to produce products that drive a positive aesthetic impression. Designers' understanding of perception and visual composition often guide their judgments (Liu, 2003). Indeed, there are those who feel that intuitive creativity is all that is required for the design of visually attractive products and that a scientific approach is not relevant to an understanding of the

problem (Crilly, 2004). However, designers and users often interpret products differently and express different aesthetic preferences (Hsu et al., 2000). Thus, although styling is seen as the artistic part of product design process, it should be directed towards users' expectations.

2.3.2. Need for Functionality and Product Semantics

Objects are also designed as functional devices that perform the task for which they are used (Krippendorff, 1995). Consequently, a significant part of the value assigned to products is attributed to its utility. This may cover practical qualities like function, performance, efficiency or ergonomics and as identified by Bih (1992), they can be expressed to some extent by the visual form of the product.

The evaluation of a design's apparent utility and perceived qualities can be described as product semantics (Crilly et al., 2004). However, this evaluation of product semantics is limited to what the product communicates about itself. The extent to which products are seen to reflect the identity of their users will be discussed in the section of 'Need for Symbolic Association', even the term 'semantic' covers symbolic associations as well. Therefore a treatment of product semantics is explored here, which is more congruent with Monö's (1997) semantic functions.

Monö (1997) has presented a guide to product semantics from a semiotic perspective. He has stated that a product's visual form may appear to communicate its practical qualities through four semantic functions: description, expression, exhortation and identification.

> **Description** refers to the way in which the outward appearance of a product presents its purpose, mode-of-operation and mode-of-use. For example, a grooved handle may suggest the direction in which it is to be turned and indicate how much force will be required. From a product's description, consumers may infer the practical benefits the product will offer and how they must interact with it.

Expression refers to the properties that the product appears to exhibit. For example, modifications to a product's visual form may alter the consumer's interpretation of qualities such as density, stability or fragility. The properties that a design expresses may assist the consumer in understanding how the object should be treated.

Exhortation refers to the requests or demands that a product appears to make of those perceiving it. For example, flashing switches may request that they be switched off. Through exhortation the product may elicit the appropriate actions from the user for correct and safe operation.

Identification principally refers to the extent that the origin and affiliation of a product are conveyed. For example, the manufacturer, product type, product range and specific model may be communicated by text, graphics and design cues. The identification of a product assists the user in understanding the category to which the product belongs.

A semantic approach to design may guide users to interpret a product's utility and associated attributes. Furthermore, commercially successful products have been produced with consideration given to their semantic characters. Krippendorff (1995) proposes that 'design is making sense of things' and designers should help the user with interpreting the product. Monö's (1997) explanation of product semantics provides a practical guide to the communicative capabilities of products. Butter (1989) has also suggested a task that integrates semantic considerations into the design process. The stages of the process are: (1) establish the semantic character that the product should communicate; (2) list the desired attributes which should be expressed; and (3) search for tangible manifestations capable of projecting the desired attributes through the use of shape, material, texture and color. Thus, in the literature, a useful basis exists for designers looking for an appropriate semantic interpretation of their products.

2.3.3. Need for Symbolic Associations

In addition to their apparent aesthetic, functional and semantic attributes, almost all products hold some socially determined symbolic meanings. As stated in the part of 'Need for Functionality and Product Semantics', while product semantics relates to what the product is seen to indicate about itself, symbolic association is determined by what the product is symbolized about its user, or the context of use. For example, while

a chair denotes (or affords) sitting, a throne connotes (or implies) status and power (Muller, 2001 in Crilly et al., 2004). As such, the social value assigned to products determines the symbolic associations that are made.

These symbolic associations exist in all cultures for colors, shapes, numbers and so forth (Khalid and Helander, 2004). For example, red means happiness and good luck to Chinese and is, therefore, one of the most appealing; Indians identify red with power and energy. This culturally agreed meanings allow a person to communicate through products.

However, people's reasons to use products as expressive equipments are not only to communicate their identity to others, but also to themselves. Because the objects we use both reflect and contribute to who we are. This distinction between the inward and the outward expression of identity has driven Dittmar (1992) to divide the symbolic qualities of products into 'self-expressive' and 'categorical' meanings.

> **The self-expressive symbolism** associated with products allows the expression of unique aspects of one's personality. This includes individual qualities, values and attributes. These self-expressive meanings serve to differentiate the consumer from those that surround them. As such, products are used to reflect the owner's distinction from others; they 'represent a means of defining one's self as unique [and] may symbolize the person's unique identity'.

> **The categorical symbolism** associated with products allows the expression of group membership, including social position and status. These categorical meanings serve to integrate the consumer with those that surround them. Indeed, one of the principal approaches to expressing membership of a social group is through shared consumption symbols.

Referring to Dittmar (1992), it can be said that, factors like values, history or marketing determine the meanings attached to the products and influence the perceived symbolism. Therefore, the symbolic associations may be less dependent on product appearance than aesthetic impressions and semantic interpretations (Crilly, 2004). However symbolic associations are not unrelated to product appearance. For example,

the sort of material used may generate different assessments towards products like the use of metal may evoke precision or plastics are often regarded as cheap. Thus, according to Opperud (2002), designer's aim should also be to decode the common values that exist in the culture, and to reproduce them into the forms covering the appropriate symbolic meanings.

CHAPTER 3

EVALUATION METHODS FOR USER PREFERENCES

A lot of systematic methods, dealing mainly with usage functions, have been developed in engineering design to obtain successful products. These methods are efficient to assess and validate products with a scientifically based argumentation, for example a streamlined shape is chosen, in terms of engineering, to meet functional structure or production requirements because it reduces the drag coefficient of a product.

However, for designers, answering the functional structure requirements is just one of many necessary conditions when developing a product, because there is much evidence indicating that a crucial origin of product form attractiveness is that the form satisfies the consumers' psychological needs rather than simply providing utilities (Baxter, 1995). Therefore, from design's perspective, the main mission of the product form is to enhance the attractiveness of a product in the eyes of its potential consumers and users, thereby increasing their purchasing and usage desire (Chang et al., 2003).

Despite the published literature containing many discussions related to different approaches regarding affective design (e.g. Nagamachi, 1995; Chuang and Ma, 2001) and despite the acceptance that the attractiveness of a product's form plays a significant role in determining its marketing success (Baxter, 1995), few instruments capable of providing an evaluation system for the attractiveness of a product's form currently exist even though a number of qualitative theories relating to this issue have been proposed (Crilly et al., 2004). Therefore, the lack of methodology about esteem and aesthetic functions (brand image, personal aesthetics, current trends or fashion) drives form design and styling activities to a discussion which is based on opinion and subjectivity with no theoretical basis (Warell, 2001). Hsu et al. (2000) have also claimed

that idea as stating 'the perception of the shape of a product is often nothing but a style of design, depending much more on the designer's taste than real customers'.

Consequently, developing the affective aspects of a product tends to be conducted in an ad hoc manner and depends largely on the instincts of the individual designers (Chang et al., 2006). However, these instincts cannot absolutely guarantee the success of the designed product. Therefore, to minimize the risk and maximize the success in the market, it is necessary to attach information relating to the users' evaluations and preferences of the product to the design process (Schütte, 2002).

In the early stages of a product's design, user evaluation can provide helpful information to indicate means in which the design development should proceed. Later, once prototypes and visuals have been generated, this evaluation data can reveal the perceived quality of the design, or can highlight its limitations; therefore it can be improved (Chang et al., 2006). However, if this design approach is to be realized in practice, it is first necessary to develop suitable models and corresponding evaluation tools which are capable of measuring the specified characteristics of products and to establish user assessments and preferences (Mondragon et al., 2005).

According to Chang et al. (2006), developing a measurement method for product evaluation has a number of crucial advantages, including: (1) the ability to clearly discriminate multiple dimensions of a product such as usability or attractiveness; (2) the means to represent the value of product characteristics in terms of quantifiable indications; and (3) the means to characterize the whole and partial form of a product using single measures. Thus, a measurement instrument of this type can enable designers to identify the drawbacks of their designs and to then take the necessary actions to enhance the designs.

In summary, it is clearly essential to develop valid measurement instruments capable of providing detailed information regarding users' perceptions of the product form to

facilitate the design of products. Thus, this chapter will concentrate on the three methods and studies based on these methods in the literature which were developed to evaluate the user preferences empirically with the use of an appropriate scale which clearly identifies the diverse dimensions of the product's form and provides definite indexes such that each dimension can be rated in a meaningful manner. Semantic Differential method will be investigated first, which serves the basic structure of almost all methods dealing with evaluative means through user responses. Later Kansei Engineering and Semantic Environment Description, which were derived from Semantic Differential, will be analyzed as wide-spread used methods.

3.1. Semantic Differential

People communicate by words when evaluating and interacting with products to express the impressions arising by just telling the feelings evoked and the things liked about them (Khalid and Helander, 2004). At that point, Semantic Differential is used as a measurement tool to study human perception of products and the words people use to communicate it; and also to obtain emotional values of products (Alcantara et al., 2005).

Semantic Differential has been developed in the 1950s by Osgood et al. (1957) to analyse the semantic structures and the affective meaning of things. It has a standard procedure which assumes that there exists an underlying structure in the semantic evaluation of products and works with the semantics of words and ideas involved in scaling opinions. Connotation of words based on these scales is the main idea of Semantic Differential (Hsu et al., 2000).

According to Osgood et al. (1957), the method has to use a scale that can accurately map identification and localization of attitudes in a subject's thought. Furthermore, to obtain 'semantics' of objects, subjects have to be given a word and asked to rate it with

a variety of opposing adjectives along a seven point scale. Osgood contended that the adjectives picked have to be evaluative, because the method consists in listing the semantic attributes of the product to analyze and carry out user tests in which the user must assess the product according to these attributes. The attributes are often defined by pairs of antonymous adjectives which lie at either end of a quantitative scale (Table 3.1 from Hsu et al., 2000).

> "Despite different concepts and different criteria for selecting scales, high and restricted loadings on this factor were consistently obtained for scales like *good-bad, fair-unfair and valuable-worthless*, while scales which were intuitively non-evaluative in nature, like *fast-slow, stable-changeable,* and *heavy-light*, usually had small or negligible loadings on this factor. It seems reasonable to identify attitude, as it is ordinarily conceived in both lay and scientific language, with the evaluative dimension of the total semantic space, as this is isolated in the factorization of meaningful judgments (Osgood et al., 1957)."

Table 3.1 Opposite pairs of descriptors and adjectives used in a SD test (Hsu et al., 2000)

traditional – modern	heavy – handy	hard – soft	nostalgic – futuristic
large – compact	masculine – feminine	obedient – rebellious	hand-made – hi-tech
coarse – delicate	unoriginal – creative	rational – emotional	conservative-avant-
childish – mature	common – particular		garde

In the method, assigning a value along a seven-point scale between opposite adjectives is used to define the meaning of a concept as a point in the multidimensional semantic space (Figure 3.1). This space is consisted of three measurable attitude dimensions: evaluation, power, and activity (Osgood et al,. 1957). These three concepts, according to Osgood et al., transcend languages and cultures to evaluation of semantic space in any given social environment. These concepts constitute the types of adjectives chosen for judgments:

Evaluative scales: These consist of evaluation statements such as good-bad, hot-cold, smooth-rough.

Power scales: These measure power and potency of judgmental connotation such as strong-weak.

Activity scales: These measure judgments such as active-passive or tense-relaxed.
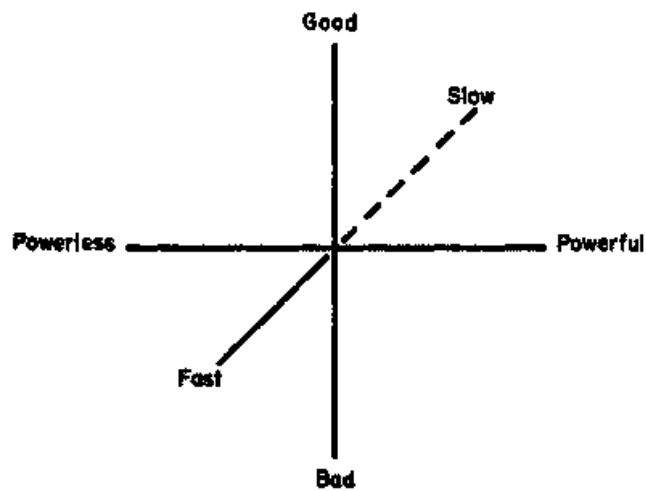
Figure 3.1 An illustration of three dimensional semantic space (Heise, 1970)

The scoring technique of Semantic Differential is also based on the adjective poles of evaluative scales where the unfavorable poles (e.g., bad, unfair, worthless, etc.) are assigned to the score '1' and the favorable poles (e.g., good, fair, valuable, etc.) to the score '7'. Then to obtain the 'attitude score', all evaluative ratings representing scales are summed. Although, on a single scale there are only three levels in intensity, 'slightly,' 'quite,' and 'extremely' in either directions, summing over several evaluative scales creates degrees of intensity. If six scales are used, for example, a range of possible scores from 6 (most unfavorable), through 24 (exactly neutral), to 42 (most favorable) can be achieved, therefore there is 18 degrees of intensity of attitude score in each direction (Osgood et al., 1957).

Psychologists have enjoyed this approach which provides information about the traditional evaluative dimension along with two other dimensions and illustrates their relations better than most other methods. Apart from psychologists, many market and design researchers have used this method as a design tool to evaluate and develop products such as street furniture (Maurer et al., 1992), cars (Hsiao and Wang, 1998), telephones (Hsu et al., 2000), table glasses (Petiot and Yannou, 2003) or mascots used in sports events (Lin et al., 1999) and to study elements of design, including styles, colors, and etc.

Nevertheless, this methodology presents some questions that need to be addressed. The first problem is to validate the word pairs. Khalid and Helander (2004) have claimed that there are two major issues about adjectives; first to create pairs that are semantic opposites and second to understand how well the chosen word pairs can be generalized for use with several products. Some (e.g. Alcantara et al., 2005) have also criticized that Semantic Differential makes adjectives seem to have the same meanings for everyone and this assumption can make the test self-contradictory for subjects who may not share the same meaning. Because semantic evaluation of products is a subjective technique relying on people's perceptions, results are influenced by subjects taking part in the experiments. In this sense, different population groups such as designers (Shang et al., 2000) or manufacturers (Nakada, 1997) have been shown to express a significantly different perception of the same product. Thus, people participating in the experiments have to be selected according to specific user profiles to eliminate the inter-subject variability (Alcantara et al., 2005).

However, the versatility of uses with the bipolar adjectives and the simplicity of understanding them have made it ideal for consumer questionnaires and interviews and Semantic Differential is widely used. Also almost all methods which are based on the theory of product semantics, focusing on the communicative language of a product such as Kansei Engineering and Semantic Environment Description, refer to Semantic Differential Method of Osgood et al. (1957).

3.2. Kansei Engineering

Kansei Engineering which was first practiced by Mitsui Nagamachi in the early 1970s, is defined as 'translating consumers' affective responses to new products into ergonomic design specifications' (Nagamachi, 2002). According to Ishihara et al. (1997), when buying or using something, consumers or users have some kind of preconceived image

called the 'kansei' and this Japanese term implies feelings and emotions that the consumer has in his or her mind.

Kansei Engineering implements the human's kansei in the design fields to produce a product which matches the users' feelings in an effort to maximize consumer satisfaction (Nagamachi, 2002). However, the users' responses (the kansei) are more general qualitative characteristics. To transfer kansei to the design field, the qualitative data must be quantified. Relational rules are needed between the kansei and design specifications to design a new product or to evaluate it, and according to Nagamachi (2002); this procedure requires Kansei Engineering technology to link kansei to design specifications.

The idea has been derived from Osgood et al.'s (1957) works in the 1950s. Kansei Engineering uses Semantic Differential (SD) method for modeling semantic space which shows relations between the sample and meanings of typical adjective words. Therefore, products belonging in the same domain are collected and evaluated using a Semantic Differential scale (Osgood et al., 1957), and these data are analyzed by a multivariate statistical analysis. Then, the Kansei structure is analyzed by principal component analysis (PCA) which is used to transform an original set of correlated variables into a new set of uncorrelated variables. Therefore, PCA summarizes most of the variation in a multivariate system in fewer variables (Ishihara et al., 1997).

