Chapter 3 Research Methods

Chapter 3 presents all the primary research methods employed to collect and analyse data in this research. The tools used to formulate and validate a conceptual model will be explained in detail in chapter 5 and 6. The primary research aims to answer objectives no. 3 – 6 (see figure 3.1). The process employed to select the appropriate primary research methods comprises of four steps. Firstly, objectives no. 3 - 6 were analysed. Secondly, their key issues were defined (figure 3.1). Thirdly, each primary research method was selected for every key issue according to the specialities. Finally, all research was planned and executed.

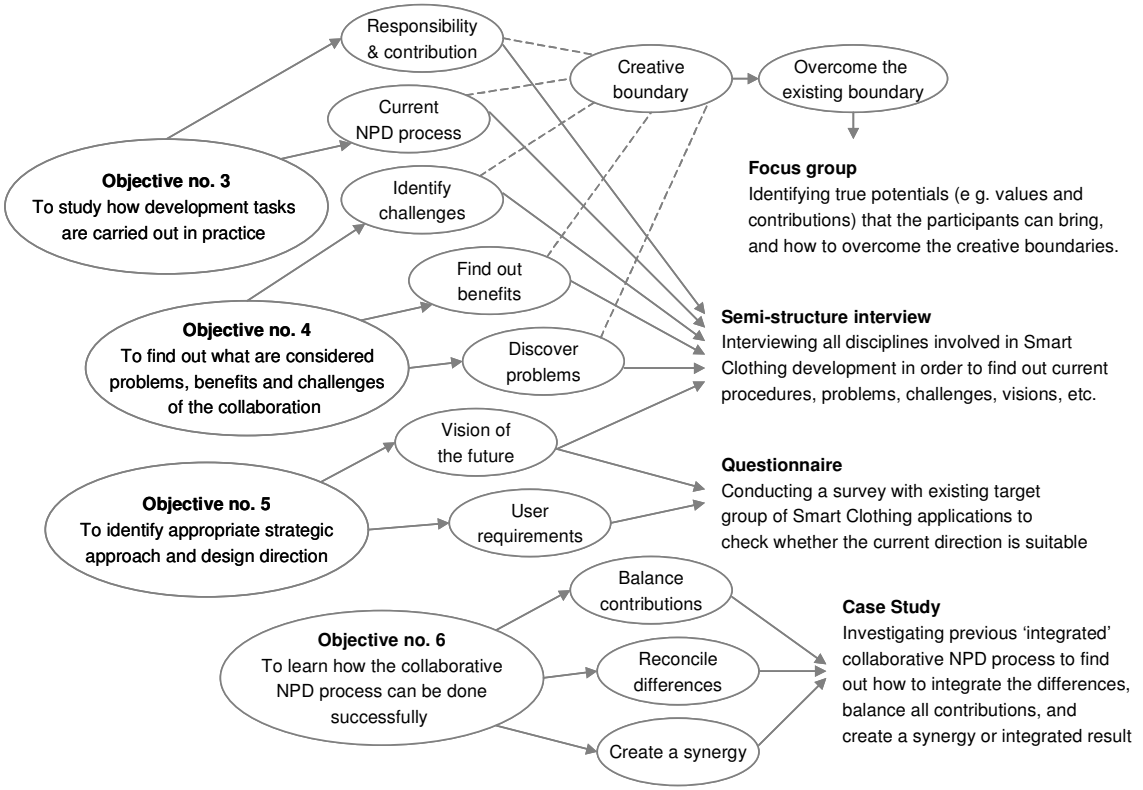

Figure 3.1: Diagram presenting key issues addressed in objectives 3 - 6

According to the diagram, objective no. 3 addresses two key aspects: 1) NPD processes

that development teams employed, and 2) responsibilities and contributions that each participant provided in order to identify the creative boundaries, which, in this case, refers to established ways of thinking or creative methods that each participant used. Although identifying the existing creative boundary is not part of the objective, this area needs to be investigated because the literature review (see Tidd, 1995; Sonnenwald, 1996 for example) indicates that it is one of the main challenges and problems that prevent the development teams from achieving a high level of collaboration and an integrated outcome.

Objective no. 4 comprises of three issues: 1) main problems, 2) key benefits, and 3) major challenges of this collaboration. Objective no. 5 consists of two topics: 1) visions of the future, and 2) user requirements. Objective no. 6 aims to discover practical methods to balance contributions of all disciplines, reconcile the differences among the participants, and create an integrated outcome. After all issues in each objective were identified, the research methods were selected accordingly. A semi-structured interview was chosen to gain an in-depth understanding about the NPD processes, work procedures, responsibilities and contributions of each discipline, ways of thinking, main problems, key benefits, major challenges of Smart Clothing development, and future design directions that the developers envisioned. This research method was chosen to study these areas because it allows the respondents to describe what is important for them, and ensures that all crucial topics are covered (Bell, 2000; Flick, 2002). Thus, the richness of the cultural issues can be examined.

The questionnaire was employed to explore consumer aspects, such as vision of the future lifestyle and user requirements, because the research needed sufficient quantitative data in terms of consumer needs to verify whether the new strategies and design approaches are

appropriate. Case study was used to examine previous successful 'integrated' projects in other fields. This was because none of existing Smart Clothing projects was considered successful. Firstly, garment design and electronic engineering to date were still separate. Secondly, none of them were commercially successful in the mass market. Lastly, the outcomes did not provide extra value from the user point of view. By investigating similar collaborative projects that were able to integrate fashion design and high technology successfully, the researcher could find out how to solve the problems that Smart Clothing development currently faces, such as balancing different contributions. In this way, the knowledge from previous projects could be transferred to Smart Clothing development.

The focus group approach concentrated on the true benefits that each discipline could bring to the development team in order to utilise and/or incorporate them into the process or product. Moreover, it investigated how to break though the creative boundary successfully. This method was selected because of its strength in 1) exploration and discovery, 2) context and depth, and 3) interpretation. Morgan (1998b) explains that focus groups provide an insight into topics that are poorly understood. Moreover, the author states that a process of *'sharing and comparing'* information among the participants from similar backgrounds in a group discussion produces large amounts of concentrated data about a chosen topic, which, in this case, are what the major design contributors think of Smart Clothes, what values and contributions each member can bring, and how to overcome the boundaries.

