A NEW PROCESS FOR CREATING DESIGN BRIEFS TO IMPROVE DESIGN INNOVATIONS IN HOME HEALTH CARE

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ABSTRACT

Many companies are exploring opportunities for improving Home Health Care (HHC) provision, at a time when the demand for well-designed home healthcare products (HHCPs) and associated services is rapidly growing. Research into their approaches found that innovation strategies and techniques adopted by many HHCP suppliers have not matured to realise the best innovative solutions.

This practice-based PhD thesis presents the research journey which investigated the strengths and weaknesses of product innovation approaches of small and medium sized enterprises (SMEs) which dominate the HHC field. It considers how to improve HHC product innovation by using more robust New Product Development (NPD) processes that aim at enabling more effective team working; improving information management; and establishing a better understanding the needs of all stakeholders, particularly end-users, in the design and development process.

Working collaboratively with companies in the sector innovation shortcomings are identified at the fuzzy front-end (FFE) of a project cycle. The majority of these issues are related to poor practices in creating and applying the design brief. The study found that few SMEs engage in structured approaches to the development of the HHCP brief, which leads to numerous (often very costly) design modifications as the product life develops.

As a solution an original toolkit for improving the design brief development process is presented. It is focussed on managing innovation within the FFE of NPD. It takes the form of a new and novel online web service that guides and supports SMEs in writing a multi-stakeholder design brief.

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LIST OF ABBREVIATIONS

FFE	Fuzzy Front End
HHC	Home Health Care
HHCP	Home Healthcare Product
NPD	New Product Development
SME	Small and Medium Sized Enterprise
UCD	User Centred Design
UX	User Experience

SUMMARY

This practice based design thesis presents research findings and conclusions, which investigated the strengths and weaknesses of innovation management strategies of Small and Medium Sized Enterprises (SMEs) in the Home Health Care (HHC) field. It explores how to improve opportunities for successful innovation by better understanding the needs of all stakeholders, particularly users and carers, in the design and development process.

The demand for well-designed Home Healthcare Products (HHCPs) and associated services grows whilst product development strategies adopted by many suppliers, such as SMEs, who often lack skills and experience, have not matured to realise innovative solutions which adequately address the real needs and requirements of the target audience in a resource-efficient manner. Working collaboratively with companies in the sector, this research identifies that the shortcomings are most prominent in the front-end stages of a product's development cycle, and the key for improvement is adopting a well-established process for creating design briefs. It suggests a new process for creating design briefs which addresses the factors that have significant influence on innovation success but are generally missed. This new process focuses on addressing end-users' real needs, adapting to changing environments, fostering greater stakeholder engagement, and managing information processing in a formal and structured manner. It has been transformed into an online toolkit for communicating and promoting the proposed innovation approaches, as well as for producing robust design briefs that are ready for use.

1 INTRODUCTION

1.1 MOTIVATION

Background of the Author

Prior to taking this PhD journey, I received my bachelor's degree in Industrial Design in China and my master's degree in Product Design (specializing in medical design) in the Netherlands. During the master's course, I completed several collaborative medical design projects with local companies. I have had several years' experience of working in a healthcare design group of a large multinational company and I have also worked at three research and design consultancies based in China and the Netherlands. These experiences revealed some critical issues in the development of medical/healthcare products. For example, formal research and design methodologies were thought by many healthcare/medical product development practitioners to be too time consuming and expensive to be adopted in real practice even though the market appeared to be desperate for better products, particularly in the household environment. This personal background underpins this doctoral research and the rational for exploring new (home) healthcare products with the aim of developing more effective solutions.

Aims and Objectives

Health systems worldwide have been actively exploring ways to improve the quality of care that is cost-effective; often with a focus on people with long-term health conditions and with the aim of providing people with care in their own homes (Steventon & Bardsley 2012). Home healthcare is viewed as one of the potential solutions, and is a fast developing sector. In England, the *3millionlives* project launched in January 2012 aims to support three million people with long-term health conditions. There is obviously a growing demand for well-designed home healthcare products to support the well-being of the expanding group of residents with long term health conditions.