As a result, the procedure of Kansei Engineering has been described as follows: (1) Selection of kansei words regarding the product; the majority of the words are adjectives but some nouns can also occur, (2) Evaluation; the product is presented as a picture, 3D model or an actual product and evaluated by subjects using kansei words which can be over a hundred. The collected words are grained on a 5 or 7 point Semantic Differential scale (Figure 3.2), (3) Statistic analysis of gathered data by PCA; different kinds of analysis methods are used to analyze the product, the kansei of the product, the relationships between the words and the physical characteristics of the

product (e.g. color, shape etc.), (4) Construction of a Kansei Engineering System (KES); with the results from the analysis above a KES, which is a program that gives a recommendation of how a product should be designed to correspond to the consumer's kansei, can be created (Schütte, 2002).
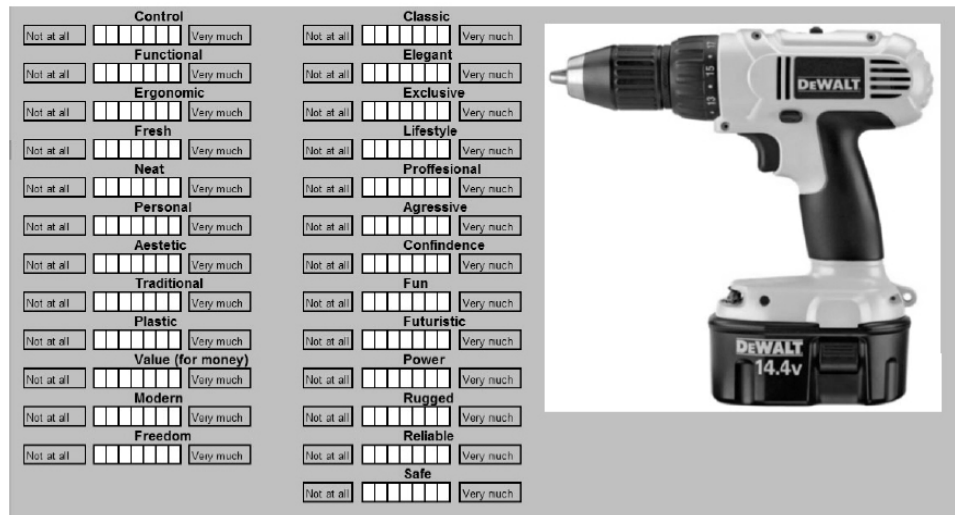
Figure 3.2 An example of seven point semantic differential scales used in a KE research with the extremes 'not at all' and 'very much' (Grimsæth, 2007).

According to Schütte (2002), there are six different types of Kansei Engineering which enable a wide range of applications and can either be used separately or combined:

Kansei Engineering Type I - Category Classification: This is the simplest and quickest method. A product strategy and market segment is identified and a tree structure identifying the customer's affective need is developed. The customer's affective needs are then connected manually to the product properties.

Kansei Engineering Type II - Kansei Engineering System: Mathematically statistically tools are used to connect Kansei and product properties. This is a computer aided system using interference engines and databases with Kansei words. The KES typically consists of coupled databases for words, images, design and color and knowledge about relations between the data.

Kansei Engineering Type III - Hybrid Engineering System: This is similar to Type II but can also predict the Kansei the product properties elicit and is called a hybrid system. The designer can feed his ideas into the interference engine which links the ideas with Kansei words which are presented.

Kansei Engineering Type IV - Kansei Engineering Modeling: Kansei Engineering Type IV builds a mathematical prediction model that even assesses the human feelings of series of words.

Kansei Engineering Type V - Virtual Kansei Engineering: This type replaces the presentation of a real product with a VR representation by integrating Virtual Reality with standard data collection systems.

Kansei Engineering Type VI - Collaborative Kansei Engineering Designing: This is an Internet supported Kansei Engineering System that makes it possible to bring the viewpoints of designers and users together. The system offers many benefits such as efficiency of the product development speed.

A great benefit of Kansei Engineering is that it can be used to link a variety of product properties to product emotions and therefore, has been applied in the development or assessment of a number of products worldwide (Nagamachi, 2002). Studies have been done on surface finishes of glass materials (Barnes, 2004), development of new cosmetic products (Nagamachi, 2000) or car interiors (Jindo and Hirasago, 1997). However, the most known example is probably the Mazda Miata, where many details of the car were developed with the support of Kansei Engineering. The car is today the world's most sold sport coupe (Schütte, 2002).

Despite the advantages that Kansei Engineering serves, like to take into account the user's kansei, to lead to a greater user satisfaction or to suggest the future trend of a new product domain; it has some disadvantages. According to Nagamachi (2002), it can be difficult to capture the users' kansei, as the users' behavior and psycho-physiological settings can vary. Additionally researchers who practice the method have to have a sophisticated knowledge and to have ability in order to interpret data from statistical methodology to multi-variant analysis.

3.3. Semantic Environment Description

The SMB-method (Semantic Environment Description, in Swedish: Semantisk Miljö Beskrivning) is a method that can be used to evaluate and better understand the overall

impression of an environment. The SMB-method was developed by Rikard Küller at Lund University, Sweden to study architectural appreciation by using the Semantic Differential technique (Karlsson et al., 2003).

To constitute the method, more than 1000 words that can describe environments have been collected from the National Swedish Dictionary. Later, this collection of words has been reduced to 36 adjectives within 8 semantic factors (pleasantness, complexity, unity, enclosedness, social status, potency, affection and originality) with the help of a questionnaire and factor analysis. According to Karlsson et al., (2003 referred to Küller, 1975) these adjectives were chosen on the following basis: (1) The adjectives should have high loading in a factor and low in other factors, (2) The adjectives should not show tendencies to float between factors, (3) The adjectives should be applicable for built environment in general, (4) Inside each factor variables were chosen that fulfilled point 1 – 3 and furthermore were slightly different character among themselves.

As the SMB-method was originally developed to evaluate architecture, it claims to measure the overall impression of an environment. This is done with a questionnaire consisting of 8 factors and 36 adjectives mentioned above. The participant answers how well each adjective suits the environment on a semantic scale. The ratings of each adjective are numbered in the interval of 1 to 7, where '1' is 'slightly' and '7' is 'very' for each adjective while the eight factors group the adjectives (Table 3.2). Therefore, the results could be easily presented in diagrams with scalar values and factor analyses in several empirical tests have shown that this grouping is reliable (Karlsson et al., 2003 referred to Küller, 1975). Simply explained, the factor scores are the mean values of the ratings for each adjective included in the factor. However it should be taken into consideration that the scores of adjectives that are negatively correlated to the factors are needed to be inverted in the scale. For example, if a subject scores the adjective 'ugly' as '2', it should be converted to '6' before including the score to the factor 'pleasantness'.

Table 3.2 The SMB-factors and the included adjectives in each factor (Karlsson et al., 2003)

Factor	Description	Adjective included in each factor	
		positively correlated to the factor	negatively correlated to the factor
Pleasantness	The degree of pleasantness, beauty and security which the individual experiences in the environment.	stimulating, secure, idyllic, good, pleasant.	ugly, boring, brutal.
Complexity	The environment's liveliness and complexity.	motley, lively, composite.	subdued.
Unity	How well the various components in the environment seem to fit and function together.	functional, of pure style, consistent, whole.	
Enclosedness	The closedness and degree of demarcation of the space.	closed, demarcated.	open, airy.
Potency	The expression of strength and force	masculine, potent.	fragile, feminine.
Social Status	Economic and social evaluation of the environment.	expensive, well-kept, lavish.	simple.
Affection	An age aspect as well as a feeling of the old and genuine.	modern, new.	timeless, aged.
Originality	The unusual and surprising in the environment.	curious, surprising, special.	ordinary.

Another factor that should be taken into consideration is that; even the words in each factor were deliberately chosen not to direct their opposites, when a factor score is computed the words can actually treat as their opposites (such as feminine and masculine in the factor potency). That situation can be regarded as a weakness for the method when the keywords are checked with the basis of selection explained above.

On the other hand, it was stated that the SMB is a useful tool for evaluating vehicle interiors. Laike's study (1999, referred in Karlsson et al., 2003) with four medium sized cars showed that the SMB method can discriminate among different car interiors and the method has been described as easy to administrate, has high reliability and validity, adaptable for cross cultural comparisons. However, it was seen that the type of product representation affected the SMB assessment as the result of an SMB evaluation of a virtual test-object differed slightly from a result made on a real car. Nevertheless, according to Laike (1999, referred in Karlsson et al., 2003) the SMB-method can even

discriminate car interiors when using virtual representations, although the differences seemed to decrease.

The methodology used when developing the SMB-method has similarities with Kansei Engineering and also with Semantic Differential. The development and use of the three methods basically includes: (1) Construction of semantic scales for evaluation, (2) Assessment of products (environments) with semantic scales, (3) Interpretation of semantic scale assessment (Karlsson et al., 2003). However, in contrast to Kansei Engineering and Semantic Differential, the SMB-method can be viewed as a specific method while the others can be regarded as more general methodologies and there are some differences among them.

In step (1), the Semantic Differential and Kansei Engineering mainly rely on factor analysis in order to form the adjectives and categories. However, the SMB method has 4-8 eight words which were already chosen in order to represent the categories. In step (2), assessment with semantic scales, the methodologies differ as well. While the SMB-method uses unipolar seven point Likert scales with the extremes of 'slightly' and 'very', Semantic Differential and Kansei Engineering can use different scales such as five point or bipolar with the extremes of opposite adjectives (Schütte, 2002). In step (3), interpretation, Semantic Differential and Kansei Engineering offer several different ways to connect the semantic assessment to design elements (Nagamachi, 1999). However, the SMB-method includes this step generally in terms of 'mean values'.

CHAPTER 4

THE CONTRIBUTION AND THE EFFECT OF INTERIOR ELEMENTS AND

THEIR FEATURES ON THE OVERALL PERCEPTION OF COACHES

In this chapter, users' perceptions of semantic dimensions on interior elements and their design features are assessed quantitatively by means of coach design alternatives in order to achieve design criteria and recommendations of such urban railway transport interiors. A set of empirical studies were conducted to validate the arguments proposed. This chapter gives the details about the method followed including the surveys conducted with data collection tools used, subjects to whom questionnaires and interviews were applied, the analysis performed, the results, and lastly the discussion of findings.

4.1. Objective of the Study

Although user centered design has been an increasingly important factor in new product development, few practical studies exist to assess the attractiveness of coach interiors from the passengers' perspective (Jung et al., 1998). Consequently designers lack reliable indicators to guide their decisions which would satisfy the users. The literature reveals that interior designs have been emphasized as an important factor determining their competitiveness in the market and the quality of an interior design can be effectively improved by using information about passengers' perceptions and preferences.

Therefore, primary objective of this study is to develop the guidelines which assist designers while evaluating or developing an urban railway transportation vehicle's

interior. To demonstrate the argument proposed, determining elements and their design features constituting the coach interior, investigating the contribution of elements and features to the overall perception of the interior and measuring the opinions of users on the assessment of interiors have also been set as secondary objectives and explored. To summarize, this study has been aimed to provide an understanding of the users' subjective evaluations and perceptions towards the coach interior elements and features through interior alternatives that would be created.

4.2. Methodology

Coach interior includes many elements such as seating units, grabbing bars, air conditioning or communication systems and also design features of these elements like material, color or layout. While coach is moving or stopping, these design factors - formed as combinations of elements and features - provide different types of service to passengers for comfort, safety, and entertainment requirements. As a fact, designers have to deal with many dimensions while developing an interior and have to make choices among them within a harmony since the possible combinations of these elements and features can be estimated as hundreds.

Therefore, in such a study, opinions about each element's design features could not be collected because it would be too complicated and difficult to analyze. It is also difficult to evaluate the contribution of each design factor to the overall perception of the coach interior. Instead, the experiment was structured to investigate the relations between the most influential design factors with regard to the user perception of semantic dimensions mentioned in previous chapters and their effects on the overall perception of interiors. This situation does not only increase the possibility of effectuating healthy relations among variables, but also increases the possibility of gaining practical knowledge.

Therefore a study structure consisting of three phases is proposed (Figure 4.1). For the first phase, the most influential design elements and features of coaches are aimed to be determined and their attributes are defined with regard to the subjective needs and preferences of passengers. In the second phase, appropriate interior alternatives, presenting descriptive design factors acquired in the former phase, are visualized and these visuals are evaluated through subjective criteria with the use of a semantic assessment tool. The data obtained, so the comparisons among alternatives, would be investigated in the last phase in order to provide guidelines and recommendations for the design of such interiors.
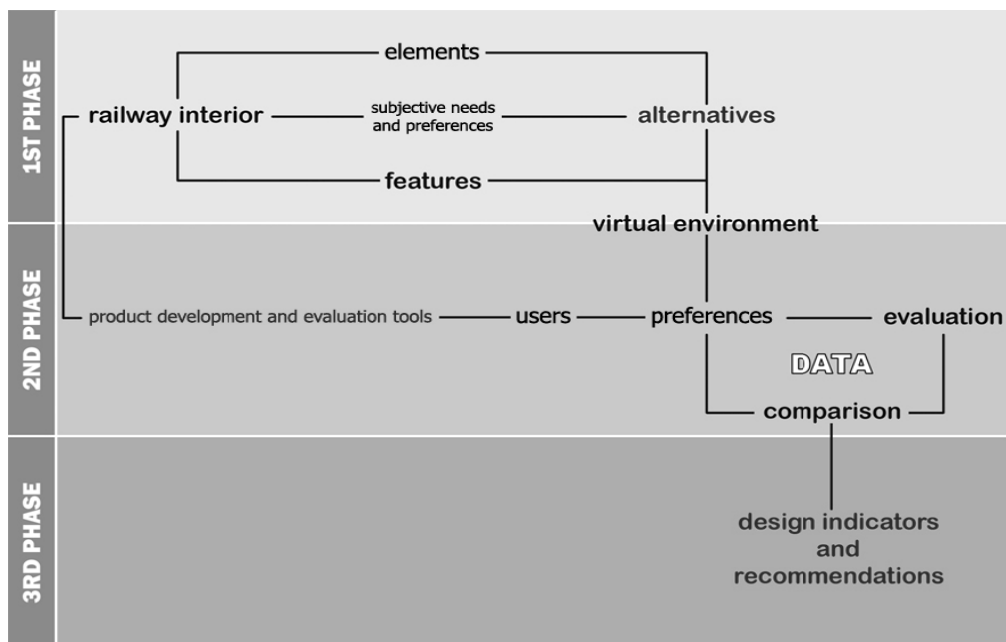
Figure 4.1 Proposed study structure

However, before the determination of the most influential factors in coach design, a pre-interview was performed on selected participants in order to identify any possible interior factors from users' perspective. Another aim of the interview was to validate the literature claiming that, for products, users' expectations can be conceptualized along with design factors consisting of element and their features as well as overall design and functionality attributes (e.g. Khalid and Helander, 2004; Hsu et al., 2000).

The interview included a set of coach interior images to be selected as the most and the least liked according to the participants' preferences and two open ended questions which were asked to describe their reasons. Thus, the task in this study was to identify the interiors first. Determining representative coach interiors was a challenging task since there is a lack of literature indicating property of the interiors that can be utilized in such a survey. Therefore, it was decided to collect alternatives from a wide range of design concepts in order to capture and uncover any possible opinion. Consequently, six images representing a variety of walk-paths, different densities of grabbing bars and seating units, different uses of colors and multiple layout arrangements within a wide range of interior volume were selected via Internet (Figure 4.2).
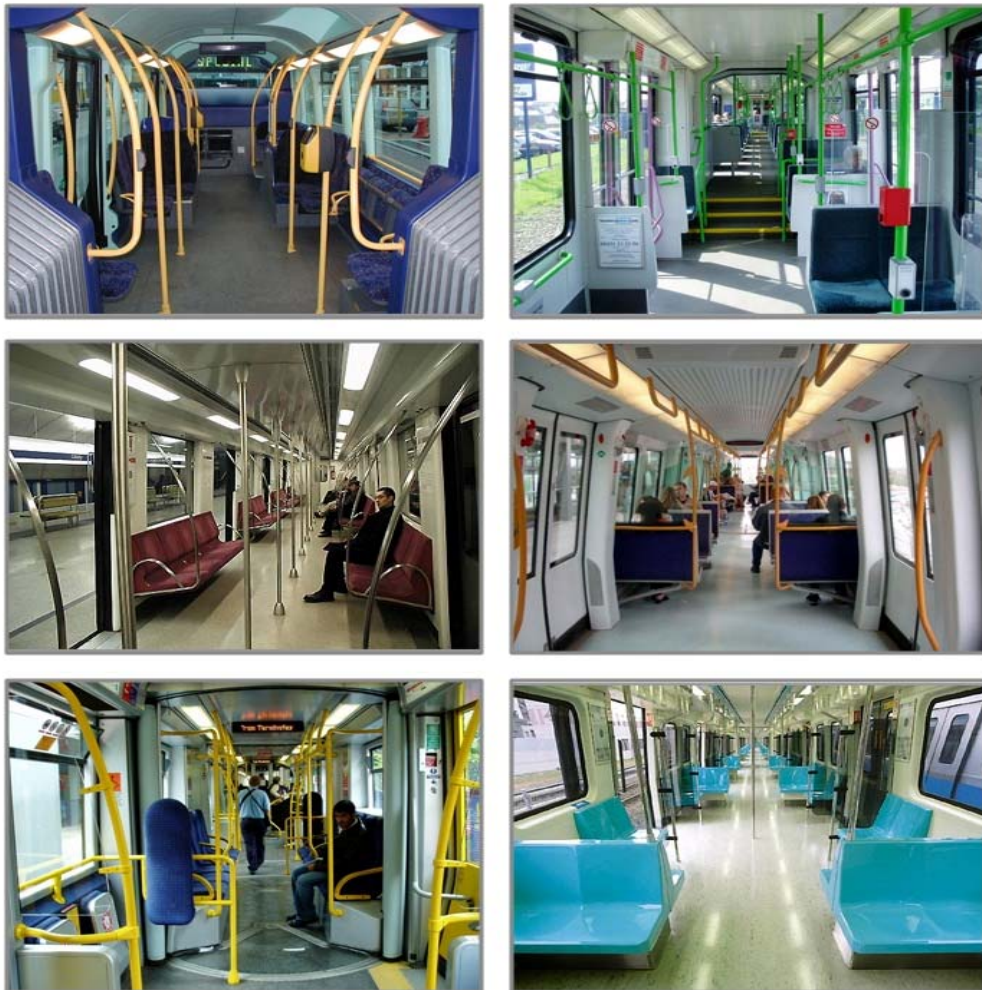
Figure 4.2 Six coach interior images used in the pre-interview

The interview was performed on a group of ten participants, who were reached at METU Library, with color printing of the selected images on an A3 sheet. All participants were METU undergraduate students and they were active passengers using inner-city railway vehicles. According to the results by means of elements; seating units (7), grabbing bars (5), air conditioning systems (2), interior lighting units (1), and overall attributes of coach interior such as roominess (6) were mentioned. On the other hand by means of features; layout (2), form (1), color (4), material (3), quantity (7) were mentioned. Additionally, all the elements were mentioned in relation to the features. The elements and their related features can be seen in Table 4.1.