There were certain overlaps in terms of the research methods and key issues (see figure 3.2). For example, both the interview and questionnaire aimed to identify new directions. Whilst the interviews concentrated on what the developers envision, the questionnaires focused on

user opinions. In this way, the visions from all stakeholders were covered.

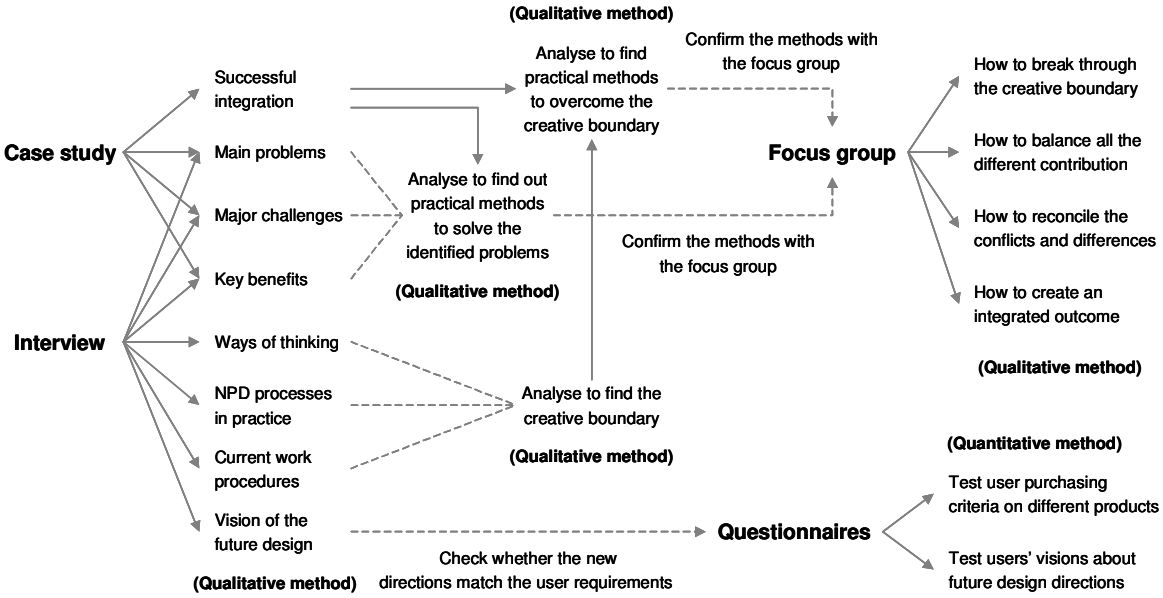

Figure 3.2 Diagram demonstrating structure of primary research

3.1 Semi-structured Interviews

Aims: This primary research aimed to confirm and gain an in-depth understanding about the key issues identified from the literature review. Thus, it studied the following four areas:

1. Collaborative NPD processes that Smart Clothing developers used in practice
2. Responsibilities and contributions required from each discipline
3. Problems and challenges that the development teams encountered
4. Personal opinions about the future design direction of Smart Clothing

Subjects: Since it was important to understand every type of discipline involved, the interviewees were selected based on their expertise, responsibility and organisation (see table 3.1). The criteria used to select the interviewees are shown as follows:

1. The interviewees must represent the key disciplines involved in Smart Clothing development. According to the literature review, the key disciplines are:

- **Designer manager**: This discipline is responsible for developing strategic plans and design specifications, and managing designs. However, the development plan and design specification are generally a consensus decision of the whole team.
- **Intelligent textile scientist**: This discipline is responsible for sourcing out the technical textiles and applying them according to the specifications in terms of physical appearance and technical properties based on specific functions required.
- **Electronics engineer**: This discipline is responsible for developing electronic components according to design specifications and specific functions. In this case, the electronic components include both software and hardware systems.
- **Smart Clothing designer**: This discipline is responsible for creating design concepts and producing prototypes. In many cases, this work was carried out by a fashion designer and/or a product designer. Thus, the interviews are conducted with a Smart Clothing designer, a fashion designer, and a product designer.
- **Intelligent textile designer**: Although this discipline is not currently involved in the Smart Clothing project, there is a potential need for this expertise. This person would be responsible for developing designs and prototypes of the Smart textiles.
- **Future trend researcher**: At present, this discipline is not involved in the Smart Clothing development project. However, since Smart Clothing is looking into the future, this discipline is potentially required in the development team. This person is responsible for conducting user and market research, and predicting the future trends in terms of design directions, new technologies and changes in the society.

2. The interviewees are the members of Smart Clothes development teams or potential developers. As they are potential users of the new strategy and NPD model, it is important to address their requirements in order to ensure the usefulness of the model.

3. The interviewees were chosen based on the project in which they were involved, in order to investigate varied work methods and opinions of Smart Clothing developers.
4. It is preferable if the interviewees have previous work experience in the electronic or clothing industries. Consequently, they can compare the conventional NPD processes used in electronics and apparel industries and those of Smart Clothing field.
5. It is also preferable if the interviewees have conducted and published research papers in the Smart Clothing field or if the applications they developed are available in the market.

Further interviews with the professionals in related fields, namely sportswear and fashion accessory, were conducted, since their areas are of interest to Smart Clothing developers.

Table 3.1: Profiles of each interviewee

Expertise	**Profile of the Interviewees**
Design manager	• This person is a design manager of an international electronic product company. • He is responsible for managing the interdisciplinary product development team called Industrial Design Human Factor (IDHF), and the new product design and development.
Fashion designer	• This person has work experience as a fashion curator for the British Council. • She was a former course director of MA Fashion at one of the leading design universities. • At present, she is a senior research fellow at a leading school of fashion and textile design. • She currently involves in several research projects in the Smart Clothing field.
Product designer	• This person has five years experience as a product designer with two international awards. • She was a former Product Design lecturer at one of the leading design universities. • She has involved in many electronic product development projects with the international electronic product companies, such as Hewlett-Packard Korea.
Smart Clothing designer	• This person has developed several technical clothes for professional and amateur athletes. • He has been involving in technical clothing and Smart Clothing development since 1998. • The applications developed by his team have been available in the market since 2001.
Intelligent textile designer	• This person has been working as a textile designer and project manager in the R&D sector since 1998. She is responsible for new production fields, e.g., sound-insulating fabric. • Her current project is optical fibre that can transmit data, and a textile circuit board.