In the UK, the design, manufacture and supply of medical equipment products is dominated by small companies - 90% employ under 50 employees (The Department for Business, Innovation and Skills 2009). Typically they are under resourced to carry out the (emergent) practice of front-end research and this lack of knowledge has led to significant problems for subsequent innovation activities. Research undertaken on behalf of the Department of Health by the Design Council in 2007 identified that 'confusing, complex and unwieldy designs – which are all too often present in healthcare – are, at best, less effective than they could be, at worst they are potentially dangerous to either medical staff or the patient – or both'. Blache (2007) states that 'Many bodies such as Medicines and Healthcare Products Regulatory Agency (MHRA) and the National Patient Safety Agency (NPSA) have long identified bad ergonomics and functions

(of medical products) as a major contributor to patient related incidents' and, 'the design of medical equipment plays an important role in minimising the risk of an incident occurring during use'. These findings demonstrate that small and medium- sized companies (SMEs) in the home healthcare sector need to understand innovation approaches and the target audience better in order to address these serious failings. Norman (1986) used the term 'user-centred design' to highlight the importance of designing for the needs of the user. Other user focussed research practices include empathic design, participatory design, people-centred design (Wakeford 2004) and context mapping (Sleeswijk Visser et al. 2005). All claim that involving people in the design process results in better products that meet their needs and reduces the chance of market failure. However, these principles, even the methods supporting their implementation, such as the pragmatic IDEO (UCD) Toolkit (2009), remain generic and not specific to the home healthcare sector. Generic UCD methods are problematic, as Shneiderman (2000) argues there is no 'average' user on whom a system should be based, indicating how complex UCD can be.

Addressing the above concerns, this study explores the issues that hinder home healthcare product suppliers, especially those of small and medium size, from developing functional, user friendly, and profitable products. To tackle these issues, the study also aims to generate an effective and feasible strategy for improving the current situation.

1.2 RESEARCH AIMS AND OBJECTIVES

For the purpose of supporting and improving wellbeing, this doctoral study explores the concern that many Home Healthcare Products (HHCPs) are poorly conceived and identifies the issues that lead to such a situation. It proposes a new approach to reinforce the new product development process, to ensure safe, user friendly and time and cost effective product solutions. This approach is created to share with suppliers involved with HHCPs, especially those based in Cornwall.

Addressing this objective, research activities were engaged in 4 categories:

1. User centred design methods - to explore the appropriateness of UCD methods for all stakeholders of the HHCP in question, with the aim of improving the design of HHCPs.

2. The HHCP industry – to gain a general insight of the HHCP industry, such as the product suppliers' type, size, motivation and development trend, with particular attention to Cornwall.

3. Individual HHCP suppliers – to understand the real situation of HHCP development, to identify the root causes of the poor performance of HHCPs on the market, and to unveil the opportunities for improvement.

4. New product development approaches – to generate effective and feasible solutions for the key problem areas, and to evaluate the solutions generated in the research.

1.3 OVERVIEW OF THE THESIS

The research journey

As illustrated in Figure 1.1, the initial research topic was aiming to improve the design of HHCPs by developing cost effective User Centred Design (UCD) approaches. The 'secondary research' and the 'workplace study' showed that the poor performance of many existing HHCPs was related to various factors in the fuzzy front end stage of a project cycle such as information management, user engagement and the control of the development process, in addition to the common absence of effective user input. Hence the focus of further exploration was shifted to finding the best opportunity for improving the whole. The 'workplace study' concluded that the process for creating a design brief was the key. A new design briefing process as well as implementation strategies were generated and this knowledge was then transferred into an online toolkit. This design briefing toolkit was tested with academic and industrial experts and with companies in the sector.