Table 4.1 Summary of the results for pre-interview

	layout	Form	color	material	quantity	overall
seating unit	1	1	1	3	1	
grabbing bar	1		1		3	
lighting unit					1	
air conditioning unit					2	
overall			2			4

The results have showed that coaches are evaluated like other user products by means of elements and their features. Furthermore, with the 'element and feature' relations mentioned by participants, a matrix (Table 4.1) has been developed to be used in the first phase of the study in order to determine the most influential ones among all.

4.3. Determination of Design Factors

The pre-interview has shown that the subjective impressions of users, depending upon how the interior is perceived, define the coach interior as a composition which consists of design elements and their features. However, the lack of variable control on selected images has driven the results to an unfeasible manner for assessing user expectations through identified design factors. Therefore, the most influential elements and features

should be determined with regard to the expectations of users and transformed into a set of measurable and comparable specifications within controllable variables.

4.3.1. Data Collection Tool

In order to determine the comparative magnitudes of coach interior factors according to the user needs and preferences, a questionnaire composed of two parts has been designed as data collection tool (see Appendix A).

The first part of the questionnaire was related to the demographic information of the participants including gender and age. The second part was designed by using the identified interior design factors in pre-interview and also with the help of the matrix developed to create all possible combinations of design elements and their features. Accordingly, 20 appropriate factors were used and they were stated in sentences like 'It is the layout of seating units' or 'It is the color of grabbing bars'. Furthermore, the questionnaire was tried to be designed as simple as possible, without using any visual stimuli, not to direct participants and to be able to control the variables which were not handled in the pre-interview. A brief description of the study was also given in the A4 questionnaire sheet.

4.3.2. Sampling

As this study's main concern is the coach interiors of urban railway transport, the participants should have been passengers who have had experience in such vehicles. Therefore the sample that the questionnaire was administered was selected among the ones that have been using urban railway vehicle at least for one year and have been active passengers. Because potential users could have possibly more tendency to evaluate the questionnaire and to declare their needs and preferences than anyone, a random selection was made to determine the sample meeting those criteria from the employees of METU Technopark.

The questionnaire was conducted with a group of 16 participants as 8 of them were females and 8 of them were males. The ages were between 18 and 39 with an average of 26,6 and age interval distribution was given in Figure 4.3.
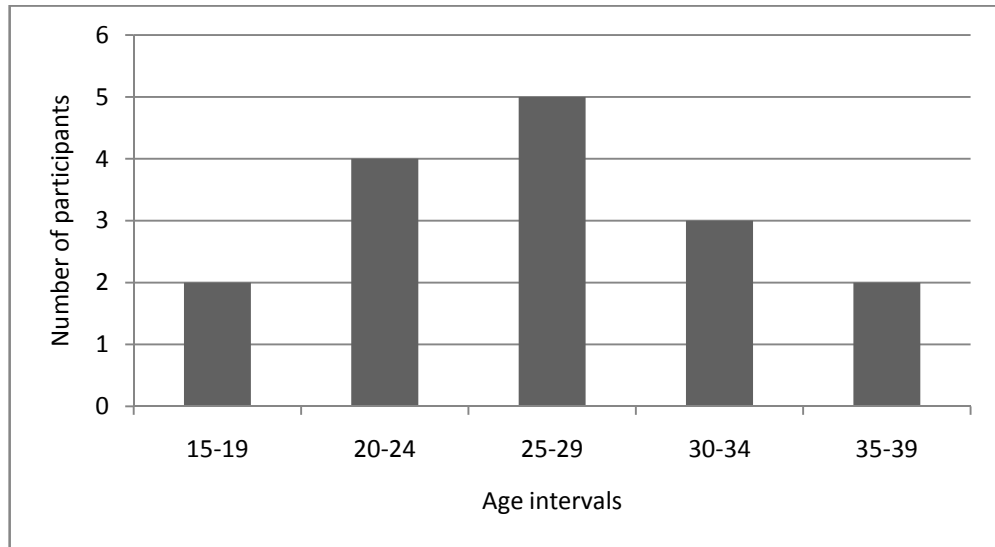
Figure 4.3 Age interval distribution for the participants of first enquiry

4.3.3. Procedure

As stated before, the questionnaire was designed without using any visuals not to direct participants with the stimuli that visuals may have and to control the presented variables. Rather, participants were encouraged to think about their expectations from coach interiors with the help of twenty factors.

Therefore, participants were first asked to read the suggested sentences of the questionnaire and then were asked to determine the most five influential design factors among all. Lastly, an arrangement among selected factors was requested, according to their level of importance for a coach interior, with the use of each rating from 1 (the least) to 5 (the most).

4.3.4. Results

Table 4.2 and Table 4.3 summarize the results of the questionnaire performed within the matrix used. While the former gives the frequencies of selection within the most five influential factors, the latter displays the total scores of factors with the assigned ratings from 1 to 5.

Table 4.2 Summary of the results for the first study (frequency of selection)

	layout	form	color	material	quantity
seating unit	13	11	2	11	9
grabbing bar	5	4	2	0	5
lighting unit	3	4	0	0	1
air conditioning unit	0	0	0	0	10

Table 4.3 Summary of the results for the first study (total score)

	layout	form	color	material	quantity
seating unit	47	45	3	29	32
grabbing bar	10	6	3	0	12
lighting unit	6	10	0	0	1
air conditioning unit	0	0	0	0	36

Accordingly, with quantity of air conditioning units (10); the layout (13), form (11), material (11), and quantity (9) of seating units were five of the most selected factors in total scores. Similarly, quantity of air conditioning units (36); layout (47), form (45), quantity (32), and material (29) of seating units were rated highest in total scores. Therefore, among elements, seating units were qualified as the most influential with a frequency of 46 and with a total score of 156 (Figure 4.4).
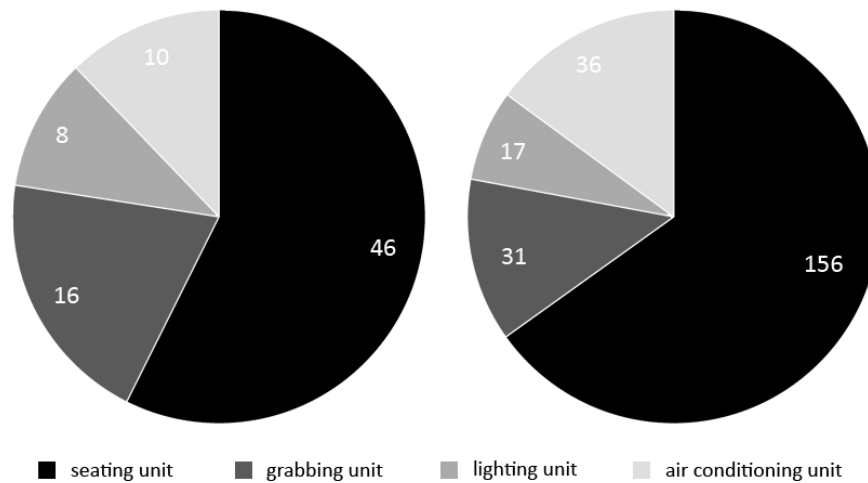
Figure 4.4 Distributions of frequencies and total scores for design elements

4.4. Refinement and Identification of Design Factors

Seating units with their four features (layout, form, material and quantity) have been determined as the most influential element for a coach interior in the previous part of the study.

However, these features have still to be investigated and refined through subjective needs and preferences of users because data that is able to present the attributes of coach interiors have not been gathered yet. In other words, despite the fact that the choice of materials for seating units is one of the most important factors for users, the variety or the kind of seat materials which would be used and presented in the second phase is still undefined. Besides, seating unit features have to be refined since the interior alternatives which would be created with regard to these features are still too complicated and difficult to compare and analyze.

Therefore, the features of seating units should be refined and transformed into a set of measurable specifications again and the variety, kind or attribute of these features should be identified.

4.4.1. Data Collection Tool

A second questionnaire was designed to refine the features of seating units and to identify the variety, kind or attribute of these features for the development of coach interior alternatives which will be used in the second phase of the study as mentioned above. A semi structured questionnaire containing close ended and probed questions was used in order to allow participants also to express themselves with their own words (see Appendix B).

In the first part, the related demographic information to be filled by the participants including age and gender was included. In the second part, five possible factors were defined with the use of seating unit as 'element' and layout, form, color, material, quantity as 'features'. They were stated in sentences as suggestions and arranged with an arbitrary order as in the previous study. Furthermore, in order to make the suggestions clearly and properly understandable and in order to encourage participants to define the factors through their subjective needs and preferences, a few basic explanations of the attributes were also given in the A5 questionnaire sheet. For example, color for seating units were identified with vivid, cold and harmonious colors while arrangement for seats were referred with well-known examples of public transportation vehicles used in Ankara such as buses, Ankaray or Metro. Therefore, a more condensed questionnaire that would provide more reliable indicators was created in comparison to the previous one by including five factors instead of twenty.

4.4.2. Sampling

As stated in the previous questionnaire active passengers have more ability and tendency to interpret their needs and preferences in a conscious manner than anyone. Therefore the sample group was, again, selected among the ones that have been using inner-city railway vehicles at least for one year and once in a day.

However, the sample group was enlarged in number when comparing with the previous studies'. That is because the qualitative data which would be gathered through the subjective impressions on the variety, kind or attribute of seat features have to be quantified and refined in order to be used in the second phase of the study while creating coach alternatives.

Consequently, the questionnaire was conducted with 20 female, 20 male and a total of 40 participants meeting the criteria mentioned above among the employees of METU Technopark. The ages of participants were between 19 and 45 with an average of 27,4 and age interval distribution was given in Figure 4.5.
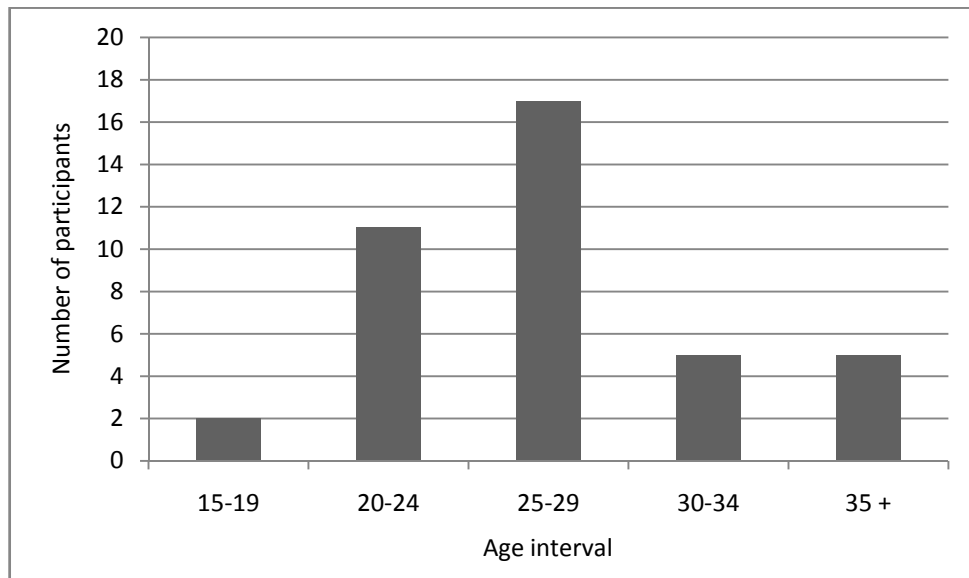
Figure 4.5 Age interval distribution for the participants of second enquiry

4.4.3. Procedure

As the questionnaire sheet included a part to gather the demographic information, first of all a brief description of the study was given to the participants orally. Later, they were asked to read the questionnaire and then an arrangement among five factors according to their importance for a coach interior was requested with the use of each

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rating only once, from 1 to 5, as 1 was representing the least and 5 was representing the most.

Lastly, participants were asked to define the attributes of all the five factors and wrote them on the questionnaire sheet. In other words, they suggested and described the attributes for layout, form, color, material and quantity of seating units according to their subjective needs and preferences.

4.4.4. Results

The data collected during the questionnaire was analyzed using the descriptive statistics, mean values and standard deviations, which would be used on the actual data collection for the second phase.

The questionnaire results showed that three features for seats have been found as more influential among all (Figure 4.6). While the mean for the first part of the questionnaire was 3; the ratings of seating unit layout (3,5), material (3,45), and form (3,25) have exceeded that value.
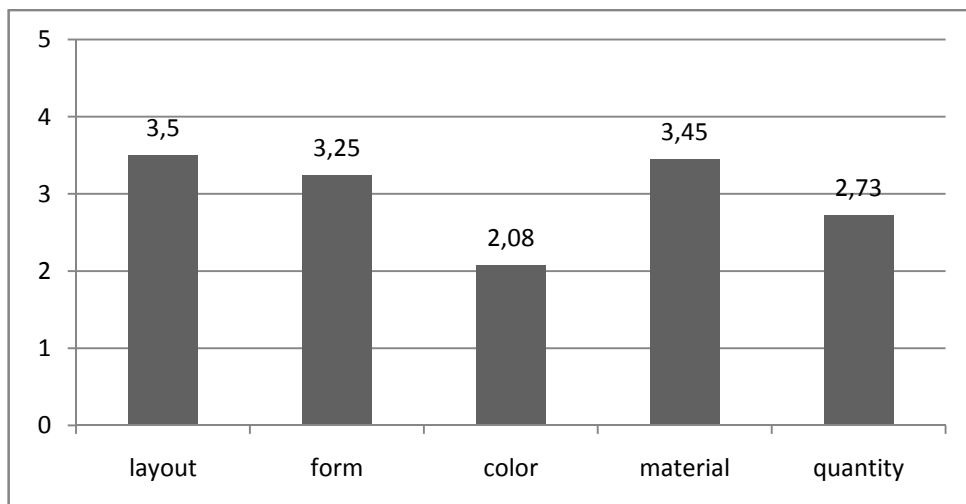
Figure 4.6 Mean values for seating unit features

In addition to the mean values, to be able to analyze the extent to which features were spread around their averages, the standard deviations and also the frequencies of ratings which were assigned to the each feature were also calculated (Table 4.4 and Figure 4.7). The results showed that 'color', 'layout' and 'material' had more continuous rating distributions within smaller standard deviations; while 'quantity' and 'form' had discrete distributions with higher standard deviations.