Expertise	Profile of the Interviewees
Electronic engineer	• This person has four years work experience with a pioneer in the Smart Clothing field. • He involved in several collaborative projects between electronic and apparel companies. • Many applications developed by his team have been available in the market since 2000.
Future trend researcher	• This person works in one of the UK biggest research and strategy consultancies. • She conducted future trend researches for several international electronic product companies in many countries. Her work focuses on a new design direction of the product.
Intelligent textile technicians (2 persons)	• They are senior researchers at the Fibre Material Science at one of the leading university. • They set up the 'SmartWearLab' and a network for Smart Clothing developments. • They have conducted many basic and applied research and product developments in the intelligent textiles and Smart Clothing field, such as the intelligent textile survey. • Their current Smart Clothing research project is a protective garment for the fireman.
Sportswear Educator	• This person has eight years experience as a Programme Leader of MA Performance Sportswear, which has a strong connection with international sportswear companies. • She is an expert in technical textile & functional clothing with fashion design background. • Currently, she is a project director of a Smart Clothes and Wearable Technology network.
Product Management	• This person is a member of the product management team in a fashion watch company, which is responsible for benchmarking, competitor analysis, and future trend research. • The product management team is also responsible for product line development.

Materials: The same set of questions was used in every interview in order to ensure consistency. These questions can be divided into four groups as follows:

1. **Interviewee's profile:** All the interviewees were asked to describe their educational backgrounds, expertise, work procedures, previous and current jobs, and roles and responsibilities within their organisations and product development teams.
2. **The current development team:** The interviewees were questioned about their development team, such as what type of disciplines involved, what were the role and responsibility that each member had, and how their team communicated or exchanged ideas, and the NPD processes they currently employed. Moreover, the interviewees were asked to identify the main problems and challenges of their current projects.

3. **Opinion on working practice:** All interviewees were asked to compare their responsibilities and expertises with other disciplines in related areas. For instance, the product designer was asked to contrast product design with fashion design. If the interviewees had the experiences in both Smart Clothing development and electronic or conventional clothing development, they would be asked to identify the similarities and differences between these two NPD processes.
4. **Opinion on the future of Smart Clothing:** All interviewees were questioned about how they anticipated the future and what would be the appropriate direction for Smart Clothing in the future. In addition, they described their ideal development teams.

Procedure: Four interviews were carried out via the internet, and seven interviews were conducted face-to-face. The responses were tape-recorded, transcribed, sorted out according to the topics, and prepared for the qualitative analysis in the next stage.

3.2 Case Study

Aims: The research focuses on previous successful 'integrated' projects to identify:

1. Practical methods to achieve equal contributions from all participants.
2. Practical methods to overcome the creative constraints and create a synergic result.
3. Practical methods to reconcile the differences and achieve a successful integration of fashion design and electronic technology.

Subjects: The projects were selected based on the similarity of their approach compared to Smart Clothing development. In this way, the knowledge from the previous projects could be compared and transferred. Due to the design focus, visual and verbal evidence was

analysed. Performance Sportswear and Smart Car were selected, as they met all criteria set out below. In this case, 'Performance Sportswear' refers to sportswear designed to enhance the physical performance of the athletes. Nike's NPD process was frequently used as an example due to the sufficient data in terms of the NPD process, product strategy, and product development team. Nevertheless, this research investigated the Performance Sportswear's NPD process as a whole, and was not confined to only Nike's NPD process.

Criteria no. 1: *'The project is a collaboration of advanced technology and fashion design.'* Since the participants come from two opposing backgrounds, which have two different cultures and two different work procedures, methods employed to overcome the creative barrier and develop a 'shared' process can be investigated and transferred.
Performance Sportswear: Sportswear product development is a collaboration of fashion design and high technologies. For example, Nike's product development involves many disciplines from different areas, such as scientists from Physiology, Biomechanics and Sensory/Perception, a product design team, and material technicians (Nike, 2003).
Smart Car: Originally, the Smart Car development project was a collaboration of the fashion watch company, SMH (producer of Swatch), and the car company with advanced technologies, Mercedes Benz AG. Although, Smart Car was 100 percent taken over by Mercedes Benz AG in 1998, the input from Swatch remains its chief influence.

Criteria no. 2: *'The outcome represents a synergy of fashion design and advanced technology.'* The output should be different from their parents' mainstreams products in terms of physical appearance and product concept. Thus, the means, which were employed to go beyond their current creative boundaries, can be explored and transferred.

Performance Sportswear: O'Mahony and Braddock (2002) stress that a sportswear product is a convergence of fashion design and high technology. Moreover, sportswear must be positioned differently from the apparel or high-tech products because they have their own image and identity, otherwise they will lose their values (Vanderbilt, 1998).
Smart Car: The design of Smart Car is considered a convergence of fashion design and advanced technology, as it represents a new concept of vehicle design – that is: a mass-customised and environmentally friendly car. Van Hoek, and Weken (2000) comment that the advanced technologies, such as fully recyclable components, and innovative design, such as modular concept, differentiate it from the small cars of the other brands.

Criteria no. 3: *'The outcome demonstrates equality of contributions.'* The contributions from each partner must be clearly expressed. Moreover, the differences of the participants are regarded as the key benefit. In this way, all contributions are optimally balanced.
Performance Sportswear: Sportswear demonstrates the contributions from all participants involved. For products like Nike Air and Nike Shox, attractive design and high technologies are perceived as equally important. Moreover, Vanderbilt (1998) emphasizes the importance of technology and design at Nike: *'Nike has doubled its design staff and tripled its research and development budget since 1995.'*
Smart Car: Smart Car illustrates the equal contributions, as Corter (1995) says *'the car's comfort, security and quality reflect Mercedes' traditional high-end values. Its originality and affordability, though, mirror the innovative splash and low cost of Swatch watches.'* In addition, it represents the sharing of brand values from both partners (Lillford, 2003).

Criteria no. 4: The outcomes must be feasible and able to attract the mass market, since

satisfying the customers and making profits are the main reasons of the collaboration and the key factors to judge the success (Littler, Leverick and Bruce, 1995).