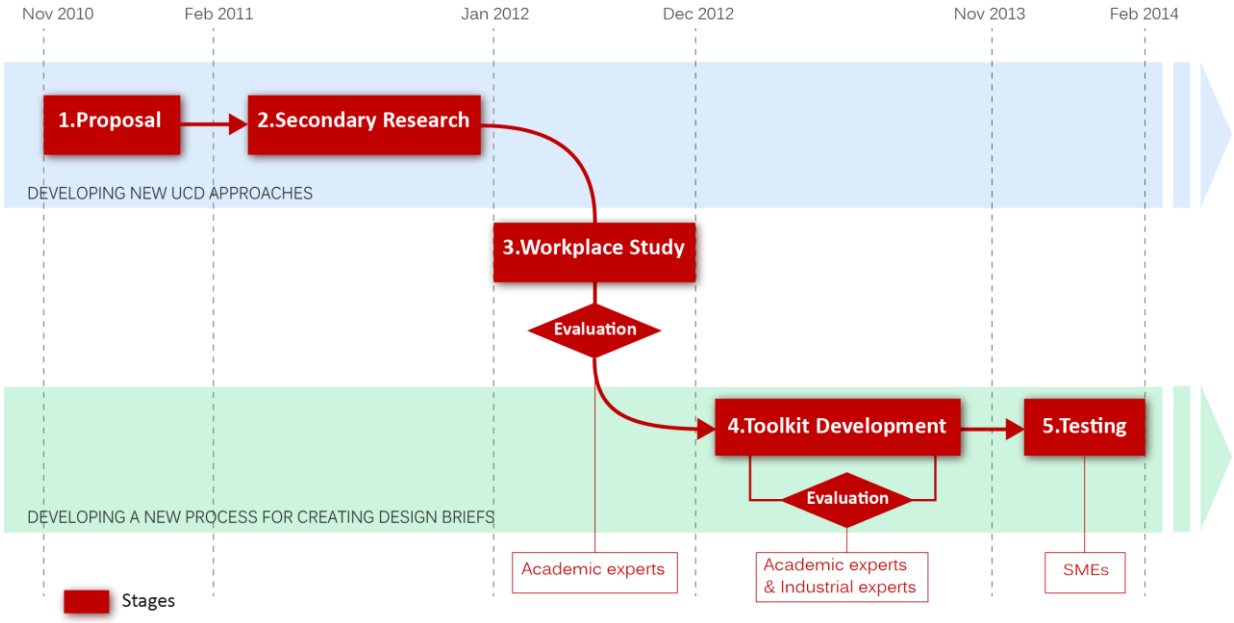

Figure 1.1 The illustration of the doctoral research journey

Structure of the thesis

The thesis is structured in five sections: 1. Introduction, 2. What is the problem, 3. Why the problem exists, 4. How to deal with the problems and 5. Conclusion. Sections 2, 3 and 4 are the main sections, each with two to four chapters:

Section 1 Introduction	A summary of the thesis. These initial pages outline the research motivation, objectives and the structure of the thesis.

Section 2 What is the Problem 2.1 Summary 2.2 A Review of the Home Healthcare Sector 2.3 Cornish Context 2.4 Conclusion and Research Plan	This section reviews the background and the relevance of the literature study. It concludes that there is a pressing need for well-designed HHCPs Chapter 2.2 introduces the history, present status and the development trends of HHC and HHCPs. Chapter 2.3 introduces the key facts of Cornish social context, demography, and health and well-being.
Section 3 Why the Problem Exists 3.1 Product Innovation in the Home Healthcare Sector 3.2 New Product Development Processes 3.3 Case Study Planning, Observations, Events and Experiences 3.4 Lessons Learnt and Identified Issues	This section analyses the HHCP industry – based on the primary research that the researcher has done. Chapter 3.1 explores the HHCP industry as well as the features of individual companies in the sector. It also determines the target company group of this study. Chapter 3.2 establishes a general understanding of the new product development (NPD) processes, through analysing existing NPD techniques. Chapter 3.3 introduces the procedures, methods and research activities of the case study which was carried out with a carefully selected HHCP supplier. Chapter 3.4 summarises the central research findings. It concludes that engaging a well-established design briefing process is a highly cost effective approach to NPD success, particularly for SMEs.
Section 4 How to Deal with the Problem 4.1 Theoretical Models and Opportunities 4.2 The Toolkit for Creating A Strong Design Brie	This section elaborates the development of the new brief creation process and the web-based toolkit which communicates and promotes the proposals. Chapter 4.1 analyses the principles behind a strong briefing process. It proposes a formalized but adaptable brief creation approach which can address the characteristics of individual projects, companies and industries, to ensure consistent high quality design briefs. Chapter 4.2 outlines the development and the evaluation of the brief creation toolkit, based on the proposed new design briefing process and its associated approaches for implementation.
Section 5 Conclusion	This section concludes with the research knowledge contributions, and limitations and further research opportunities.

2 WHAT IS THE PROBLEM

2.1 SUMMARY

This section discusses what Home Health Care (HHC) is, what features the HHC system has, and why the term Home Healthcare Product (HHCP) is adopted in this thesis.

This section also briefly introduces the key facts of the Cornish social context, demography, and health and well-being, and why Cornwall a perfect testing area for this research. The exploration of these factors influence the conclusion that there is a pressing need for well-designed HHCPs to support and improve wellbeing.

2.2 A REVIEW OF THE HOME HEALTHCARE SECTOR

2.2.1 DEFINITION OF HOME HEALTH CARE PRODUCTS

Why use the term 'home healthcare product' ?

For centuries, health care services have been performed by medical practitioners such as midwives, medicine men and travelling doctors visiting people's homes. As opposed to the short visits generally aimed at meeting a specific need in the past, modern Home Health Care (HHC) addresses ongoing and long-term health needs. There is increasing recognition that HHC plays an important role for patients of all ages with significant acute and chronic illnesses (Murkofsky and Alston 2009).

Throughout the history of its development, the HHC system has endured a long-standing lack of consensus regarding the principle goals and target populations of the benefit (Goldberg Dey et al. 2011). For example, 'home health care' and 'home care' have been used interchangeably in the past to mean any type of care given to a person in his/her own home, regardless of whether the person requires skilled care or not. However, there has been a recent development to distinguish the two terms - the former tends to mean skilled nursing care and medical care at home and the latter means non-medical care (e.g., Dey et al. 2011; U.S. Department of Health and Human Services 2010).