Table 4.4 Standard deviation values for seating unit features

	layout	form	color	material	quantity
Standard Deviation	1,19	1,44	0,97	1,25	1,64
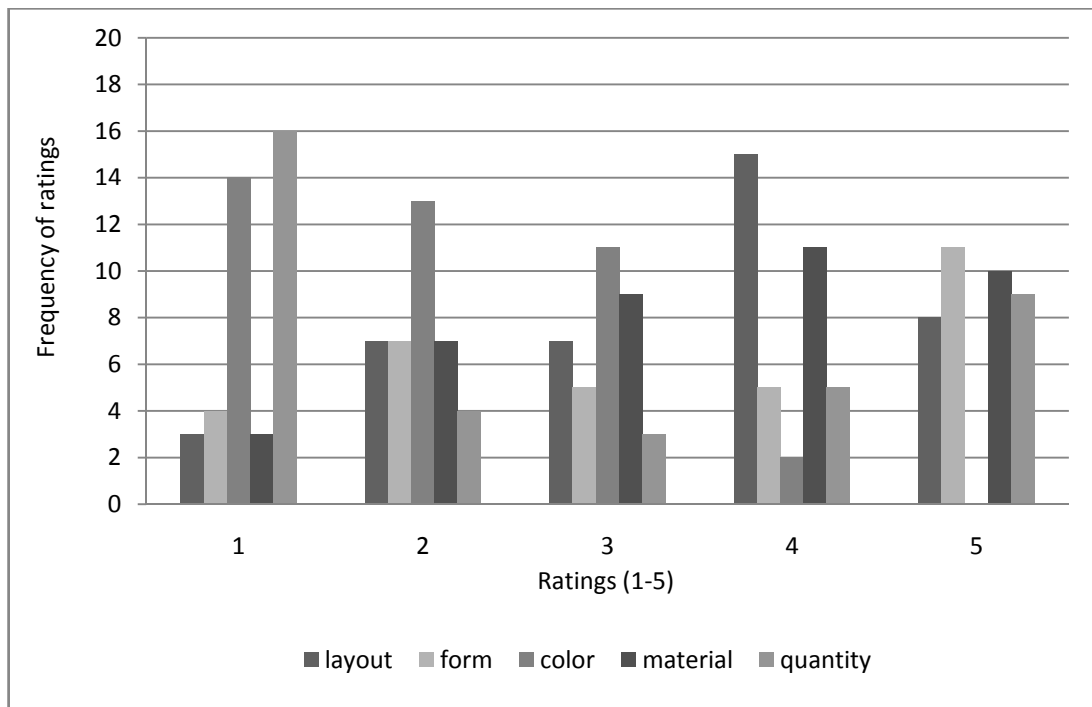
Figure 4.7 Rating distributions for seating unit features

The preferences of participants for the attributes of factors that had been investigated at the second part of the questionnaire were also quantified (Figure 4.8). The results showed that for the 'layout of seating units', participants preferred classic back-to-face

arrangement (7) that is used mostly in motor vehicles as someone sees another's back at the seating posture, face-to-face arrangement (9) used mostly in railway vehicles to obtain a more spacious space and compound arrangement (10) as a combination of former ones.

As participants had difficulties to define the attributes of 'form', their expectations were mainly focused on seats' comfort (10) with a well-designed (7) and a unique (5) form. In terms of 'seat color'; they preferred vivid (10), harmonic (9) and pure (6) colors. On the other hand, the comfort of seating unit (9) was again mentioned in the 'material' section (as in the 'form') with material definitions and descriptions like plastic (8), spongy (7), soft (6). Lastly, participants declared their preferences by means of 'quantity of seats' in a coach interior as mentioning 'neither much nor few' (19) and 'as much as possible' (14).
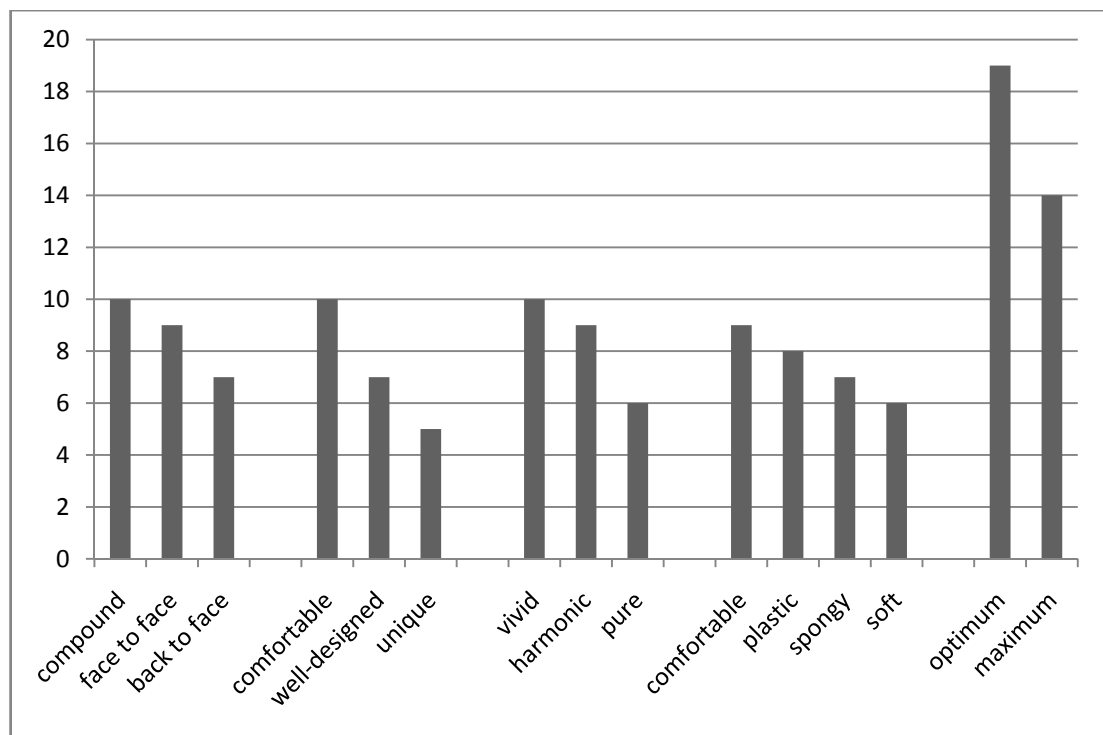
Figure 4.8 Preferred attributes for seating units

4.5. Evaluation and Comparison of Interior Alternatives

In the first phase of the study, the attributes of interior alternatives which are carried by means of design elements and their features were tried to be defined in two steps.

In the first step, the most influential five design factors, among possible twenty factors, were determined. Accordingly, seating units with their features were qualified as the most influential element for a coach interior. In the second step, the features of seating units were refined and investigated through subjective needs and preferences of participants. This is because, the attributes of alternatives which would be created by means of design factors are still too complicated and difficult to compare therefore far from presenting the alternative coach interiors. Consequently, the five features of seating units were refined into three (layout, form, material) and their attributes were identified.

4.5.1. Data Collection Tool

Although the data obtained through the former enquiries has constituted an infrastructure, it is not sufficient alone in order to design the questionnaire for the second phase of the study that will concentrate on measuring users' preference levels according to different coach interior alternatives. Therefore, the outputs of former enquiries have to be interpreted into the variables of interest first, and accordingly visual stimuli and preference scales that would be presented to the participants have to be prepared.

4.5.1.1. Variables of Interest

As this part of the study has to present design alternatives of coach interiors, the variables of interest have been determined considering the data obtained and the visual stimuli which would frame that data. Accordingly, (1) the layout and (2) the

material and form of seating units have been defined as the variables of interest and three attributes were defined to represent each.

The layout was described with (1) face-to-face, (2) back-to-face and (3) compound arrangements for seating units. On the other hand, material and form features were combined since the descriptions of participants for the attributes of these two features were similar and it is a fact that while developing a seating unit, form and material attributes affect each other. In this manner, appropriate forms that would satisfy the preferences of participants were determined by means of the materials defined. Therefore, the 'material and form' of seating units was described within three variables again: (1) plastic, (2) spongy-soft, and (3) combined. Consequently, nine combinations were obtained (Table 4.5) in order to prepare the visual stimuli.

Table 4.5 Suggested seat layout and material-form combinations for nine interior alternatives

	layout	material and form
combination 1	face-to-face	plastic
combination 2	face-to-face	spongy-soft
combination 3	face-to-face	combined
combination 4	back-to-face	plastic
combination 5	back-to-face	spongy-soft
combination 6	back-to-face	combined
combination 7	compound	plastic
combination 8	compound	spongy-soft
combination 9	compound	combined

4.5.1.2. Visual Stimuli

Three seating units (Seat A, Seat B and Seat C) covering the preferred 'material and form' dimension were designed first according to three manipulated forms that meet the defined materials within the same width, length, and height measurements. The virtualization processes of seat designs were verified with the use Rhinoceros4.0® for

computer aided drawings, and then with the exported .3ds data, a scene with two cameras was set up in 3dsMax9.0® for material assignments and photorealistic renders. Later, because blue is described as a genderless, neutral color and also evaluated as one of the most pleasant colors for interior design (Kwallek et. al, 1996), a glossy blue plastic material was assigned to Seat A, while same color fabric cloth was used on Seat B. On the other hand, a combination of glossy white plastic and blue fabric cloth was assigned to Seat C. Lastly; two renders for each seating unit were taken (Figure 4.9, 4.10, 4.11).

Figure 4.9 Visual stimuli for Seat A

Figure 4.10 Visual stimuli for Seat B

Figure 4.11 Visual stimuli for Seat C

Later, a coach interior with basic components of grabbing bars, lighting units etc. was designed according to the user expectations acquired in the former phases of the study and drawn again in the CAD environment of Rhinoceros 4.0. Each seating unit meeting the 'material and form' dimension was arranged into the created interior according to the most preferred three layouts (face-to-face, back-to-face, compound). At the same time, with the quantity of seating units for each layout, the position of virtual cameras that were assigned to capture renders were fixed.

As a result; three sets of three images, for a total of nine, representing each 'material and form' and 'layout' combination were created and visualized. These visuals had the capacity to represent every possible interior combination within the variables of interest (Figure 4.12, 4.13 and 4.14).

Figure 4.12 First set of coach interior alternatives

Figure 4.13 Second set of coach interior alternatives

Figure 4.14 Third set of coach interior alternatives

4.5.1.3. Preference Scales

The scales which could provide quantitative measurements with an estimation of interior assessments were explored. As a result, the preference scales of questionnaire were determined to be based on the Semantic Differential method of Osgood et al. (1957) in which participants are asked to rate the products' attributes over a set of opposite adjective pairs. Since the method has a standardized procedure for a subject's placement of a word(s) continuum in a seven-point scale, to validate the word pairs which were semantic opposites and to understand how well the word pairs could be used to represent a coach interior was a problem.

Therefore, it was decided to use keywords which were already used and validated in such studies. The thirty-six keywords and eight factors of Semantic Environment Description had been validated in the assessments of both architectural environments (Küller, 1980 in Khalid and Helander, 2004) and car interiors (Karlsson et al., 2003). However, even the words in each factor were deliberately chosen not to direct their opposites, Karlsson et al. (2003) admitted that when a factor score is computed the words can actually treat as opposites (see Chapter 3.3). Therefore, eight keyword pairs representing the factors of Semantic Environment Description method were decided to be used instead of thirty six keywords (Table 4.6).

Table 4.6 Keyword pairs used in preference scales (As the questionnaire was performed in participants' native language, pairs were translated into English).

	Negatively Correlated Keywords	Positively Correlated Keywords
Pleasantness	ugly	good
Complexity	simple	complex
Unity	partite	composite
Enclosedness	airless	spacious
Potency	feminine	masculine
Social status	cheap	expensive
Affection	aged	modern
Originality	ordinary	original

As a result, a structured questionnaire containing two close ended questions was designed to evaluate and compare the coach alternatives which were created and virtualized through the outputs acquired from former parts of the study (see Appendix C). For the first question, the 'material and form' factor was investigated through three seat alternatives. On the other hand, with the use of three interior alternatives representing the identified 'layout' factors (for each seating unit) and with eight adjective pairs attached to the visuals of each alternative, second question was designed to measure the effect of layout and seating unit on the overall perception of the interior. Besides, the questionnaire was exported to '.asp' format within two pages in order to be published via Internet (http://www.buromod.com/rail/anket.asp). Thus, a condensed questionnaire that could be performed with a large sample in a relatively short time was created.

4.5.2. Sampling

Since time constraints involved in the last part of research, it was aimed to attain as much assessments as possible in short time. Consequently, the study was performed via Internet as mentioned above. Therefore, the participants were not selected only among active passengers as in previous enquiries, but also among everyone who had the desire to evaluate the presented visual stimuli with regard to the preference scales were deemed appropriate as participants.

Consequently, with the help of the invitations which was sent to a variety of groups through different channels of Internet (such as google-groups and www.facebook.com), the questionnaire was conducted with 152 female, 127 male, and a total of 279 participants within three weeks. The ages of participants were between 18 and 64 with an average of 28 and age interval distribution of participants was given in Figure 4.15.
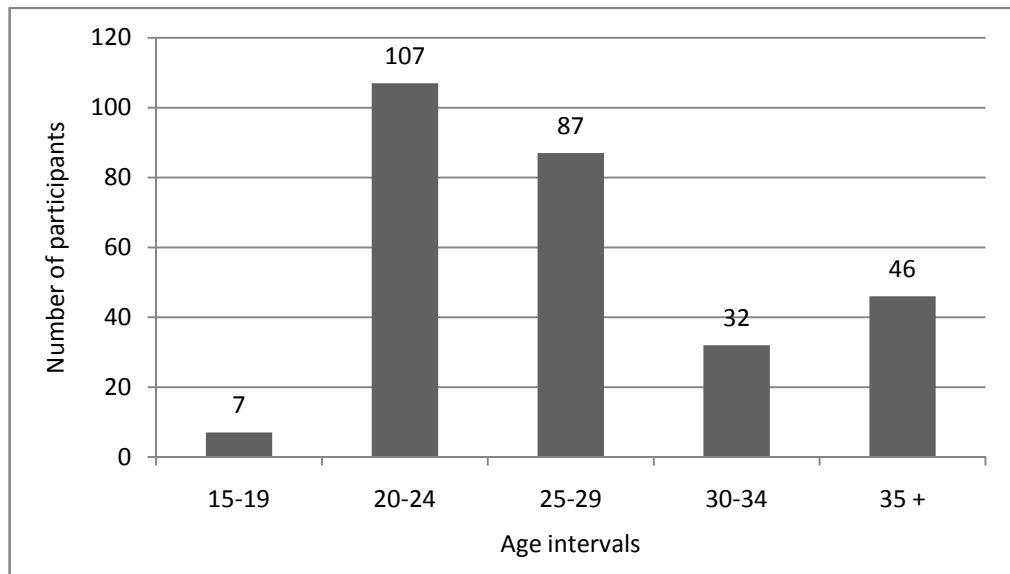
Figure 4.15 Age interval distribution for the participants of third enquiry

4.5.3. Procedure

A brief description of the study, and a part to gather the demographic data (gender and age) were presented to the participants with three seating unit alternatives in the first page of the questionnaire. Later, participants were asked to select one of the seating units that would be used in a railway coach interior with regard to their subjective impressions. After the approval of selection, the second question of the questionnaire appeared in a new page.

Accordingly, three coach layout alternatives using the priorly selected seating unit were asked to be evaluated within the rating interval of one to seven according to eight keyword pairs representing the factors of Semantic Environment Description method. In other words, each participant rated three coach interiors covering the preferred seating unit (seat A, B or C) within three arrangements (face-to-face, back-to-face, compound). Additionally, to avoid possible misuse and distortion on results, some precautions were provided during the preparation of questionnaire web page such as

the recognition of computer IP numbers for multiple submits from one person; or the creation of warning messages for possible blank scales.

4.5.4. Results

The questionnaire results were analyzed in three parts. First, the preferences among seating units were investigated. Then, all participants' opinions on coach interiors were explored according to the effects of layouts and seating units on the overall perception of the interior. Lastly, an analysis of variables (three seating units and three layouts) was made with regard to the eight semantic factors in interior assessment.