Performance Sportswear: Sportswear is successful commercially and attracts wide audiences, as O'Mahony and Braddock (2002) report *' the sports industry in America was bigger than motion picture, radio, television and education service combined.'* Moreover, recently, sportswear product is of interest to the Smart Clothing developers.

Smart Car: Smart Car has proved to be commercial and attracts a global target audience. The cars are sold in more than 20 countries and product lines continually extend. Daimler Chrysler (2003) states that in 2003 Smart Car's sales rose by five percent to 12,300 vehicles.

Material: The information concerning the two cases was obtained through a literature research and supported by four interviews. The literature research on performance sportswear covered design theories, strategies, NPD process and sportswear companies. The information about the Smart Car, which covers the developers, the design strategies employed, collaborative NPD process and Smart Car company, was gained from Micro Compact Car (MCC), the producer of Smart Car. This included the documents provided by Smart Info Centre and its website. Further information was obtained from two papers:

1. SMART (car) and smart logistic: A case study in designing and managing an innovative de-integrated supply chain (Van Hoek, and Weken, 2000)
2. Master of Art dissertation, Brunel University – Building Creative Collaborations: Enriching the Collaboration Innovation Process through Design and Branding Strategy (Lillford, 2003): The information includes three interviews conducted with 1) the Head of logistics at Cranfield University who had studied the Smart venture, 2) a Smart brand manager, and 3) a Smart product marketer.

Procedures: Semi-structured interviews were conducted with two sportswear design educators, one sportswear design researcher and one personnel of Swatch Product Management Department. The interview with the manager from Swatch focused on its product development approach. The same set of questions was used for every interview to ensure consistency. The interview structure is shown below:

1. Role and responsibility of the interviewees within the companies
2. Description of the product development team and the NPD process
3. Challenges and problems in bringing together fashion design and high technology
4. Methods employed to achieve equal contributions from all the participants
5. Methods employed to integrate the differences among all participants
6. Methods employed to overcome the creative boundary of each discipline
7. Methods to optimise the true potentials of every participant to create a synergy

Literatures and interview responses were collected. All interviews were tape-recorded and transcribed. Comparisons were conducted in order to find out the similarities and differences between these examples. As a result, the key factors influencing a successful collaborative product development were identified. The qualitative analysis tool called the 'Grounded Theory' was employed to analyse and interpret the data. Finally, practical methods that were used to 1) achieve balanced contributions, 2) integrate the differences, 3) break through the creative boundary, and 4) generate a synergy were deduced.

3.3 Questionnaire

Aims: The questionnaire aims to identify three key issues:

1. Gaining an understanding about consumer perceptions, personality and lifestyle of the

specific group in order to produce a profile of Smart Clothing potential users.

2. Identifying purchasing criteria of electronic devices, fashion clothes and sportswear products and finding out if there is any relationship between these criteria. Sportswear products, a combination of fashionable design, serious function and high technology, were chosen in order to investigate whether their position is appropriate for Smart Clothes. Moreover, Smart Clothing developers are interested in sportswear, as many interviewees recommended carrying out user research with this product.
3. Obtaining consumer visions of future lifestyles and comparing with the vision of the developers in order to check if the existing scenario is still appropriate for this group.

Hypotheses: In this case, there were two experimental predictions. Firstly, it was predicted (two-tailed prediction) that there would be an association between product categories and purchasing criteria of the consumers. Secondly, it was predicted (two-tailed prediction) that there would be a significant difference between the purchasing criteria of three different products. In this research, there was only one independent variable: product categories.

Participants: Potential users of existing Smart Clothes, identified by the developers, were chosen as the targets of this questionnaire survey because of two main reasons. Firstly, this research could bring about better understanding of the target users in terms of personality, desirable lifestyle, purchasing criteria of related products, etc, which could help the developers improve their design and commercialisation of existing applications. Secondly, the literature review and the interviews revealed that these existing targets still had strong potential as early adopters of Smart Clothing application. The potential users, described by Smart Clothing developers, were rather broad, as they included several groups of people

with different demographic backgrounds, e.g. elderly people, soldiers, intensive-care patients, etc. In this case, the most common targets usually described as young and design-conscious individuals who were interested in advanced technology (Van Heerden, Mama and Eves, 2000; LUNAR Design, 2001; Mori, 2002) were chosen as an example. The respondents were randomly selected from design students at Brunel and other London universities (age between 16-35), as they were interested in design and new technologies, and often exposed to innovative products. The proportion of the respondents is:

Table 3.2: Age groups of the questionnaire respondents

Age group	**16-20**	**21-25**	**26-30**	**31-35**	**Total**
Number of respondents	15	28	18	9	70
Percentage	21.4%	40.0%	25.7%	12.9%	100

Material: The questionnaire was designed according to the three key issues it addressed (see Appendix A). Thus, the questions could be divided into three groups as follows:

1. **User Profile**: This set of questions included demographic and personal information, e.g. personality, personal interest, desirable product and role model. The eight personalities, used as alternatives, were those identified in the interviews with chosen developers.
2. **Purchasing criteria of electronic, apparel and sportswear products**: Eight leading brands of mobile phones, high-street fashion retailers and sport shoes were chosen to represent these three categories because the respondents are familiar with these products. In this case, the high-street fashion retailers selected offered both male and female ranges; therefore, the same questionnaire could be used with both genders. The respondents were questioned about their favourite brand, the frequency of their purchasing, and the main reason that they chose or rejected a particular brand/model.

3. **Vision of the future**: Eight scenarios of future lifestyles were selected from:
    - The key trends identified by leading research consultancies. For instance, Seymour Powell Foresight (2003) produces the 'Trends Overview' including all the major trends, such as health consciousness, risk consciousness, etc.
    - The visions of leading companies. For example, Samsung envisions that, in the future, data can be automatically transferred from one device to another without the user's awareness (An *et al*, 2003). This way, a personal data assistant updates appointments and address books daily by communicating to with a computer.
    - The opportunities identified by the developers, e.g. crime prevention (Lee and Stead, 2001) and pollution protection (Van Heerden, Mama and Eves, 2000).
    - The future scenarios developed by researchers in academic institutes. For example, Pantzar (2000) investigates future consumption and illustrates many scenarios, e.g. people will learn, work and shop at homes, which have intelligent systems, or become computer-dependent and are always connected to entertainment devices.