The issue of lacking formal definition applies also to the organizations delivering HHC services. They are described by the U.S. Food and Drug Administration (FDA) (2014) as:

> *"home use medical devices - a medical device intended for users in any environment outside of a professional healthcare facility such as a hospital, including devices intended for use in both professional healthcare facilities and homes."*

Whilst according to the European Commission's Directorate for Public Health and Risk Assessment (2014):

> *"medical devices are intended for the diagnosis, prevention, monitoring, and treatment of diseases and the improvement of the quality of life of people suffering from disabilities."*

A similar definition to that of the Commission is enforced in the UK by the Medicines and Healthcare products Regulatory Agency (MHRA) (Ward and Clarkson 2002; Williams 2012):

> *"any instrument, apparatus, appliance, material or other article, whether used alone or*

in combination, including the software necessary for its proper application intended by the manufacturer to be used for human beings for the purpose of:

- *diagnosis, prevention, monitoring, treatment or alleviation of disease*
- *diagnosis, monitoring, treatment, or alleviation of or compensation for an injury or handicap*
- *investigation, replacement or modification of the anatomy or of a physiological process*
- *control of conception*

and which does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its function by such means."

The issue of a definition of what are home health care products becomes more complicated when we talk about products such as a grab handle in the bathroom, a sleep monitor and an activity tracker. Products which are also used by healthy people for preventing illness or injury, and can be bought online and 'health and wellbeing' stores and supermarkets, without a prescription from medical practitioners. Such products do not belong to the medical device category based on the above definitions, but are closely related to people's health and wellbeing. To tackle this complex issue and ambiguity around a common definition this thesis uses the term Home Healthcare Product (HHCP), which is defined below.

Definition of HHCP in this thesis

A Home Health Care Product (HHCP) in this thesis refers to all products rendering actions related to the health and wellbeing of people, in a home setting. This incorporates medical or psychological assessment, wound care, medication teaching, pain management, disease education and management, physical therapy, speech therapy, or occupational therapy, together with life assistant services related to illness prevention, health monitoring and post-operation recovery (Figure 2.1).

The users of HHCPs include trained healthcare personnel such as carers and monitoring technicians and para-medical staff, and lay operators like healthcare recipients and their family members, who either directly use the products or provide assistance in the operational procedures. It should be noted that HHCPs are intended not only to enable patients to remain at home rather than using residential, long-term or institutional-based nursing care services, but also to support healthy people in maintaining and developing their fitness.

'High quality HHCPs'

Throughout thesis the term 'High quality HHCP' is used. The term means that the HHCP should be ergonomic[1], economical[2] and mechanically and electronically robust. Being profitable, light weight, discreet, informative and easy to clean and to maintain are also common features of many well-designed HHCPs.

Wireless Fingertip Pulse Oximeter

Walker

Mobility Scooters

Wheelchair lift

Rollator

Diabetic device

Invacare Adjustable Toilet Safety

Arthritis Shoulder Wrap

Blood Pressure Monitor

Figure 2.1 Examples of HHCPs

1. An ergonomic HHCP is a HHCP designed with proper considerations to the user's capabilities and limitations, in order to optimize human well-being and overall system performance.

2. An economical HHCP should be both cost-effective and affordable

2.2.2 GROWING DEMAND FOR WELL-DESIGNED HHCPS

New requirements in health care delivery arise due to socio-economic and cultural changes. For example, the expansion of the aging population and the rising prevalence of lifestyle-related chronic (nosocomial) diseases worldwide tend to require more medical and social care resources, which is unfortunately dropping in many countries including the United Kingdom (UK). This trend places increasing pressure on healthcare delivery systems and leads on to patients being discharged earlier than they previously were. As a result, family members have a greater responsibility to provide a higher level of health care for their family members. While traditional health care focuses only on clinical requirements, present healthcare solutions need to be shifted beyond problem oriented 'one-off' solutions towards integrated systems which enrich the subjective well-being of patients, such as their psychological demands. These solutions are also required to be affordable, on the condition of providing satisfactory performances. HHC can address many of these demands, and therefore is viewed as one potential solution to improve the quality of care that is cost-effective. This estimation has been proven by the increasing demand for HHC from both people and the market, and the significant development of the sector over the last two decades. For example, the 3 million lives project launched in England in January 2012 aims to support as many as three million people with long-term health conditions. Such a trend is expected to continue in the future.