4.5.4.1. Preference on Seating Units

Participants' preferences on three seating units showed that Seat C was the most preferred one among three (Figure 4.16). Seat C had a frequency of 128 representing 46% of all participants, while Seat B was preferred by one of three participants and had a frequency of 93. On the other hand, Seat A was come out as the least preferred seating unit with a frequency of 53 which represents 21% of total.
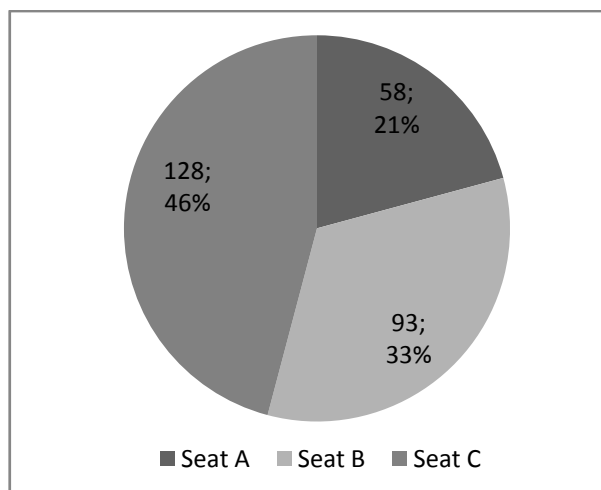
Figure 4.16 The preference values on three seating units

4.5.4.2. Effect of Layout and Seating Unit on Coach Interior Assessment

Significant differences were found among the assessments on coach interiors according to the different layouts for all types of seating units. The overall ratings for interiors (Figure 4.17) showed that 'Layout 1' was assessed as significantly less complex, more unit and more spacious in comparison to the others. 'Layout 2' was significantly less spacious, original and had the lowest affection rating, while 'Layout 3' was evaluated as the most pleasant, complex and affective with minor differences and also evaluated as the most original significantly.
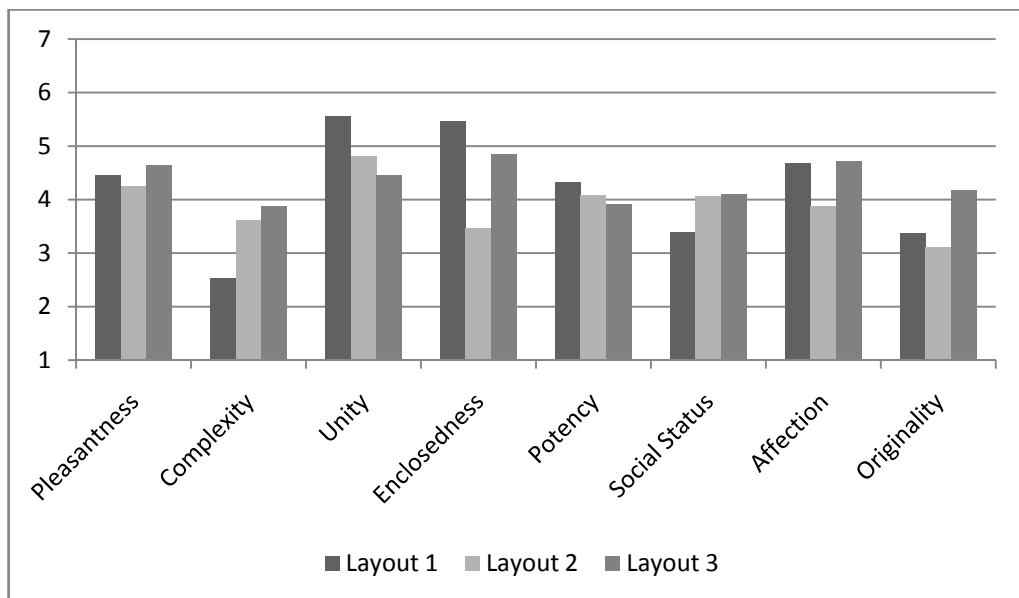
Figure 4.17 The overall mean values for interiors according to layouts

On the other hand, very minor differences were found out in terms of participants' opinions for coach interiors according to the different seating units within all layouts, when comparing the effect of layout alteration (Figure 4.18). According to the results, the interiors in which 'Seat A' was used were assessed as slightly more complex, but less enclosed when comparing to the others. The interior alternatives that used 'B' as seating unit were rated slightly high in unity, while the interiors used 'Seat C' were assessed as less complex but were rated slightly higher in enclosedness.
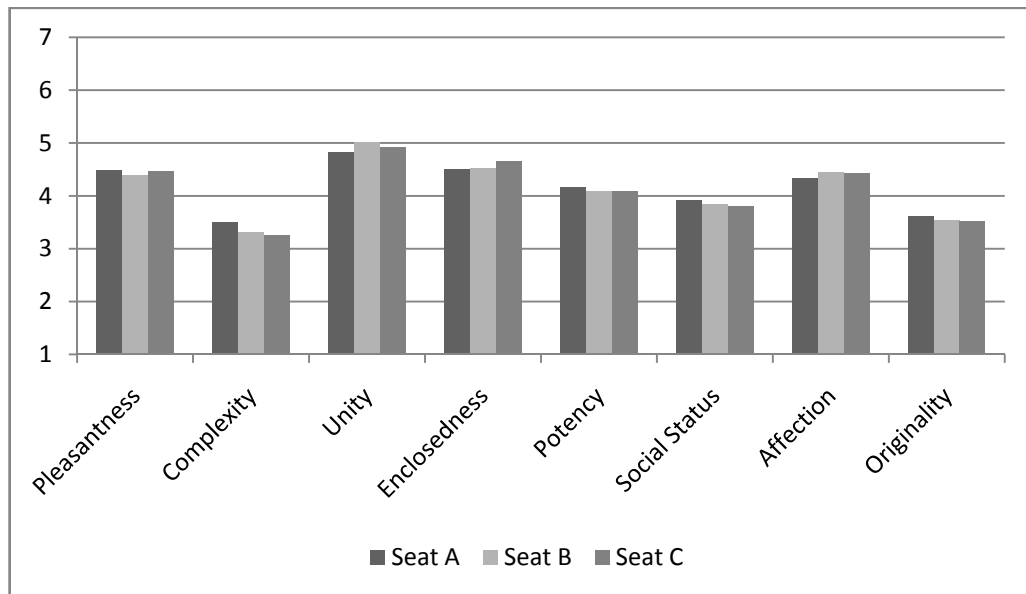
Figure 4.18 The overall mean values of interiors according to seating units

4.5.4.3. Relations between Factors and Design Variables

In order to find out relations between eight semantic factors represented by opposite pairs of keywords and design criteria, a table consisting of mean values of nine interior alternatives was built (Table 4.7). Additionally, a 3 × 3 ANOVA was conducted to explore and evaluate the effects of seating unit and layout variables on presented design factors and each factor was analyzed to obtain a comprehensive view (see Appendix D).

Table 4.7 The mean values of nine interiors in terms of semantic factors and variables

	Layout1			Layout2			Layout3		
	Seat A	Seat B	Seat C	Seat A	Seat B	Seat C	Seat A	Seat B	Seat C
Pleasantness	5,02	4,31	4,3	3,94	4,15	4,46	4,48	4,74	4,64
Complexity	2,75	2,46	2,44	3,67	3,65	3,56	4,09	3,84	3,78
Unity	5,75	5,69	5,37	4,5	4,73	5	4,22	4,62	4,43
Enclosedness	5,74	5,37	5,4	3,2	3,13	3,8	4,6	5,06	4,78
Potency	4,15	4,34	4,37	4,29	4,05	4	4,04	3,88	3,89
Social Status	3,55	3,24	3,41	4,17	4	4,07	4,04	4,32	3,95
Affection	4,52	4,72	4,7	3,84	3,78	3,93	4,64	4,82	4,68
Originality	3,55	3,34	3,33	3,22	2,98	3,14	4,08	4,31	4,12

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Pleasantness (ugly-good): The interior in which Seat A was used within Layout 1 was assessed as the most pleasant (5,02). However when Seat A was used within Layout 2, the mean ratings were dramatically fallen (3,94) and the interior was evaluated as the least pleasant. On the other hand, it was observed that the best match for Seat B was significantly Layout 3 (4,74) when comparing with two other layouts. The best suit for Seat C was also Layout 3 (4,64), but additionally it was Seat C which was assessed with the highest ratings among three seating units within Layout 2.
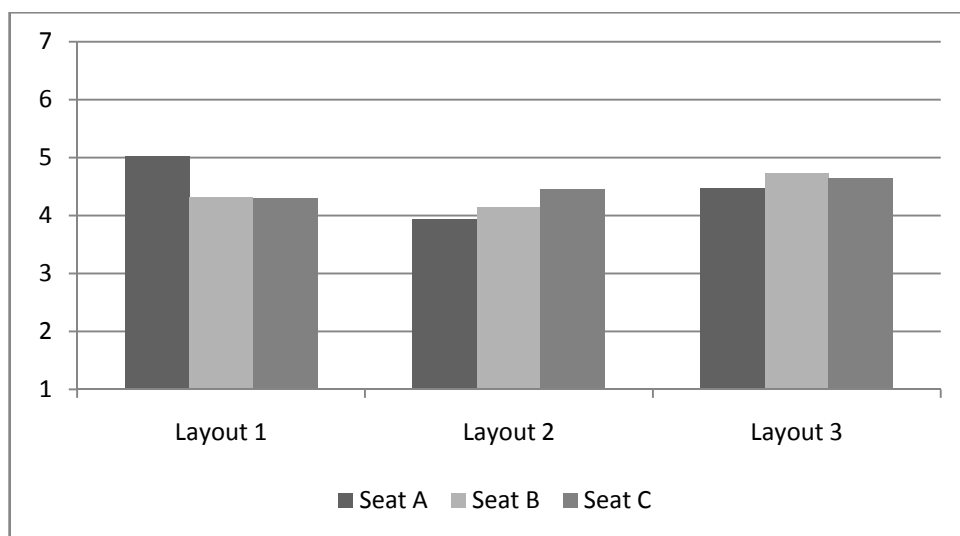
Figure 4.19 The mean values of nine variables for factor pleasantness

Complexity (simple-complex): The overall mean ratings showed that interiors that used Layout 1 were assessed as significantly less complex (2,75; 2,46; 2,44) while interiors using Layout 3 were assessed as more complex (4,09; 3,84; 3,78). The ANOVA analysis also showed that it is neither the seating unit - layout relation nor the seating unit that affects the complexity level perception of coach interiors but it is the choice of seating unit arrangement.
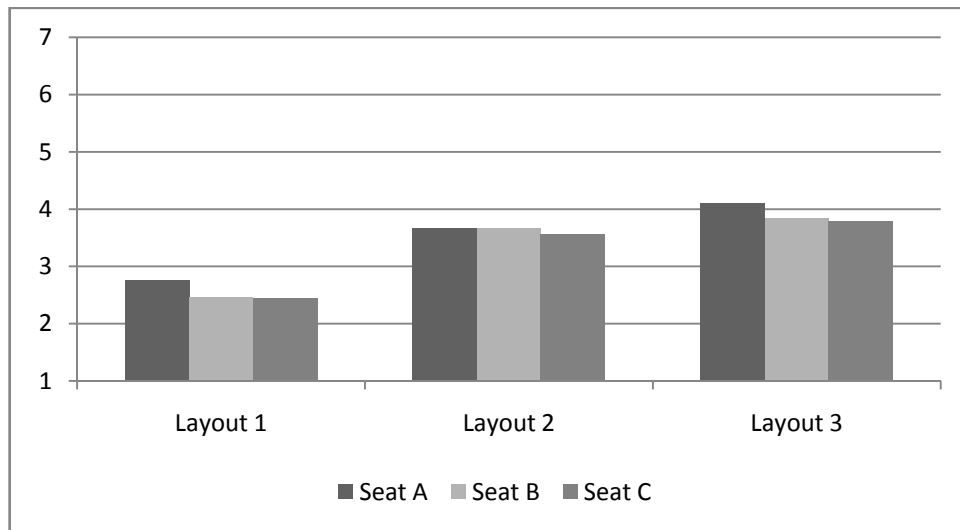
Figure 4.20 The mean values of nine variables for factor complexity

Unity (partite-composite): It was seen that the most important factor affecting the unity was the layout of seats. The interiors using Seat A, B and C within Layout 1 were assessed as more unit (5,75; 5,69, 5,37), while the interiors which were arranged according to Layout 3 were assessed as significantly less unit (4,22; 4,62; 4,43). Furthermore, to demonstrate a coach interior which could be perceived as more unit, the most appropriate matches of layouts for seating units were observed as Seat A for Layout 1 (5,75), Seat C for Layout 2 (5), and Seat B for Layout 3 (4,62).
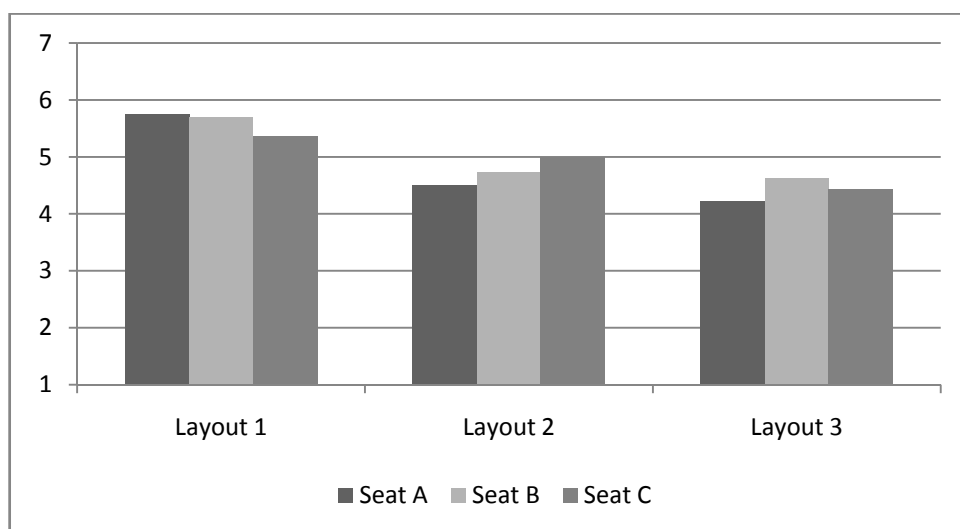
Figure 4.21 The mean values of nine variables for factor unity

Enclosedness (airless-spacious): Within the content of all seating units, the interior alternatives which were arranged with regard to Layout 1 were assessed as significantly more enclosed (5,74; 5,37; 5,4) while the interiors representing Layout 2 were evaluated with lower ratings (3,12; 3,13; 3,8). Additionally, Seat A for Layout (5,74), Seat C for Layout 2 (3,8), and Seat B for Layout 3 (5,06) were again assessed as appropriate combinations to obtain an airy environment. Therefore it can be said that seating unit – layout relation significantly affects the perception of a coach interior in terms of enclosedness.
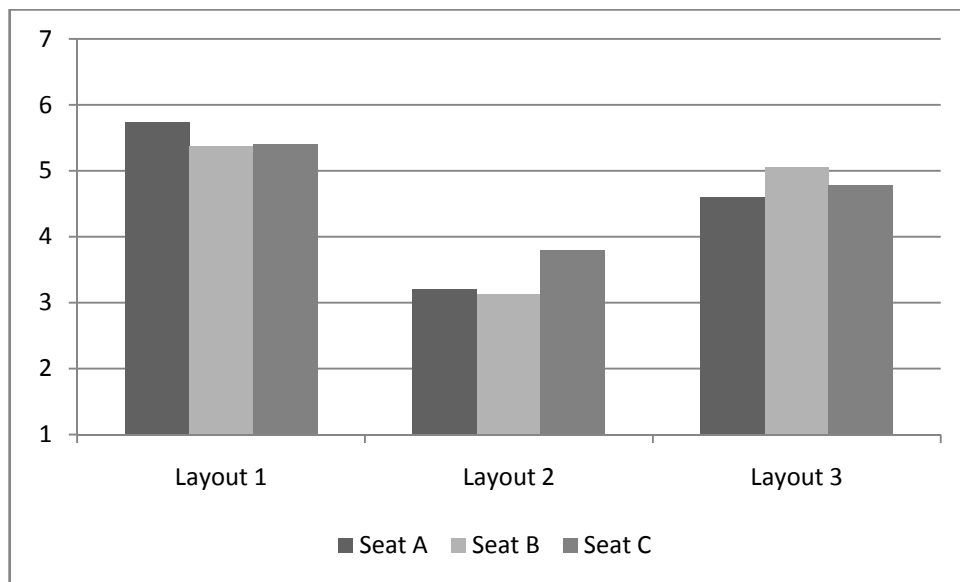
Figure 4.22 The mean values of nine variables for factor enclosedness

Potency (feminine-masculine): Without demonstrating any significant differences (their reasons will be discussed in the next part), the ANOVA analysis showed that it is neither the seating unit - layout relation nor the seating unit that affects the complexity level perception of coach interiors but it is the choice of seating unit arrangement. The alternatives using Layout 1 was assessed as more masculine (4,15; 4,34; 4,37), while coach interiors arranged according to Layout 3 were perceived as more feminine (4,04; 3,89; 3,88).
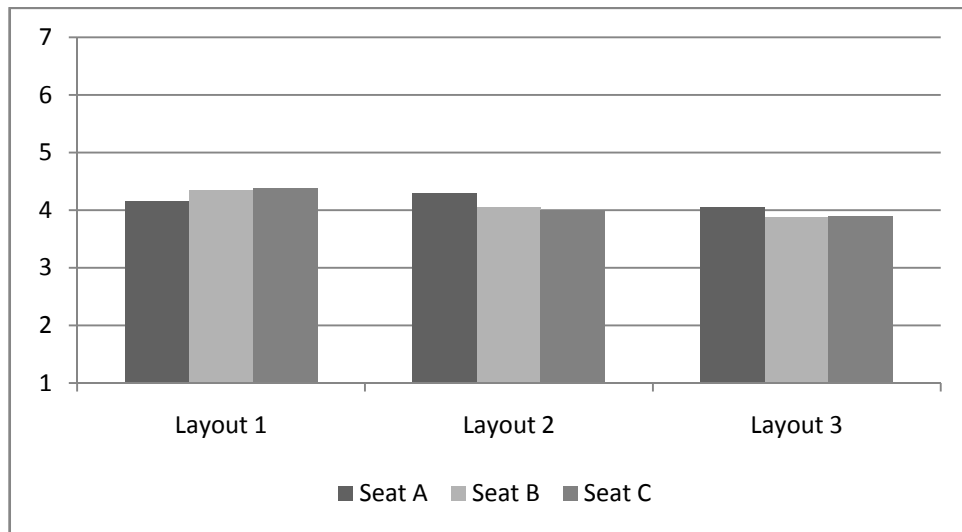
Figure 4.23 The mean values of nine variables for factor potency