    The scenarios that were shared by many sources were used to form the alternatives for the respondents to choose in order to see how the consumers anticipate the future.

Most of the questions were in multiple-choice form, and images were used wherever they were required to make each multiple choice as comprehensible as possible (see Appendix A). The results were sorted and assessed with computer software, SPSS, which is specialised in statistical calculation. Finally, conclusions about consumer profile, user requirements, purchasing criteria and the consumer's vision of future lifestyle are deduced.

Focus group

Morgan (1998a) states that conducting focus groups consists of four basic steps: 1) planning, 2) recruiting, 3) moderating, and 4) analysing and reporting. However, this section only describes how it is planned and conducted, and how participants are recruited.

Aims: There were three objectives that the focus group aimed to fulfil:

1. To obtain personal opinions from the major design contributors of Smart Clothing development, which are the fashion and product designers, about appropriate design directions of future applications and how these design approaches should be implemented. This is to reconfirm the results from the interviews and questionnaires.
2. To discover the true potential of each discipline. Thus, it investigated the values and contributions that each discipline could bring to the collaboration, and how to optimise the values and contributions in order to make the most of the multidisciplinary team.
3. Identify practical methods that the major design contributors, namely fashion and product designers, employ to break through their existing creative boundaries.

Subjects: In this research, there were two types of the focus groups.

1. The first type was an extended study of the previous research; therefore, its structure and questions were developed based on the findings of the interviews and questionnaires. Nonetheless, its topics of discussion were more specific than the interview's, as the focus groups aimed to discover, not only precise design directions and true potentials that the major design contributors could bring to the teams, but also how these approaches and values could be implemented in practice. As a result, one

focus group was conducted with five product designers and another was carried out with five fashion designers. Although, the interviewees also included product and fashion designers, the criteria to select the interviewees and focus group respondents, as well as the outcomes expected from these two researches, were different. While the interviewees must have some work experience in Smart Clothing research and developments or related fields, the focus group respondents needed not to have any experience or be aware of Smart Clothing. As a result, the researcher was able to gain insightful opinions from the 'insiders' and the fresh ideas of the 'outsiders'. The samples of each group were a mixture of three design researchers and two professional designers. Consequently, the researcher was able to gain both academic and industrial viewpoints, especially in relation to how they collaborate with other designers.

2. In order to gain a broad range of ideas on how different disciplines go beyond their creative boundary, the second focus group (see table 3.3) was conducted with five participants, which were selected from varied areas and not restricted to the product and fashion design fields, for example architecture and automation. These participants were selected as they had an experience of working in a project that was entirely different from their established professional backgrounds (see figure 3.3), and they were able to discuss the methods they used to break through their creative boundary.

Table 3.3: Profiles of all the participants in the second type of the focus groups

Educational background	**Work experience**	**Current project**
Industrial design	Product designer	Researching and developing a brand for craft products
Graphic design	Graphic designer	Researching and developing a design policy for a fashion city focusing on creating a fashion culture
Architecture	Architect and photographer	Researching and developing a brand for furniture and home decorative items made from natural materials

Educational background	Work experience	Current project
Automation and computing	-	Researching and developing an emotional brand experience for high-street fashion retailers' websites
Business and marketing	-	Researching and developing new methods to enrich brand experience in food and beverage retails

To summarise, there were three focus groups conducted in this research as shown below.

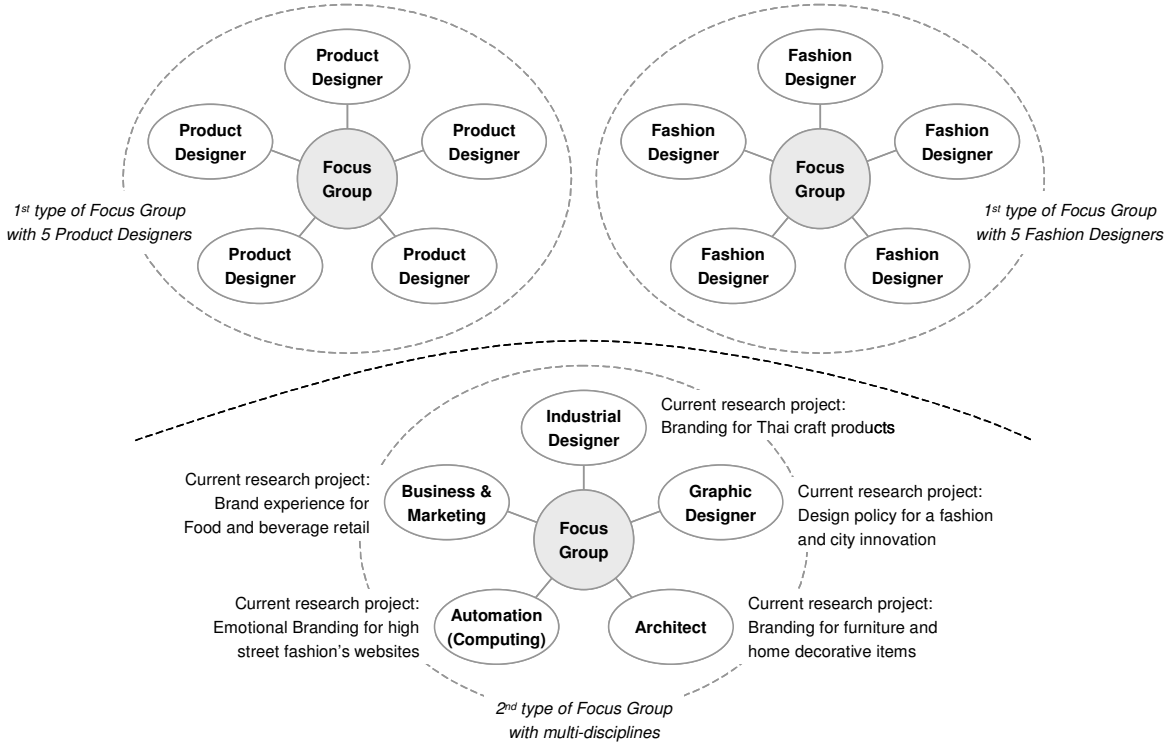

Figure 3.3: Diagram demonstrating three focus groups conducted in this research

Materials: The topics of discussion were different according to the different types of the focus groups and the different outcomes expected from each group as shown below.