Equally important in determining the potential of HHC is ensuring that it is well delivered to people in need, a large percentage of which is realised through HHCPs. HHCPs as a whole have become an essential and integral part of HHC today. They include a range of devices, from simple weighing scales and thermometers to complex equipment such as oxygen concentrators and home dialysis machines. Recent advances in healthcare product design and technologies have greatly simplified the operation of equipment, which has enabled people without advanced medical training or with reduced physical functions to operate the equipment. Besides realising the functions for clinical requirements, HHCPs are capable of providing individual users and their families greater comfort, pleasure, and well-being by addressing their broader needs. For example, Telecare devices enable people with chronic conditions to be treated in the comparative comfort of their own homes, rather than having to endure the daily, weekly or monthly trip to the hospital, and improve their independence and confidence in life. Another example is the sensor-embedded houses (smart houses) which are intended for people with reduced physical functions and also aid in reducing the social isolation they face. Smart houses are capable of providing assistance without limiting or disturbing the resident's daily routine, giving him or her greater comfort, pleasure, and well-being with implanted

intelligent devices (Chan et al. 2008).

In addition, promoting the use of HHCPs is beneficial to society by reducing the overhead cost of supplying HHC services, by eliminating the need for the presence of a medical practitioner or a full time care-giver in patients' post operation recovery, adjuvant treatment, health and illness monitoring or remote diagnosis and treatments.

The potential benefits of implementing HHCPs include:

1. Quality improvement

- Improving clinical outcome
- Empowering patients, shifting them from passive recipients of care services to active participants
- Aiding in patient recovery by enabling them to receive medical services in a more familiar setting and be surrounded by their family and friends
- Increasing patient independence and satisfaction
- Aiding in preventing lifestyle diseases in users' own environmental context by enabling them to change their lifestyle over time
- Improving the management and control of chronic diseases (enabling patients continuously to take care of their own clinical data)
- Shifting the care process towards more continuous collaborative relationships between patients and providers

2. Cost reduction

- Decreasing hospitalization and accident and emergency (A&E) visits by identifying problems sooner
- Promoting earlier discharge from acute care settings (replaced with continuous home services)
- Reducing the number of clinic visits

As pointed out by Lathan et al. in 1999, successful HHC should enable the user to do less while providing the same or better 'weIlness' and/or 'activities of daily living' (Lathan et al. 1999). The design of HHCPs must evolve to meet the new needs driven by socio-cultural changes as well as healthcare trends (Bielderman et al. 2007).

In the near future, HHCPs are expected to be miniaturized, simplified, and sometimes portable and colourful versions of the original professional hospital equipment with innovative technologies, computing, ICT, virtual reality, etc. They should provide optimal personalized performance for each user and improved compliance with maximum integration with any environment, whether this is the home, office or a mobile environment. Besides, they should bridge care settings and provide care continuity for sick, chronically ill individuals, instead of being operated in a 'silo' (Alliance for Home Quality and Innovation 2014).

These requirements have led to the fast development of solutions such as mobile health (m-health), digital and genetics revolutions (digital health) and smart houses. This trend is expected to continue. This new emphasis on high quality HHCPs needing to perform in a wide range of environments and with different users demanding investment in design and user centred requirements must be realised.

2.2.3 PRESSING NEED FOR IMPROVING THE DESIGN OF HHCPS

Confusing, complex and unwieldy designs are, at best, less effective than they could be, at worst, potentially dangerous to product users (Clarkson et al. 2004).

Poorly designed HHCPs are likely to fail to realise their intended functionalities

Here I take a Telecare product from the 'company partner' (refer to Chapter 3.3) of this study as an example. A personal alarm intended mainly for people with long-term conditions, to give them peace of mind that they are safe in their own home, without having to make regular visits to medical institutions. It has two components - a 'box' installed at the user's home and connected with the landline and a 'pendant' which is expected to be functional within 20 metres of the 'box'. Pressing the button on either of the two components should enable the user to raise the alarm that something is wrong. However, the potential sources of wireless interference in the home setting were not properly addressed in the product design process, and as a result, some users reported that the 'pendant' sometimes could not be triggered when they were in the garden. Although the chance of this failure was small, it inevitably led to a disproportionate fear that the product would not perform when it was needed. This fear resulted in the complete failure of the design goal, even though only one element was at the root.

Another example where a poorly designed falls alarm failed its user was an accident reported in the West Briton newspaper on 15th January 2015 that a 93 year old drove his mobility scooter into a dock (a fall of 15 feet down steps onto mud). Unfortunately, he was wearing a pendant but could not get it to operate to give an alarm (West Briton 2015). His daughter was quoted as saying "… because of his arthritis he couldn't push the button".

Poor design may even pose a threat to the safety of the user.