Social Status (cheap-expensive): The ANOVA analysis proved that the factors affecting the level of social status perception are both seating unit and layout choice, but there are not direct correlations between these two variables. Therefore, it can be said that, even the coach interior combining Seat B within Layout 3 was evaluated higher in social status than all the others (4,32), using alone Seat B as seating unit and Layout 2 as an arrangement option make coach interiors to be perceived more expensive.
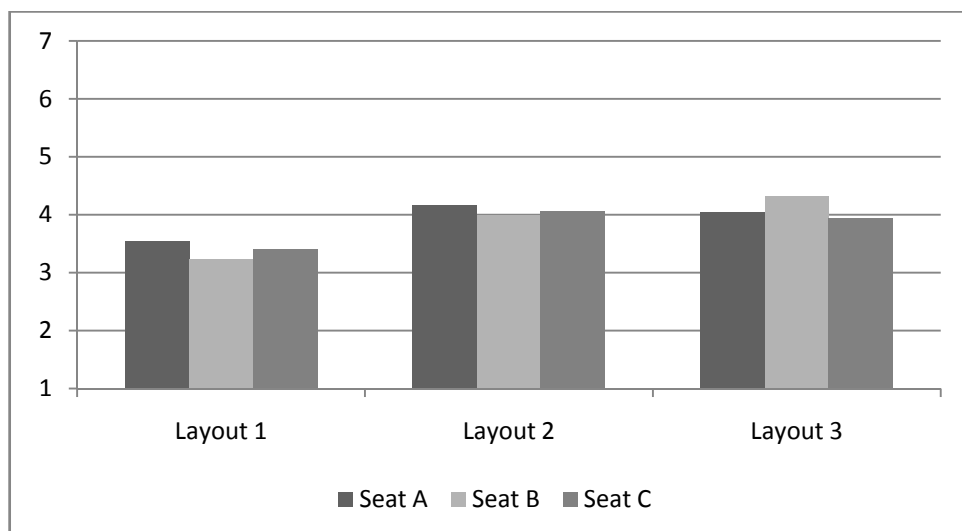
Figure 4.24 The mean values of nine variables for factor social status

Affection (aged-modern): Within layout sets**,** all three interiors using Seat A were assessed with the lowest ratings (4,52; 3,78; 4,64). On the other hand, the interiors in which seating units were arranged according to Layout 2 were significantly lower than the others (3,78; 3,84; 3,93). The combination of Seat B and Layout 3 had the highest rating (4,82), while the combination of Seat A and Layout 2 had the lowest rating in affection. Therefore it is observed that seating unit – layout relation affects the perceived level of affection factor.
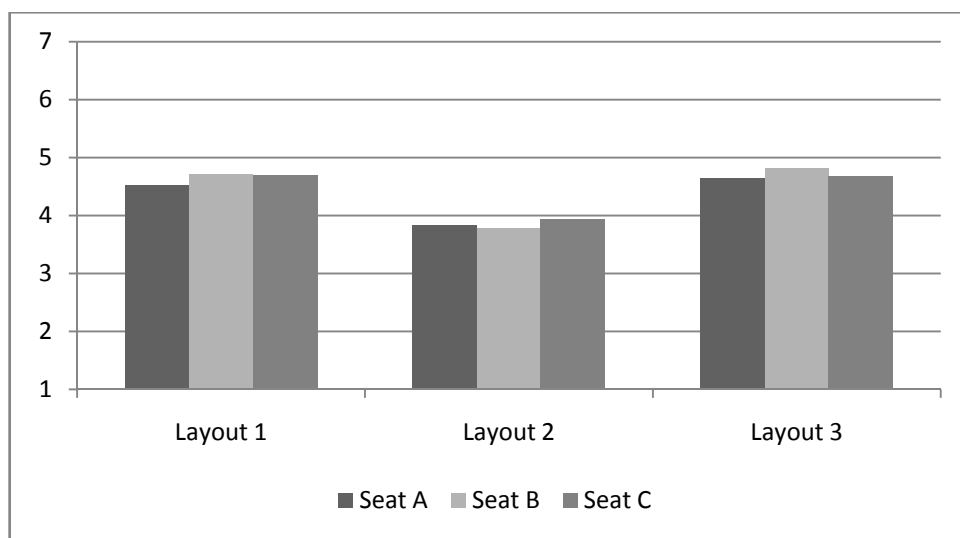
Figure 4.25 The mean values of nine variables for factor affection

Originality (ordinary-original): As in affection, the interior in which Seat B was used within Layout 3 was assessed as the most original among all (4,31). However, the mean ratings were dramatically fallen (2,98) when Seat B was used within Layout 2 and the interior was evaluated as the least original. Besides, it was observed that seating unit arrangement proposed by Layout 2 caused interiors to be perceived weaker on originality (3,22; 2,98; 3,14), while Layout 3 had an opposite effect (4,08; 4,31; 4,12).
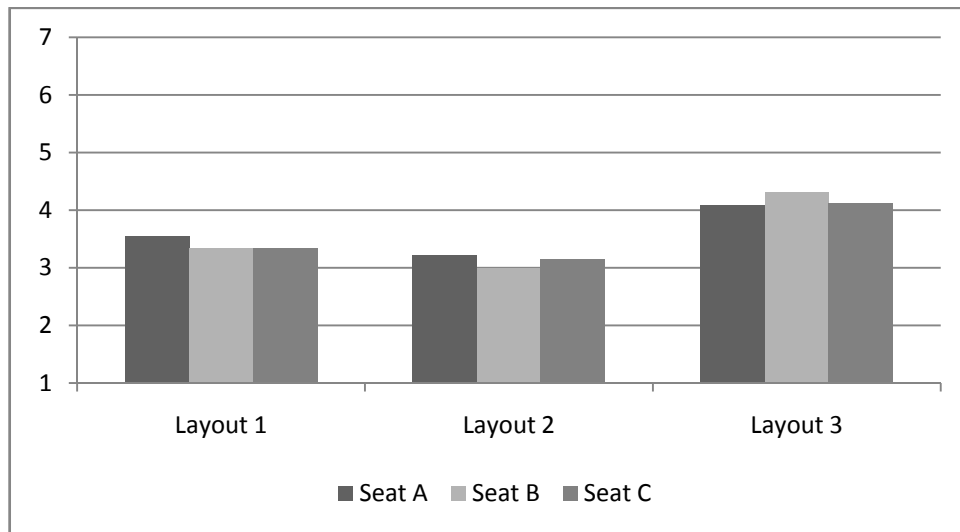
Figure 4.26 The mean values of nine variables for factor originality

In addition to the mean values, to analyze the extents of factors and variables around their averages, the standard deviations were also calculated (Table 4.8). The results showed that factors 'potency' and 'social status' were assessed with significantly fewer spreads, while 'enclosedness' had the highest values in terms of standard deviation. On the other hand, the interiors representing Seat A and Layout 3 were evaluated within fewer spreads than all other alternatives in their sets.

Table 4.8 The standard deviations of nine interiors in terms of factors and variables

	Layout1			Layout2			Layout3		
	Seat A	Seat B	Seat C	Seat A	Seat B	Seat C	Seat A	Seat B	Seat C
Pleasantness	1,43	1,56	1,66	1,47	1,46	1,65	1,45	1,59	1,64
Complexity	1,54	1,46	1,48	1,45	1,7	1,34	1,38	1,42	1,58
Unity	1,09	1,51	1,75	1,6	1,6	1,52	1,42	1,45	1,53
Enclosedness	1,51	1,92	1,83	1,5	1,56	1,66	1,45	1,39	1,64
Potency	1	1,21	1,53	0,87	1,03	1,31	0,95	0,87	1,05
Social Status	1,41	1,43	1,4	1,17	1,33	1,22	1,12	1,19	1,2
Affection	1,55	1,76	1,67	1,36	1,7	1,54	1,22	1,5	1,47
Originality	1,56	1,81	1,67	1,38	1,52	1,53	1,36	1,47	1,52

4.6. Discussion

In this chapter, users' preferences and needs were assessed quantitatively by means of coach design alternatives to achieve design criteria and guidelines for such public transportation vehicle interiors. In order to determine the variables of interest which were presented within alternatives, a set of empirical studies including questionnaires and interviews were conducted.

First, six candidate coach interior images representing different design concepts were collected. The participants were asked to select the most and the least liked samples according to their preferences and two open ended questions were asked to describe the reasons of selections. Accordingly, it was observed that coach interiors are evaluated like other user products as compositions of elements and features and also according to the overall impressions that they evoke. However, the difficulty to control variables with presented images was determined as a limitation. Because the findings of the interview proved that the identified factors were based upon the dominant attributes of interiors affecting users' responses as well as their needs and preferences.

Later, with the outputs of former study, a questionnaire was designed to determine the comparative magnitudes and the contributions of design factors to the overall perception of coach interiors. The findings showed that the quantity of air conditioning units with the layout, form, material and quantity of seating units had the highest frequencies among all. However the quantity of air conditioning units was not captured as a factor for the next step of the study, since the questionnaire was performed in summer and all participants specified one need for the quantity of air conditioning units as: 'It should be as much as possible'.

Then, another step of study was performed to refine and specify the most influential factors for a coach interior and to set the attributes of alternatives which were created for the second phase of the study. Suggested five factors related to seating units

were transformed into a set of measurable specifications. The frequency rankings of factors showed that the findings of last two studies were overlapped and this situation proved the validities of each other. Besides, definitions of the varieties or kinds of seating unit features were collected from participants. The outputs of definitions on 'material and form' feature were used to design three seating units. Accordingly, a total of nine coach interior alternatives were created by using each seating unit within three defined 'layouts'.

Lastly, with the visual stimuli of seating units and coach alternatives, another survey consisting of two questions was conducted via Internet. After a brief description, 279 participants were first asked to choose one of the seating units among three alternatives. Then three coach layout alternatives using the priorly selected seating unit were asked to be rated within the interval of one to seven according to eight opposite keyword pairs representing the factors of Semantic Environment Description method. The findings of the study about seating units showed that participants preferred the use of soft materials instead of plastic especially in seat area and backrest. Additionally, major effects of seating units and their layouts on the overall perception of the coach interior were observed. However, while very significant differences were found out on the assessment of layout contribution to the overall perception, the contribution of seating units were associated with fewer differences. The reason may be the fact that each participant evaluated only three alternatives and the only variable within these alternatives was the arrangement of seating units.

Additionally, the findings of the study also showed how well each semantic factor suited the different attributes of interior alternatives. Therefore, the possibility to make comparisons was enabled among three passenger seats within three layout options in order to objectify design criteria and recommendations as follows:

(1) The former studies showed that pleasantness is affected by many things (Karlsson et al., 2003). It is hard to find general statements to explain pleasantness. However, it can

be said that the balance between complexity and unity could affect pleasantness. There should be a good balance between these two factors. For example, if the environment is too high on unity and too low on complexity this could be perceived as a boring and not so pleasant environment. On the other hand, if the environment is too high on complexity and too low on unity, this will create a less pleasant interior because the environment is perceived too messy (Küller, 1977 in Karlsson et al., 2003). Layout 3 had complexity-unity profile that is quite different from all the other interiors with closer values. This could be one explanation of the higher pleasantness values for the coach interiors which were arranged according to that layout.

(2) Complexity has to do with the amount of details in an environment (Küller, 1977 in Karlsson et al., 2003). The interiors which represented Layout 3 had more complicated seating unit arrangements when compared to the others. That could contribute the increase of the complexity value for Layout 3.

Figure 4.27 Three layout alternatives with the use of Seat C

(3) Unity is an assessment of how well elements and their features seem to fit and function together and could be evaluated as the opposite of complexity. In the case of Layout 1 which represented the most comprehensible arrangement of seating units for railway coaches, seating units were assembled to each other as much as possible within a unity. That is why the unity assessment for Layout 1 was significantly high.

(4) Enclosedness could of course be affected by the perceived size of the interior (Küller, 1975 in Karlsson et al., 2003). Since interiors which were arranged according to Layout 1 had a wider walk-through path, it is not surprising that it was perceived to be

open. On the other hand, three alternatives representing Layout 2 were assessed as significantly airless as the horizontal distance between seating units were smaller.

(5) The potency factor could not contribute the study as much as expected. It was observed that the potency of interiors were all rated near the average rating (four) with smaller spreads on standard deviations. Although the opposite keywords (feminine – masculine) used for potency were two of the four adjectives used in the original Swedish version of Semantic Environment Description method, participants had difficulties to assess coach interiors as feminine or masculine. Nevertheless, interiors arranged according to Layout 1 were assessed as more masculine while interiors using Layout 3 were perceived as more feminine.

Figure 4.28 Three layout alternatives with the use of Seat B

(6) Social status is an economic and social evaluation of the environment and could be affected by many things like pleasantness (Küller, 1975 in Karlsson et al., 2003). However, unlike pleasantness, the perceived social status level has not been affected by seating unit – layout relation. Instead the seating unit and the layout have affected it individually. It was observed that interiors which were arranged with regard to Layout 2 and interiors using Seat B were assessed more expensive than others. The reason could be that unity and complexity levels are effective on the assessment of social status as the difference between two levels increases the social status level decreases. There should be a good balance between these two factors. Additionally, keyword pairs of social status were evaluated within smaller spreads as in potency. The reason could be either the difficulty to evaluate coach interiors as cheap or expensive or the agreement on their levels of social status.

(7) Affection is mostly influenced by what is well-known to the users (Küller, 1975 in Karlsson et al., 2003). The interiors which were arranged according to Layout 1 and Layout 3 were marked higher on affection with close values while alternatives of Layout 2 had significantly lower ratings. That could be because Layout 2 was the most conventional so the familiar arrangement for public transportation. Therefore, the alternatives of Layout 2 were not found as original as the others and were rated lower on social status.

Figure 4.29 Three layout alternatives with the use of Seat A

(8) Originality, like affection, was also influenced by what is well-known. As interiors which were arranged according to Layout 2 were the most familiar ones when compared to others, they had the lowest ratings on originality. On the other hand, because Layout 3 served an unfamiliar arrangement for seating units, it was assessed as more original.

As a conclusion, the results indicate that coach interiors are evaluated like other user products as compositions consisting of elements and their features and also evaluated according to the overall impressions that they evoke. However, the importance of these elements and features vary, since seating unit was significantly determined as the most influential element for a coach interior. In addition, the effects of design factors on the overall perception of coach interior differ since they generate relative strengths and weaknesses with regard to the semantic dimensions. Therefore, instead of data which are fulfilled with strict guidelines, the study constituted a useful preference data to understand users' perceptions of semantic dimensions and also to assist designers

when developing such interiors or when it is necessary to make trade-off solutions based on engineering decisions.

A shortlist of design guidelines with regard to user perception of presented semantic dimensions can be listed as:

- Although the former studies showed that pleasantness is affected by many things (Karlsson et al., 2003), the use of Seat C within Layout 3 seems as the best option to obtain a pleasant interior.
- As the layout is found as the only factor affecting the perceived complexity level independent from seating unit or seat–layout relation, Layout 1 is the best solution to obtain simpler interiors.
- To use Seat A or Seat C in Layout 1 is highly recommended in order to be perceived as a more unit interior.
- As in unity, to obtain a more spacious environment; using Seat A or Seat C in Layout 1 are the best options.
- The factors affecting the level of social status perception are both seating unit and layout choice but not their relation to each other. Therefore, Seat B or Layout 2 can be used one by one to design an expensive looked interior.
- To use Seat B in Layout 3 or Seat A in Layout 1 are highly recommended in order to obtain a modern coach interior.
- As seat–layout relation is the factor affecting perceived originality, the use of Seat B in Layout 3 is recommended as the best option to create an original coach interior.

CHAPTER 5

CONCLUSION

This chapter presents a brief review of the answers to the research questions which are acquired from literature survey and empirical studies conducted. The chapter concludes with an account of limitations, and provides suggestions for further research.

5.1. Concluding Remarks

Industrial design is the connection between product and user. Therefore, the purpose of industrial design should be to answer user needs and preferences by creating products within a wide range of considerations including functionality, usability, aesthetics or utility. However, it is a challenging task for designers to identify the users' implicit perceptions and to transfer them into design specifications; because it is a fact that the choices are often made on the elegance, functionality and social significance of products based on visual information rather than requirements. Therefore, designers are often drawn into trap of trying to find 'uses' for 'beautiful' tools, forgetting their primary objective as providing value to the end user. Consequently, the user's needs and preferences are often referred to the degree to which he/she likes a product's appearance and are defined as multidimensional psychological constructs which are composed of cognitive, affective, and behavioral dimensions.

Therefore, as the most important requirement, user needs should be understood first while developing new products. However, it should be taken into consideration that the perceptual dimensions mentioned above affect user responses and can cause some misleads during the identification of users' needs. Consequently at this stage, it is

recommended not to use any visual stimuli in order to neutralize the effect of perceptual responses. Opinions of user about the visual appearance are then collected and used to determine the preferred requirements of the product; because in the early stages of a product's design, user opinion can provide helpful information to indicate means in which the design development should proceed. Later, once prototypes and visuals are generated, this evaluation data can reveal the perceived quality of the design, or highlight its limitations with regard to the perceptual dimensions.