1. The focus groups conducted with five product designers and five fashion designers aimed to identify the true benefits that they could bring to the collaboration. Therefore, the discussion concentrated on core values of the product or fashion design and how these values could be addressed successfully in the collaboration.
   - What are the core values of product or fashion design?

- What do you generally contribute in a collaborative project?
- When you approach a collaborative project like Smart Clothing:
    a. Do you bring your own set of values and process to this project? If so, how?
    b. Do you work differently, as this project requires a different set of values and work procedure? If so, how?
- If you are a lead designer of a Smart Clothing development project, which design direction will you take and why?

2. The focus group, that was conducted with mixed disciplines, aimed to identify three issues: 1) how different disciplines adapt their approaches and procedures when encountering a project that is different from their background and work experience; 2) the similarities and differences between the approach and work methods these disciplines employed in their regular projects and the project that is different from their background and work experience; and 3) how different disciplines go beyond their creative boundary. As a results, the topics of discussion in this focus group were:
    - What are the core values of your field?
    - Please describe your work procedure briefly.
    - How do you approach a project which is different from your background?
        a. Do you bring your own set of values and process to this research? If so, how?
        b. Do you work differently because this research requires a different set of values and work procedure? If so, how?
    - How do you overcome the creative boundary?
    - If you are a leader of a Smart Clothing development project, which design direction will you take and why?

Procedure: Before starting each focus group, the researcher briefly introduced the subject area, Smart Clothing. Next, the researcher explained the purpose of the focus group and discussion topics. There were four to five topics in each focus group. After the discussion amongst the participants about the topic, the researcher summarised all the key issues and agreements made. Each focus group took approximately one hour to complete. All discussions were recorded and transcribed with a view to analysis in the next stage.

The researcher made sure that each design direction suggested by the participants was clearly explained with an example of its implementation. The ideas shared among these groups are deduced and described in detail, as they represent promising design directions with potential market and feasible production. Nevertheless, these design directions must match the user's profile and requirements identified from the questionnaire survey. In this way, the findings from quantitative and qualitative research are integrated. In addition, the values and contributions, that the designers suggested that they could bring, must be feasible to address in the process and provide commercial benefits to the collaboration. Furthermore, every method advised by the respondents to break through the creative boundary must reach a consensus agreement of all participants. In this way, each method was proved to be practical not only for one discipline but also for the participants from different areas. However, these ideas must be compared with other methods identified from the case studies. Lastly, practical methods to overcome the boundary were deduced.

3.5 Analytical Methods

There are two types of analytical methods employed in this research (see figure 3.4).

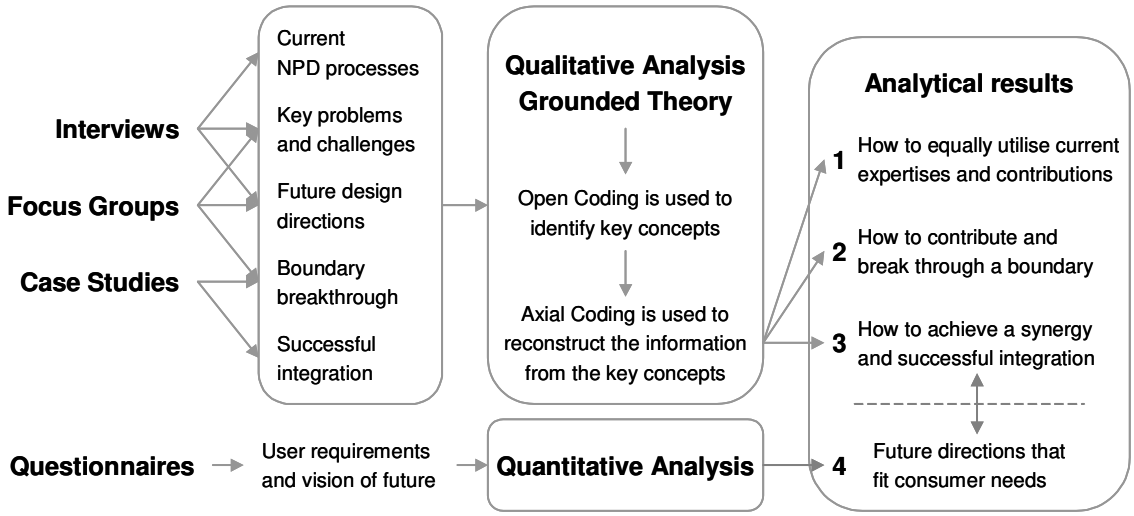

Figure 3.4: Diagram showing relationships between information and analytical methods

Firstly, quantitative analysis was employed to examine questionnaire findings and this method consisted of five stages as followings:

1. Sorting the results into different tables and checking frequencies of the data in order to identify which alternative achieved the highest score for each question.
2. Studying the data about the target's personality in order to generate a new user profile and then comparing it to an existing one created by Smart Clothing developers.
3. Identifying key factors affecting the purchasing criteria of three different products by listing three alternatives that achieved the highest score in each category.
4. Discovering relationships between purchasing criteria and product types through the use of statistical non-parametric tests. Firstly, a chi-square test assessed the (two-tailed) prediction that there would be an association between product types and purchasing criteria. Secondly, a wilcoxon test assessed another (two-tailed) prediction that there would be a significant difference between the purchasing criteria of different products.
5. Reviewing the data to find out the consumers' vision of future lifestyle and comparing it to the existing scenario to identify similarities and contrast differences.

Secondly, the qualitative analysis tool called 'Grounded Theory Analysis' was used to interpret information from the interviews, case studies and focus groups. Grounded theory analysis deconstructs the information into categories in order to extrapolate the key issues, which are then reconstructed to provide a new meaning to the information. Lastly, all analytical results are integrated to provide a basis for a conceptual model formulation.

3.5.1 Grounded Theory Analysis

The grounded theory was employed to analyse the information collected from the interviews, case studies and focus groups. This method was selected due to its appropriateness for qualitative research analysis. The result of grounded theory analysis represents the '*Studied Phenomenon,*' which is the circumstance that the research aimed to understand. For example, the studied phenomenon of the case studies included: 1) how to achieve equal contributions from all participants, 2) how to overcome the creative constraints and create a synergic result, and 3) how to reconcile the differences and achieve a successful integration of fashion design and electronic technology. The main activity of this method is coding, which is divided into three types: open coding, axial coding and selective coding. In this research, only open coding and axial coding were employed.