Historically, the healthcare delivery system has been criticized for its 'culture of blame' in which culpability for failure has been attributed to the human elements of the system: people make

errors, therefore people must change their behaviour to reduce errors (American College of Clinical Engineering 2001). However, the analysis of medical failures commonly use statistical analyses that rarely consider whether the behaviour of the people involved in these incidents was reasonable given the relevant design or situation. As a matter of fact, human errors are more generally associated with latent causes hidden within systems and processes (e.g., Bogner 1994, Cook 1998, Perrow 1999 and Martin et al. 2008). Current thinking places the responsibility for 'human error' squarely on the shoulders of latent (root) causes that can be prevented only by adjustments to systems and processes (American College of Clinical Engineering 2001). For example, Chris Smyth, Health Correspondent of The Times stated that thousands of patients were killed or seriously injured because of mistakes caused by the poor design of drugs packets and confusing medical equipment (Smyth 2014).

The UK's Medicines and Healthcare Products Regulatory Agency (MHRA) and National Patient Safety Agency (NPSA) have identified that bad ergonomics and poor functionality of healthcare products are a major contributor to patient related incidents, and that the design of the equipment plays a critical role in minimising the risk of an incident occurring during use (National Patient Safety Agency 2010).

2.2.4 CHALLENGES IN HHCP DEVELOPMENT

The unsatisfactory performance of many HHCPs on the market is unsurprising as the sector is relatively new and more complex compared with many other industries. This leads to a number of engineering and project management-related challenges during the development process (Ward and Clarkson 2002). Although these challenges often surface during the design of standard products, the complexity and safety critical nature of medical devices and the diverse user profile and application environment tend to exacerbate the difficulties.

The inherent complexities in HHCP development can be categorised in four ways:

1) Diverse, unpredictable, and fluctuating user profiles and abilities

Product innovation in the sector needs to accommodate the dynamic, uncertain and complex profile of the widest range of users and environments.

Regarding users' profile:

In a hospital, medical practitioners usually take the lead and control processes. In contrast, HHCPs are operated by heterogeneous groups of people consisting of nurses, therapists,

technicians, carers, family members, and experienced and untrained/occasional patients themselves, and may even interact with other unexpected people, for example, their colleagues and grandchildren. Among these people, the majority (two-thirds) are family members. Of the family members, sixty percent are women and sixty eighty percent are married women in mid-life (40-60) who will care for their husbands the rest of their lives even as they too develop functional limitations as they grow older (lathan et al. 1999). All these people form the profile of HHCP users. They are from different backgrounds and with diverse levels of expertise and may have different and even conflicting cognitive, perceptual and motor demands.

Regarding users' ability:

Although patients themselves and their families frequently play the role of caregivers, they are a substantially different population from the professional groups for which hospital-based devices have been designed. A large percentage of HHCP users are people with long term chronic conditions and disabilities, including motor dysfunction, visual impairment, loss of tactile and proprioceptive sensation, cognitive impairment, auditory, speech disabilities and equilibrium and balance disorders, which may impair their ability to operate the equipment. For example, motor restriction may disrupt users' ability to perform simple functions on the device interface such as turning a knob, moving a slider, pushing a button and wearing the blood pressure cuff; and visual decline will prevent reading check-up results or following colour indicator (Bitterman 2010).

Some users may even have multiple disabilities and/or disorders, and may go through unpredictable and/or frequent changes in terms of clinical status and performance during the period they use the equipment. This further complicates the design process, for example, mandating a tradeoff between modes of actions and display configurations of the medical equipment (Mclaughlin, Rogers and Fisk 2004).

2) Uncontrolled application environment

HHCP innovation is challenged by the nature of the product working environment. As opposed to the controlled and supportive milieu of hospital, household and community settings are heterogeneous, unpredictable and uncontrolled environments, in which the potential for error, and the accidents that result, is ever present. The design of HHCPs must consider the householder environment factors which may not be designed to support the safe and effective use of healthcare products (Wallace & Steinhauer 1988), such as electrical disturbances and coexistence with other devices; unpredictable levels of illumination and glare; background

noise and interaction with family members; varied temperature and moisture; and the need for transportation.

3) Multidisciplinary nature of HHCP innovation

The development of HHCPs requires interdisciplinary stakeholder participation that can involve medical practitioners, psychologists, end user patients, project/product managers, designers, researchers, engineers, marketers, sales person, service engineers, and architects.