In order to study the perceptual dimensions of user's preferences, the Semantic Differential (Osgood et al., 1957) is one of the most frequently used methods and also referred by almost all methods, such as Kansei Engineering or Semantic Environment Description, which are based on the theory of product semantics. The versatility of uses providing information about the traditional 'evaluative' dimension along with 'power' and 'activity' dimensions and the simplicity of understanding the preference scales consisting bipolar adjectives have made the method ideal for the last enquiry of this thesis. Additionally, the most problematic part of the method, creating pairs that are semantic opposites, have been overcome with the use of representative keywords for eight factors of Semantic Environment Description method which has been validated through the assessments of both vehicle interiors and architectural environments.

Consequently, to achieve design criteria for coach interior elements and their design features, the relation between user expectations and attributes of interior has a critical role. This relation has been examined through the perceptual dimensions and has been evaluated with validated tools throughout the empirical studies conducted. In the first phase, the most influential design factors of a coach interior were determined and defined by means of subjective preferences. Seating unit with form, material and layout features has been determined as the most influential element for a coach interior. For the second phase, three seating units have been visualized within three layout options; therefore nine interior alternatives have been created. In order to measure and compare the effects and the contributions of design variables on the overall perception

of coach interiors, preference scales representing the eight factors of Semantic Environment Description method have been used. Indications of the attributes of interior alternatives by means of semantic factor scales presented have offered inferences on:

- Preference on seating units
- Effect of seating unit and seating unit arrangement on the overall perception in coach interior assessment
- Relations between semantic factors and design variables represented within coach alternatives

With a general point of view, in decision-making and decision-support tasks, a model of users' needs and preferences is required to make better decisions or to suggest better alternatives. Besides, designers should ensure that coach interiors are compositions consisting of various design factors like elements and their features. Within this content, the material choice is an important determinant to assess seating unit attributes, whereas it is found out that the layout of seating units has the greatest contribution to the overall perception of a coach interior among all factors examined. Another important finding is the assessment data which helps to interpret and compare the effects of design variables of coach interiors and their relations in terms of pleasantness, complexity, unity, enclosedness, social status, potency, affection and originality on the overall perception of environment.

To conclude, the findings of the study show how well each factor suits the interior alternatives and enable a comparison among three passenger seats within three layout options. Therefore, useful data have been gathered to understand users' perceptions of semantic dimensions, and also to assist designers while developing and evaluating such interiors.

5.2. Limitations of the Study

There is a lack of literature about design criteria which is dealing with users' needs and preferences for railway coach interiors. Therefore, it was difficult to conceptualize the relations between design elements and features of coach interiors and subjective expectations through literature. In order to construct the literature review, specific areas were searched such as user needs, user behavior and responses towards product form perception, design and emotion and rail human factors. Unfortunately, only a few examples of research were found which are directly related to identify user perception of dimensions through expectations and construct the design criteria for an interior.

There are also certain limitations for the empirical studies conducted in the fourth chapter. For the first and second enquiries, participant selection was based on case specific criteria and all active passengers were deemed appropriate as participants by the researcher. On the other hand, for the last study, time constraints involved in the research and it was allowed to attain as much assessments as possible. Therefore, the study was performed via Internet and the participants were not able to be selected only among active passengers.

Another limitation was about the Semantic Environment Description method and the preference scales formed according to the factors of this method. Created adjective pairs were assumed appropriate to represent eight factors by the researcher and the thesis supervisor. On the other hand, except for the guidelines from previous studies, the method does not include any methodology on presented semantic factors in order to connect the opinions to the design criteria. Therefore, the evaluation data were examined within all possible seat and layout options to provide more concrete recommendations.

The last limitation was about the generalizability of the results of conducted empirical studies. As all samples that the enquiries were administered consist of Turkish citizens,

the results actually represent the perception of Turkish users. However in the case of conducting the performed procedure within different cultures, it is also possible to gain knowledge about the cultural differences in the perception of semantic dimensions. Additionally, more concrete outcomes which are appropriate to be generalized can be gathered.

5.3. Further Research

There are questions aroused throughout the progress of the study. These questions that are related to the issues mentioned in this thesis can be considered as suggestions for further studies.

First of all, to investigate the effect of color to the overall perception of a coach interior would be noteworthy. Because color was evaluated as the least important feature for a seating unit, the influence of color has not been investigated in the final enquiry. However, it is a well-known fact that color is an important design factor which affects user responses towards products and also interiors.

Secondly, the structure of the factors in the Semantic Environment Description method could also been further investigated. The words in each factor were deliberately chosen not to be direct opposites (Küller, 1975 in Karlsson et al., 2003). However, when a factor score is computed the words can treat as their opposites in the original version of the method. In the study, this problem has been overcome with the use of opposite keyword pairs at both ends of preference scales for each factor. However, the validity of the adjective pairs or words representing eight factors should be examined for further research.

Lastly, another set of studies focusing on the design criteria for coach interiors can be performed. However, this time subjective needs and preferences can be investigated

with the help of qualitative methods, instead of quantitative. By using the acquired infrastructure from former enquiries, such a study would provide new expansions for the achieved design criteria and provide more reliable outcomes.

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APPENDIX A

PARTICIPANT QUESTIONNAIRE FOR EMPIRICAL STUDY 1

Bu anket Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümünde yürütülmekte olan bir tez çalışması kapsamında hazırlanmıştır. Ankette amaçlanan kullanıcıların şehir içinde kullanılan raylı toplu taşıma araçları ile ilgili beklentileri konusunda bilgi toplamaktır. Verdiğiniz cevaplar sadece akademik amaçlı çalışmalarda kullanılacak, hakkınızda kişisel bir bilgi bu çalışmalarda yer almayacaktır.

Vakit ayırdığınız ve çalışmaya katıldığınız için teşekkür ederim.

Cinsiyetiniz:

Yaşınız:

Raylı bir toplu taşıma aracının iç tasarımındaki öğelere ilişkin aşağıdaki yirmi önermeden en önemli bulduğunuz beşini seçiniz ve en önemlisine 5 verecek şekilde 5'ten 1'e puanlayınız.

- Oturma birimlerinin yerleşim düzenidir…………………………………………………………….
- Oturma birimlerinin formudur……………………………………………………………………….
- Oturma birimlerinin rengidir………………………………………………………………………..
- Oturma birimlerinin malzemesidir…………………………………………………………………
- Oturma birimlerinin sayısıdır………………………………………………………………………
- Tutunma barlarının yerleşim düzenidir……………………………………………………………
- Tutunma barlarının formudur………………………………………………………………………
- Tutunma barlarının rengidir………………………………………………………………………..
- Tutunma barlarının malzemesidir…………………………………………………………………
- Tutunma barlarının sayısıdır………………………………………………………………………
- Aydınlatma birimlerinin yerleşim düzenidir………………………………………………………

- Aydınlatma birimlerinin formudur………………………………………………………………………
- Aydınlatma birimlerinin rengidir…………………………………………………………………….
- Aydınlatma birimlerinin malzemesidir……………………………………………………………….
- Aydınlatma birimlerinin sayısıdır…………………………………………………………………….
- Havalandırma ve iklimlendirme birimlerinin yerleşim düzenidir…………………………
- Havalandırma ve iklimlendirme birimlerinin formudur………………………………………….
- Havalandırma ve iklimlendirme birimlerinin rengidir……………………………………………
- Havalandırma ve iklimlendirme birimlerinin malzemesidir……………………………………
- Havalandırma ve iklimlendirme birimlerinin sayısıdır………………………………………….

APPENDIX B

PARTICIPANT QUESTIONNAIRE FOR EMPIRICAL STUDY 2

Yaşınız: ☐☐   Cinsiyetiniz: E K

Raylı bir aracın oturma birimlerine ilişkin aşağıdaki önermeleri, en önemlisine beş verecek şekilde 5'ten 1'e kadar sıralayınız.

● Oturma birimlerinde kullanılan malzemenin türü önemlidir (plastik,sünger veya kaplama türü). ☐
....

● Oturma birimlerindeki renk seçimi önemlidir (canlı, donuk veya diğer birimlere uyumlu renklerin kullanılması). ☐
....

● Oturma birimlerinin yerleşim düzeni önemlidir (birimlerin karşılıklı, sırt sırta veya klasik düzenlenmesi). ☐
....

● Oturma birimlerinin sayısı önemlidir (azlığı-çokluğu veya yeterliliği-yetersizliği). ☐
....

● Oturma birimlerinin formu önemlidir (tasarımı). ☐
....

Teşekkürler...

Figure B.1 A5 questionnaire sheet for empirical study 2

PARTICIPANT QUESTIONNAIRE FOR EMPIRICAL STUDY 3

Bu anket Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümünde yürütülmekte olan bir tez çalışması kapsamında hazırlanmıştır. Ankette amaçlanan kullanıcıların şehir içerisinde kullanılan raylı toplu taşıma araçlarından beklentileri konusunda bilgi toplamaktır.

Verdiğiniz cevaplar sadece akademik amaçlı çalışmalarda kullanılacak, hakkınızda herhangi kişisel bir bilgi bu çalışmalarda yer almayacaktır. Vereceğiniz bilgiler doğru yada yanlış olarak değerlendirilmeyeceğinden, düşüncelerinize en yakın cevapları vermeniz çalışmanın başarısı açısından önemlidir.

Vakit ayırdığınız ve çalışmaya katkıda bulunduğunuz için teşekkür ederim.

Mehmet Turhan
ODTÜ Endüstri Ürünleri Tasarımı Bölümü
Yüksek Lisans Öğrencisi

mturhan_29@yahoo.com

1 Aşağıda yer alan 3 oturma birimini inceleyiniz; raylı bir toplu taşıma aracında kullanılacağını göz önünde bulundurarak, beğeninize en uygun örneği seçiniz ve altındaki kutucuğu işaretleyip 2. soruya geçiniz.
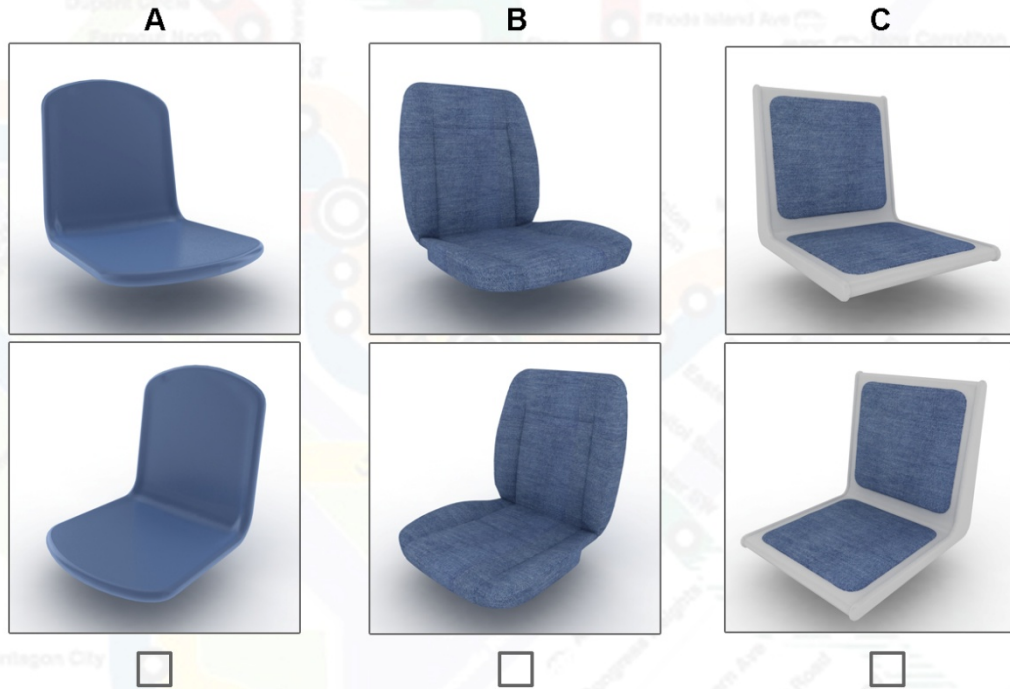
2. soru için basınız

Figure C.1 First page of the questionnaire

Figure C.2 Second page of the questionnaire (for Seat A)

Figure C.3 Second page of the questionnaire (for Seat B)

Figure C.4 Second page of the questionnaire (for Seat C)

APPENDIX D

ANOVA ANALYSIS FOR EACH SEMANTIC FACTOR

APPENDIX D-1

ANALYSIS FOR THE PLEASANTNESS FACTOR

Table D.1 Tests of between-subjects effects for pleasantness

Dependent Variable: score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
seat	26,834	2	13,417	5,433	,005
layout	24,914	2	12,457	5,045	,007
seat * layout	29,999	4	7,500	3,037	,017
Error	2044,665	828	2,469		
Total	18701,000	837			
Corrected Total	2123,192	836			

a R Squared = ,037 (Adjusted R Squared = ,028)
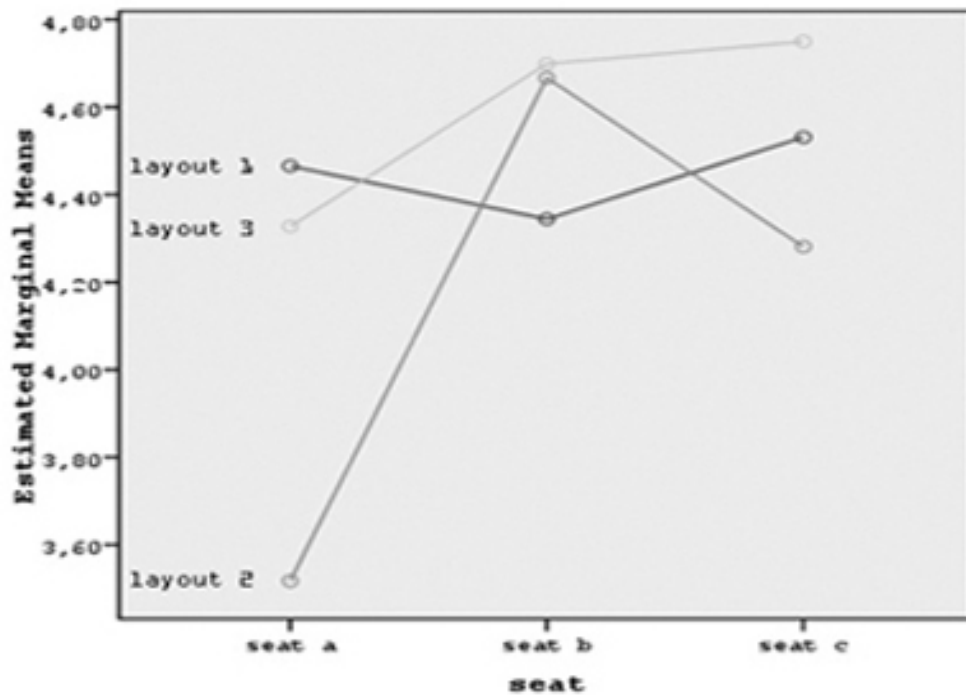

Figure D.1 Estimated marginal means of score for pleasantness

APPENDIX D-2

ANALYSIS FOR THE COMPLEXITY FACTOR

Table D.2 Tests of between-subjects effects for complexity

Dependent Variable: score

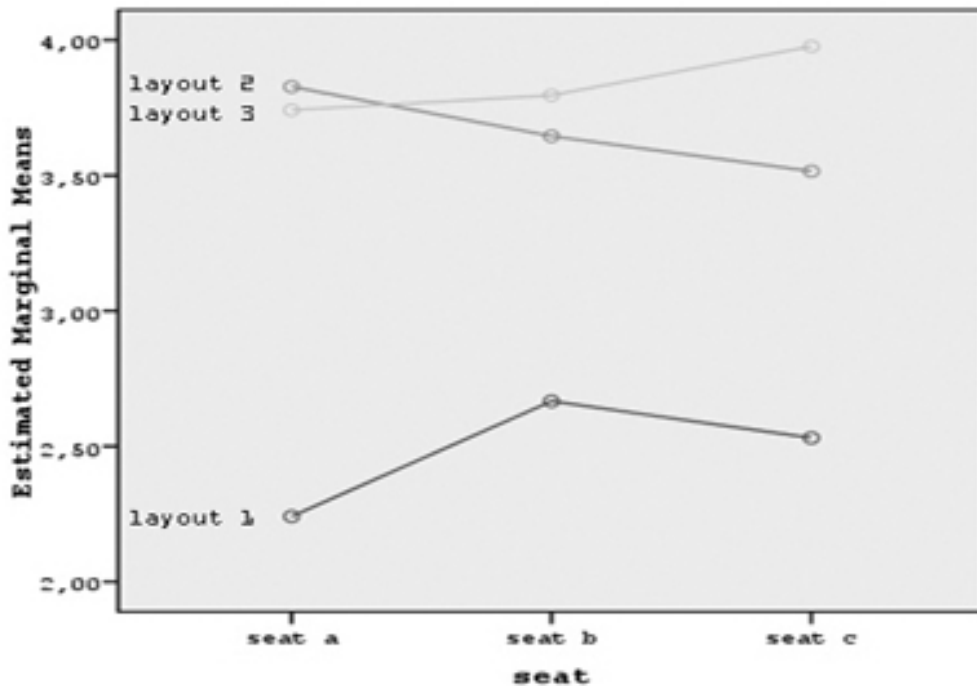| Source	Type III Sum of Squares	df	Mean Square	F	Sig.
seat	1,072	2	,536	,232	,793
layout	274,364	2	137,182	59,474	,000
seat * layout	12,316	4	3,079	1,335	,255
Error	1909,866	828	2,307		
Total	11526,000	837			
Corrected Total	2212,662	836			

a R Squared = ,137 (Adjusted R Squared = ,129)