Open Coding: Strauss and Corbin (1990) describes open coding as *'the process of breaking down, examining, comparing, conceptualising, and categorising data.'* The procedure used in this research can be divided into five steps as follows.

1. **Preparation**: The notes and transcripts from the interviews, case studies and focus groups were examined several times in order to familiarise and further comprehend the responses. Moreover, particular attention was made to distinguish the different

tone of the respondents' voices. For example, highlighting was used for the information that a respondent frequently repeated and emphasised.

2. **Labelling phenomena**: This step broke down the data into small incidents, gave each 'incident' a name, and then reviewed each incident to ensure that similar incidents have the same name (see figure 3.5 and 3.6).
3. **Discovering categories**: The incidents identified were grouped into categories (see figure 3.6). For instance, the incidents named *defining user requirement clearly*, *defining design approach clearly* and *defining product function clearly* were grouped together, as they all aimed to define a product context.
4. **Naming a category**: The name that represents the data in the group was chosen (see figure 3.6). The name 'defining product context clearly' was chosen for this example category. In this case, 'product context' was referred as the nature of a particular product including *'the purpose or goal, the character of the product, and the environment in which the product performs'* (Krose, 2002). In other words, it includes all contexts related to a particular product, such as context of use and environmental context.
5. **Developing categories in terms of their properties and dimensions**: This step identifies the properties and dimensions of each category (see table 3.6). In this case, property is an attribute or characteristic of a category that can be dimensionalised. Using the category of 'colour' as an example, the properties are shade, intensity and hue, while the dimensions are varied intensity from high to low, and different hue from darker to lighter. In this research, the dimensionalising procedure, which breaks each property down into its dimension, is based on the interpretation of the description. For example, the state of shared risk and responsibility in the Smart Car project was described '*Mercedes, although they have the history in automotive, did*

not want the responsibility for the project on their board level, but instead shared the decision on the board of the new organisation' (Lillford, 2003). As a result, the researcher interpreted and gave 'Medium' as the dimensional range. However, this given dimension range was compared with the information from other sources in the same group before the final conclusion of the dimension range was drawn.

The transcript of the interview with the Sportswear Educator:
'We try not to have people that come just from fashion and textiles. We try to have product designers and industrial designers. One comes from sport science. Two are from sport marketing. People come from different backgrounds, but what holds them all together is a passion for designing things that have to function and part of function is to look good. Quite often these people coming from different backgrounds do have an opinion already about garments that work.'
Incident: mutual understanding of product context including function, appearance, materials, etc.

Figure 3.5: Example of labelling procedure

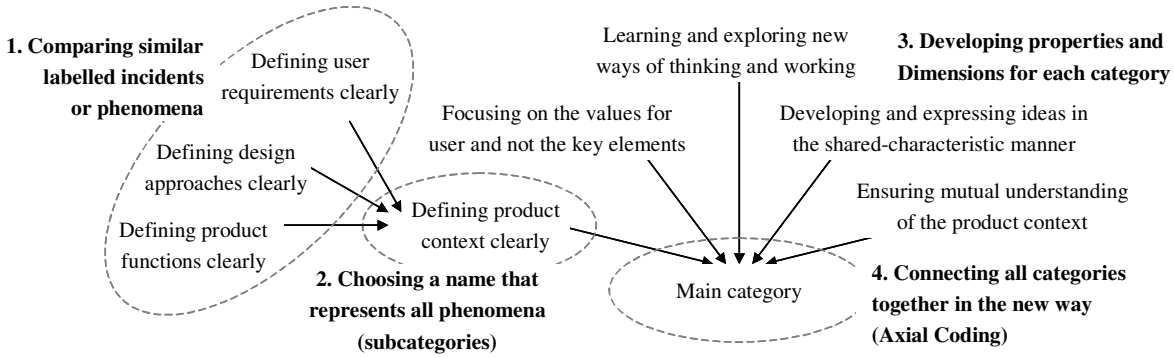

Figure 3.6: Example of discovering categories and naming categories

Table 3.4: Examples of properties and dimensional range within the categories

Category	Properties	Dimension
Balancing Multi-disciplinary Contributions	• Sharing goal and motivation among all participants (For example, Mercedes Benz and SMH shared the same vision of the car.)	High
	• Understanding other disciplines' approaches and working procedures	High
	• Embracing characteristics of all partners into an outcome equally (For example, Smart Car design embraced the characteristics of SMH and Mercedes Benz designs; therefore it had advantages of both partners.)	High

Category	Properties	Dimension
Overcoming the Creative Boundaries	• Defining context of the new product clearly	High
	• Ensuring mutual understanding of the new product's context	High
	• Defining expected contributions from all participants	High
	• Learning and exploring new way of thinking and working	High
	• Learning and incorporating other disciplines' approaches and process	High
	• Developing and presenting ideas in the shared-characteristic manner (For example, in sportswear design, high technology is expressed through fashion elements, such as pattern cutting and technical textile selecting.)	High
	• Focusing on the values for user and not the key elements of the product (For example, Swatch product development focuses on delivering its core value, "emotion", rather than the key elements, such as fashion design.)	High
	• Obtaining ideas and inspirations from other disciplines or other fields	High
Integrating the differences	• Establishing a goal and basis for collaborative product development	High
	• Sharing knowledge, resources and workspace (For example, SMH and Mercedes Benz formed a child organisation. In this way, the development team from both partners worked together.)	High
	• Embedding new cultures based on new product context into all parties (For example, the performance sportswear educators state that their courses embed the 'functional and practical approach' into their students.)	High

Axial Coding: Axial Coding is a procedure to put data back together in new way by making connections between categories (Strauss and Corbin, 1990). As a result, the subcategories are related to the main categories to create a 'story'. The relationships are presented in the 'Paradigm Model' (see figure 3.7), which includes six factors:

1. **Causal condition**: Incidents leading to occurrence or development of a phenomenon
2. **Phenomenon**: The central incident by which a set of actions/interactions are related
3. **Context**: The specific set of properties that belong to a phenomenon. Context represents the particular set of conditions within which the action/interactional strategies are taken
4. **Intervening Condition**: The conditions that facilitate or constrain the strategies taken
5. **Action/Interactional Strategies**: Strategies to manage or respond to a phenomenon