The lack of knowledge and skills in other disciplines can strangle creativity and produce problems in decision making, which is likely to lead to ordinary solutions, loop-backs in a project cycle or even the failure of a whole project. For example, a medical engineer having an idea of using a touch screen to replace the conventional interface of a computed tomography (CT) may not realise the motion of pressing physical buttons helps to prevent mistakes in device operation. Similarly, a product designer who sees probability as a key feature of designing a new household heart failure monitor may not be aware of the improved performance of fibre sensors which enables design to follow another direction. In order to cope with the interdisciplinary and complex nature of the sector, an active and continuous involvement of stakeholders, particularly in exploration, planning and design, is essential. This demand presents a new challenge to NPD management – how to enable fast and effective cooperation between all these people who think, work and communicate by different methods, and often lack understanding of other.

4) Varying regulations and policies

Compared with many other industries, HHCPs have to be compliant with more complex and stricter regulations and policies to be approved for launch. The regulations and policies vary in different regions and may change during the development processes or the life cycles of the products. This factor can hinder both the generation and the implementation of radical design solutions and can also lead to expensive design changes in the later stages of the development processes or even after the launch of a product, in the absence of full awareness of the laws and the rules of the target market(s), or of proper prediction of potential changes during the development processes or product lifecycles.

Regional variations in terms of local legislation, culture and healthcare systems may even lead to changes in business drivers and motivations, for example, my previous working experience shows that a British Telecare supplier entering the U.S. or Chinese market is likely to change its business focus from public organizations to consumers as the latter becomes the major buyer.

The NPD challenges produced by the four factors above can be further exacerbated by the range of care and medication that is delivered, and the equipment and other information used to track medication of individual patients. These are all elements of complexity and uncertainty in the equation of location, performance and design of HHCPs, which produce specified requirements and restrictions (Bitterman 2010).

The nature of complexity in HHCP development raises the question: how can we ensure product **safety** and **usability**?

A review of existing knowledge and practices

Usability as defined by ISO 9241-11:1998 is the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO 1998). In order to produce products that have a high degree of usability, there is a growing awareness and consensus in the design field that understanding the user's needs and interaction with the material world is a basic starting point for developing successful (medical/healthcare) product solutions (e.g., Glen 1994, Lang et al. 2013, Martin et al. 2006, 2008 and Rodríguez et al. 2006). In the book "The Design of Everyday Things" Donald Norman used the term 'User-Centred Design' to describe a design based on the needs of the user, leaving aside what he considers to be secondary issues like aesthetics (1986). User-Centred Design (UCD), which is also known as Human-Centred Design, is a multi-disciplinary activity and design philosophy that pays particular attention to the human factors and ergonomics - what they will do with a product; where they will use it; and what features they consider essential (Rodriguez et al. 2007). Applying UCD principles is particularly important when designing for people in health-related transitions and empowering them to change their lifestyle. In other words, this is essential for the design of HHCPs (Yang et al. 2014; Bielderman et al. 2007).

In its early stages, UCD was translated as design for users, which means that user considerations should play a part in the design process – users' social, sensorial, and emotional factors of product experience must be attended to by designers (Stappers & Szita 2009). A more recent principle 'design with users' suggests bringing users into a design process. Similar terms 'design for users' and 'design by users' take a small step further – they highlight that user insight should be positioned as the basis for forming design solutions. This evolvement reveals the changing role of the user in a development cycle; the user is increasingly seen as a design collaborator who brings valuable input and works together with the design team, beyond the traditional passive role.

With the development of UCD principles, researchers and practitioners have been generating methods and approaches to support NPD practice. Popular UCD methods include Cooperative Design/Participatory Design, Contextual Design, Empathic Design, Persona, Scenarios, Context Mapping, Focus Group, Self-Documentation, Community-Driven Discovery, Essential Use Cases and Card Sorting. The publication of ISO 9241-210:2010 'Human-centred design for interactive systems' provides requirements and recommendations for applying UCD principles and approaches for computer-based interactive systems (ISO 2010). IEC 62366:2007 'Medical devices - Application of usability engineering to medical devices' focused specifically on addressing usability in the process of developing medical devices (ISO 2007).

With the increasing concern about the safety issues of HHCPs, various regulations and standards have been established. One important international standard is IEC 60601-1 'Medical electrical equipment' which was first published in 1977 and has being regularly updated and restructured. For example, IEC 60601-1:2005 introduced the general requirements for basic safety and essential performance of medical electrical equipment and systems used in the home setting, which were classified further in IEC 60601-1-11:2010 'Medical electrical equipment - Part 1-11: General requirements for basic safety and essential performance - Collateral standard: Requirements for medical electrical equipment and medical electrical systems used in the home healthcare environment' to serve as the basis for particular standards. In the US, Food and Drug Administration (FDA) also launched the Medical Device Home Use Initiative in 2010 to support the safe use of medical devices in the home.