Figure D.2 Estimated marginal means of score for complexity

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APPENDIX D-3

ANALYSIS FOR THE UNITY FACTOR

Table D.3 Tests of between-subjects effects for unity

Dependent Variable: score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
seat	3,013	2	1,506	,636	,530
layout	169,718	2	84,859	35,834	,000
seat * layout	31,588	4	7,897	3,335	,010
Error	1958,424	827	2,368		
Total	22585,000	836			
Corrected Total	2172,128	835			

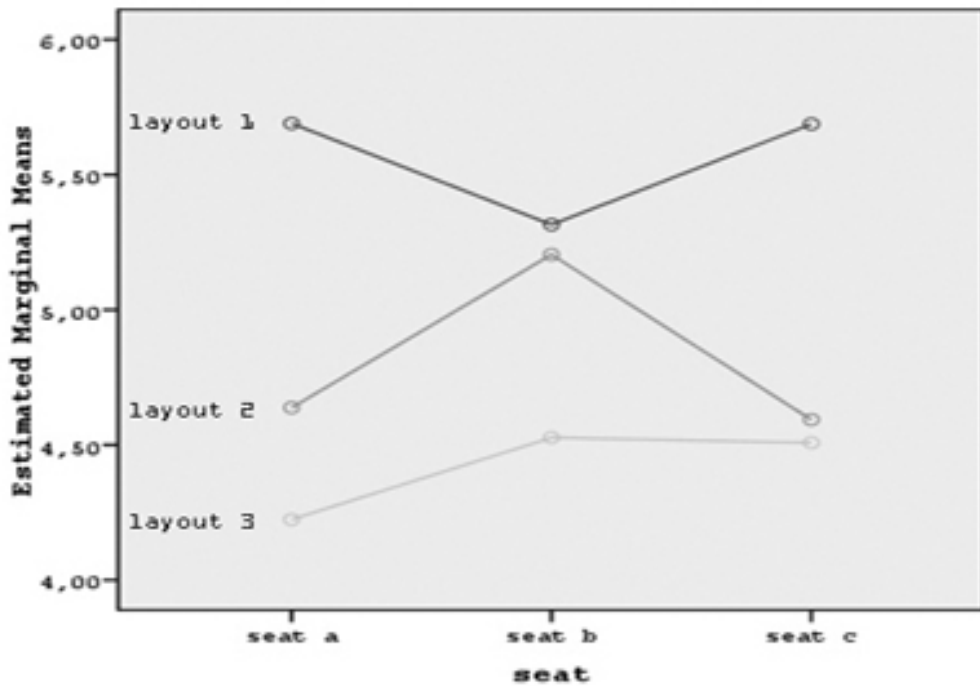a R Squared = ,098 (Adjusted R Squared = ,090)

Figure D.3 Estimated marginal means of score for unity

APPENDIX D-4

ANALYSIS FOR THE ENCLOSEDNESS FACTOR

Table D.4 Tests of between-subjects effects for enclosedness

Dependent Variable: score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
seat	8,093	2	4,047	1,493	,225
layout	562,920	2	281,460	103,868	,000
seat * layout	41,960	4	10,490	3,871	,004
Error	2243,710	828	2,710		
Total	20509,000	837			
Corrected Total	2882,619	836			

a R Squared = ,222 (Adjusted R Squared = ,214)
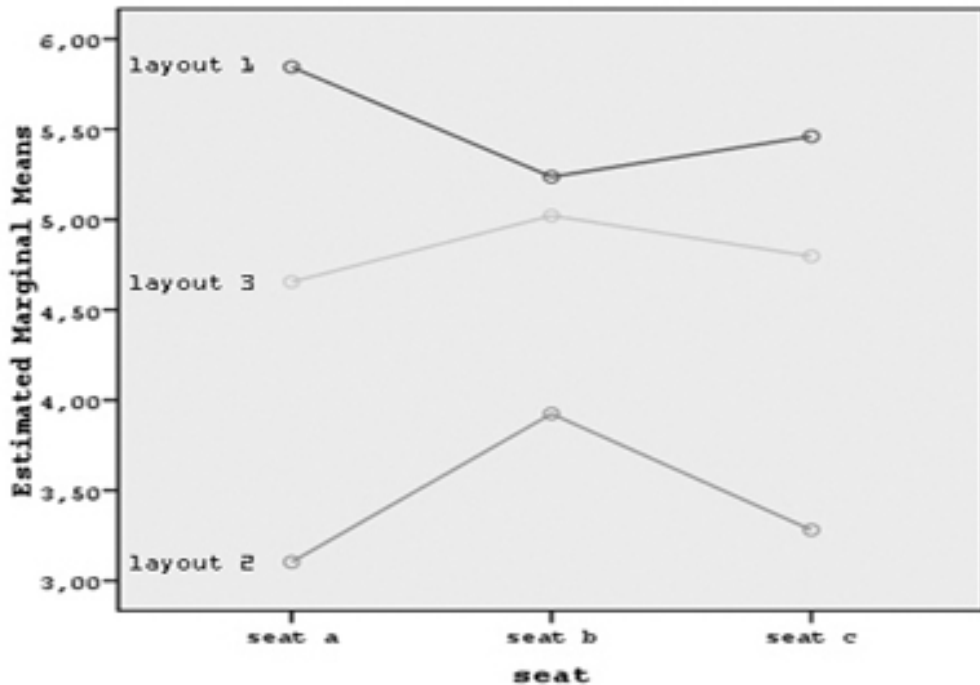

Figure D.4 Estimated marginal means of score for enclosedness

APPENDIX D-5

ANALYSIS FOR THE POTENCY FACTOR

Table D.5 Tests of between-subjects effects for potency

Dependent Variable: score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
seat	2,861	2	1,430	1,062	,346
layout	21,187	2	10,594	7,869	,000
seat * layout	5,260	4	1,315	,977	,419
Error	1114,697	828	1,346		
Total	15259,000	837			
Corrected Total	1145,536	836			

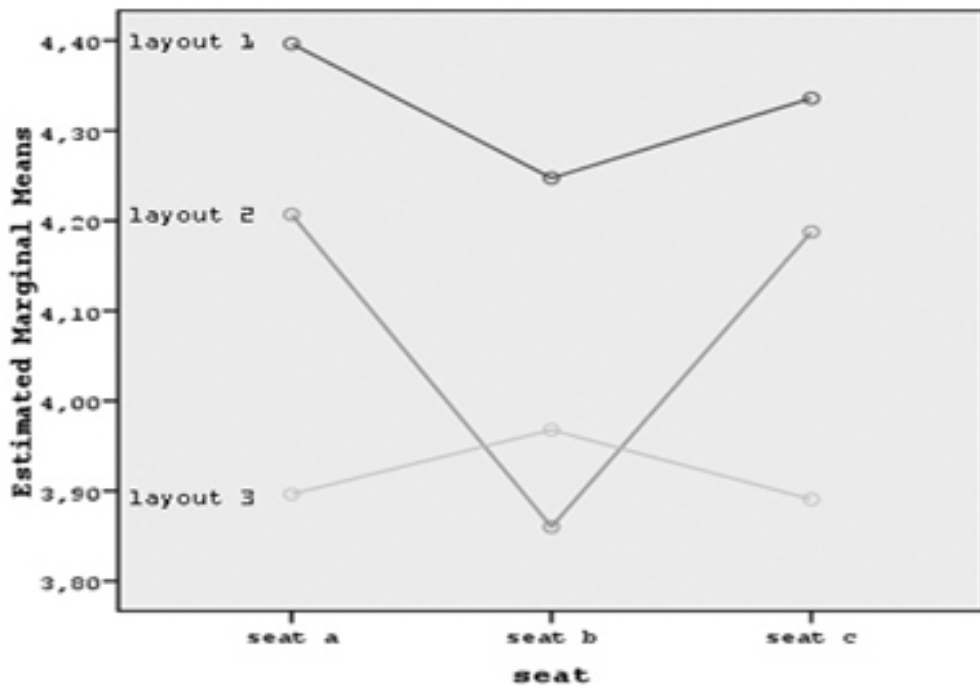a R Squared = ,027 (Adjusted R Squared = ,018)

Figure D.5 Estimated marginal means of score for potency

APPENDIX D-6

ANALYSIS FOR THE SOCIAL STATUS FACTOR

Table D.6 Tests of between-subjects effects for social status

Dependent Variable: score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
seat	20,001	2	10,000	6,090	,002
layout	88,767	2	44,384	27,028	,000
seat * layout	5,776	4	1,444	,879	,476
Error	1359,700	828	1,642		
Total	13878,000	837			
Corrected Total	1475,032	836			

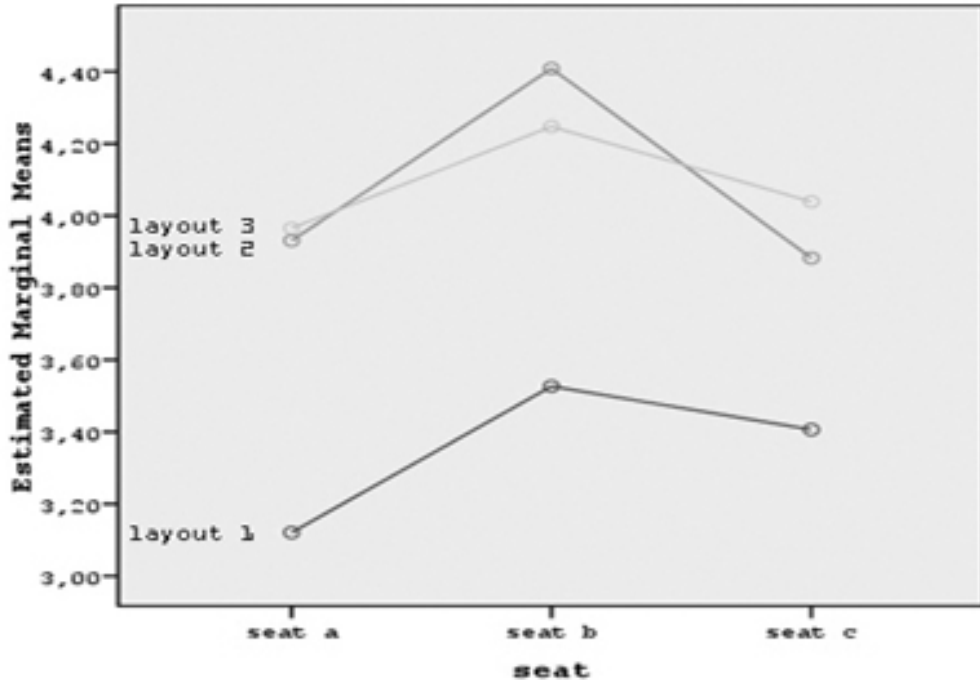a R Squared = ,078 (Adjusted R Squared = ,069)

Figure D.6 Estimated marginal means of score for social status

APPENDIX D-7

ANALYSIS FOR THE AFFECTION FACTOR

Table D.7 Tests of between-subjects effects for affection

Dependent Variable: score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
seat	12,431	2	6,215	2,568	,077
layout	125,108	2	62,554	25,844	,000
seat * layout	38,942	4	9,735	4,022	,003
Error	2004,133	828	2,420		
Total	18540,000	837			
Corrected Total	2183,967	836			

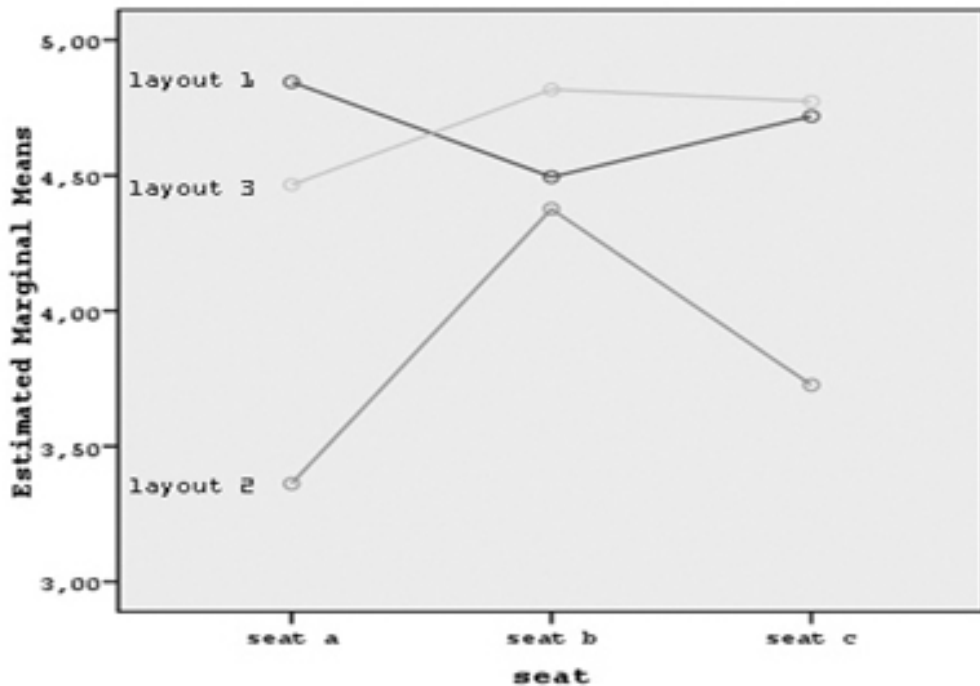a R Squared = ,082 (Adjusted R Squared = ,073)

Figure D.7 Estimated marginal means of score for affection

APPENDIX D-8

ANALYSIS FOR THE ORIGINALITY FACTOR

Table D.8 Tests of between-subjects effects for originality

Dependent Variable: score

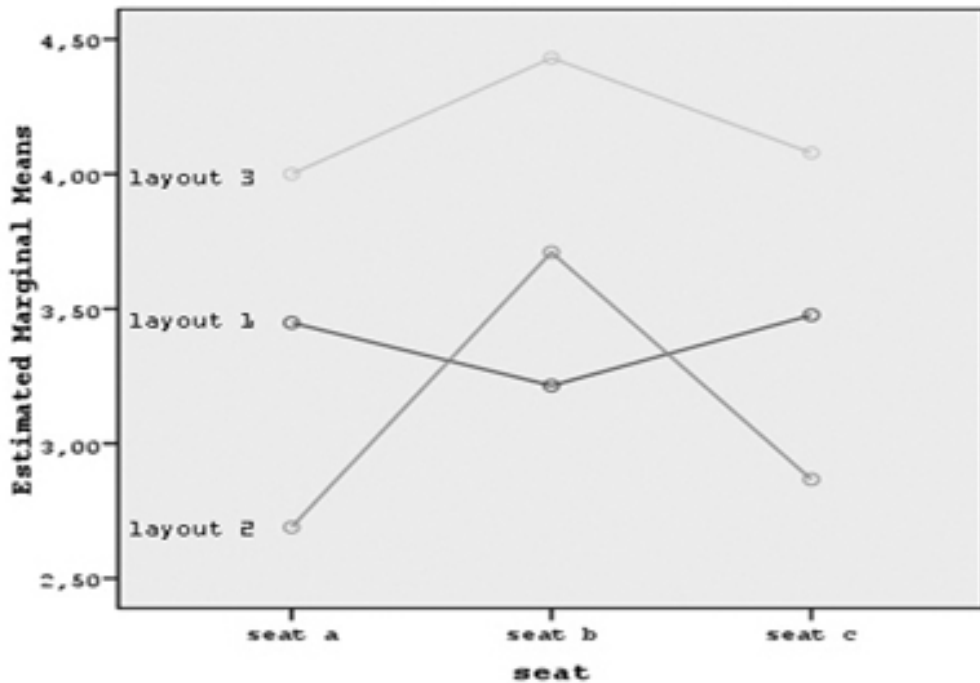| Source	Type III Sum of Squares	df	Mean Square	F	Sig.
seat	22,638	2	11,319	4,757	,009
layout	157,145	2	78,573	33,019	,000
seat * layout	41,616	4	10,404	4,372	,002
Error	1970,305	828	2,380		
Total	12802,000	837			
Corrected Total	2206,440	836			

a R Squared = ,107 (Adjusted R Squared = ,098)

Figure D.8 Estimated marginal means of score for originality