6. **Consequences**: Outcomes or results of action and interaction

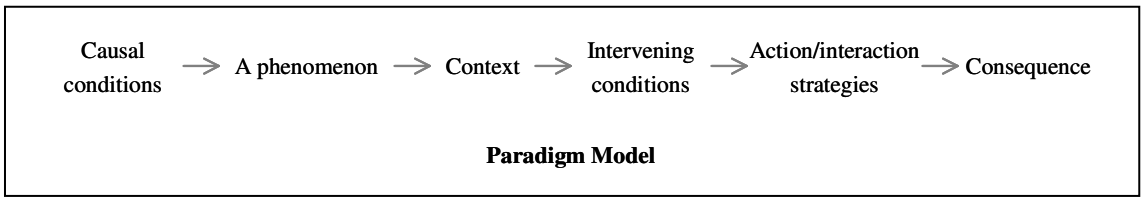

Figure 3.7: Paradigm Model presenting relationship of subcategories and main category

The categories, properties and dimensional ranges identified through open coding are examined in order to find out the relationship between them. The proposed relationships are examined and checked back several times to ensure that they are fully supported by the data. Finally, the proposed relationship of categories with properties and dimensional range are presented in the 'Paradigm Model' (see figure 3.8).

Causal condition →	**Phenomenon**	
Imbalance collaboration	Achieve integrated collaboration of fashion and technology	
Properties of integrated collaboration	**Specific Dimensional of Integrated Collaboration**	
- Shared goal and motivation	Clearly defined goal and objectives	High
	Clearly defined milestone and criteria to evaluate	High
- Shared goal and motivation	Mutual understanding the goal and criteria	High
	Well aware of the motivation to collaborate	High
- Clear understanding of other disciplines	Well aware of other discipline's capability	High
	Well aware of other discipline's work procedure	High
	Able to communicate and exchange ideas effectively	High
- Sharing characteristics of all participants	Developing design in a shared characteristic manner	High

Context of fully integrated collaboration

Under conditions where contributions of the collaboration are mainly from fashion design and high technology field and a fully integrated outcome is required, there is a need for a new framework for the team to work on and integrate the differences among participants in order to equalize contribution.

Strategies for Collaboration Management

1. Clearly defined context of the product	2. Mutual understanding of the product context
3. Clearly defined expected contributions of all parties	4. Explore new ways of thinking and working
5. Learn or understand how other disciplines work	6. Develop idea in a shared characteristic way
7. Focus on the value for user, not the key elements	8. Obtain ideas/inspiration from other disciplines

Context of fully integrated collaboration

9. Embed new cultures into all participants 10. Share knowledge, resources and workspace

11. Establish a basis for collaborative product development

Intervening Conditions

- For Smart Car, the consumer's latent needs were not recognised by the existing market at the time the car was developed. Therefore, it was difficult to define the product's context. Without a precisely defined context, it is difficult to specify expected contributions and responsibilities of each participant.
- For Sportswear, the product context is already established and all participants understand their roles and expected contributions; therefore, the collaboration has fewer problems.

Consequences

Although, both projects are able to deliver the integration of fashion design and advanced technology, the -degree of integration is different. Both projects achieve the states of 'Shared goal and motivation' and 'Clear understanding of all disciplines.' However, the Sportswear design has better achievement of the 'Shared characteristics', as every technology and function is expressed through fashion elements. This is due to the clearly defined product context and well-established framework for working and thinking.

Figure 3.8: Paradigm Model presenting result of this research

3.6 Conclusion

To conclude, the primary research investigated four key issues: 1) current work methods and ways of thinking of different disciplines involved in Smart Clothing development, 2) what were considered challenges, problems of Smart Clothing development and how to overcome them, 3) future design directions that fit consumer requirement and expectation, and 4) how to achieve successful integration between fashion design and high technology. To summarise, the primary research comprised of three qualitative tools; 1) semi-structured interview, 2) case study and 3) focus group; and one quantitative tool, the questionnaire. Each research tool has advantages and disadvantages as shown in table 3.5. The findings of the qualitative research were interpreted by grounded theory analysis, while the questionnaire results were analysed by the quantitative tool called the *'chi-square'* test and the *'wilcoxon'* test. At the end of the grounded theory analysis process,

three paradigm models representing three phenomena: 1) how to equally utilise current expertises and contributions, 2) how to break through the creative boundary whilst maintaining the core values of each expertise, and 3) how to achieve a successful integration and create a synergic outcome; were deduced. In addition, the future design directions were drawn from both quantitative and qualitative analysis. The results of primary research will be demonstrated and discussed in chapter 4, and then they will be used to form a basis for the conceptual model formulation explained in chapter 5.

Table 3.5: Advantages and disadvantages of each research methods

Method	**Advantages**	**Disadvantages**
Semi-structure interview	As it specialises in finding an in-depth information, detailed information about the NPD processes, teamwork, cultural issues, organisational aspects are covered.	It was difficult to find the interviewees in Smart Clothing field, since the area was new and most research and developments remained confidential or secret.
Questionnaire	Since the respondents needed not be aware of Smart Clothes, the information about general preferences were obtained and then used to form the new direction.	It was difficult to get response, especially from London inhabitants. Although the multiple-choice was easy to complete, it limited the ideas about future lifestyles.
Case study	Investigating previous successful 'integrated' projects provided an insight about appropriate methods to integrate fashion design and high technology and ways to organise the collaborative team.	However, these 'integrated' projects were rare and seldom gave sufficient details in terms of how they organised their teams, how both partners worked in collaboration, how they overcame conflicts and so on.
Focus groups	This method helped explore the research topics, as the group discussion generated concentrated data in short period of time. Furthermore, most ideas suggested were investigated in detail. For instance, when one respondent proposed an idea, the rest of the group discussed and examined it from many different viewpoints. Several unexpected issues had been identified through this research, e.g. sustainability.	Since most respondents were not familiar with Smart Clothing field, many of them hesitated to propose new ideas. Moreover, several ideas were not new or radical, as they were unaware of what already achieved. Although all respondents had experience of working in a team, most of them reported that they just split the brief and worked on their own. Thus, they could not suggest any means to collaborate.