Unfortunately, these standards and methods are not sufficient to result in high quality HHCPs. As a matter of fact, many HHCPs on the market are poorly designed and have poor functionality (Design Council 2007; Blache et al. 2007). Firstly, there is no "average" user on whom a system should be based (Shneiderman 2000). However, most of the existing UCD methods and standards are generic and not specific to complex HHCP development. Secondly, many of them do not provide appropriate details to guide specific NPD activities in projects of various types. Most importantly, they rarely provide a holistic solution which also addresses other key considerations such as efficiency and cost, apart from feasibility and safety. Thus, the challenges remains how to achieve a HHCP solution meeting the user's real read needs and wants instead of just saying that it is 'user centred'.

2.3 CORNISH CONTEXT

While there is a growing demand for healthcare support in the whole United Kingdom, the higher than average rate of long term illness and much faster increase of the elderly leads Cornwall into an even more critical condition.

In summary, the features of Cornish social context and demography incorporate:

- Increasing population
- Increasing and higher proportion of ageing population
- Seasonal increases in population
- Higher retired population
- Retired people are geographically distant from family support structures
- More people with learning difficulties
- Lower income than in the rest of the country

They have critical implications on Cornish health and wellbeing:

- Higher life expectancy
- Higher percentage of the population with long-term limiting illness
- Increasing prevalence of Dementia
- More people with sensory impairment
- Carers are playing a more important role
- Shortage of beds in hospitals

In view of the above facts, there is a pressing need for well-designed and affordable HHCPs in Cornwall, to assist in post operation recovery, adjuvant treatment, health and illness monitoring and remote diagnosis and treatments. This makes Cornwall a perfect testing area for this research. Section 2.3.1 - 2.3.4 provides an overview of Cornish social context, demography, health and wellbeing, at present, and in the near future.

2.3.1 CORNWALL IN BRIEF

Cornwall forms the tip of the south-western peninsula of Britain and borders with Devon in the east, over the River Tamar. There is one city, Truro and a spread of towns across the Cornwall area. Cornwall covers an area of 3,563 square kilometres (1,376 sq. mi.) and has a population of 532,300 in 2011, an increase of 6.7% since 2001 (Cornwall Council 2012).

Historically, tin mining was important to the Cornish economy, becom ing significant during the Middle Ages and expanding greatly during the 19th century when rich copper mines were also in production. However, metal mining entered a period of decline in the mid-nineteenth century and had virtually ended by the 1990s. Subsequently, china clay extraction became more important. Fishing and agriculture are the other important sectors of the local economy. Today, Cornwall's economy struggles after the decline of the mining and fishing industries, and has become more dependent on tourism, which makes up around a quarter of the economy.

(Source: http://calitreview.com/38)

Cornwall has a very low population density but a fast population growth. According to the 2011 Census, Cornwall's population density was around 150 people per square kilometre, ranking it 41st compared with the other 47 counties of England. However, the population has consistently grown quicker than the rest of the South West region, and is amongst the fastest growing areas in the UK largely due to inward migration into Cornwall (Cornwall Council 2011).

2.3.2 SOCIAL CONTEXT & DEMOGRAPHY

Research into the Social Context and Demography of Cornwall implies that there is higher need of well-designed Home Healthcare Products (HHCPs) in this area compared with the rest of England and this trend is expected to continue. Below are the key facts driving the need for HHCPs:

Lower income than in the rest of the country

Cornwall is one of the poorest areas in the UK. The Gross Value Added (GVA) per head was £12,681, which equates to 62% of the UK average for 2007 (Cornwall & the Isles of Scilly Brief 2010). The GDP per head for Cornwall and the Isles of Scilly was approximately 70% of the UK per head average and 79% of the EU-27 average for 2007 (Office for National Statistics 2007). The average gross weekly earnings of people living in Cornwall are 80% of national average (Waight and Owen 2009). Thus, Cornwall is one of four UK areas that qualify for poverty-related grants from the EU: it was granted Objective 1 status by the European Commission, followed by a further round of funding known as 'Convergence Funding'. It also is the only area in the UK to be receiving a further 5 year tranche of EU support.

Research from 2015 onwards conducted by Combat Poverty Agency and Cornwall Council has shown that those who live on low incomes are more likely to suffer poorer health, experience more psychological distress and generally lead shorter lives than those who are more affluent (2010).

Increasing population

The substantial growth in Cornwall and the Isles of Scilly's population is one of the key features of this area. Cornwall's estimated population for 2010 is 535,300, an increase of 62,900 since 1991 (NHS Cornwall and Isles of Scilly 2010). Average population growth in Cornwall since 1981 is approximately 20% - four times the UK average. Outside London, Cornwall and the Isles of Scilly has experienced one of the highest rates of inward migration in the UK, with a net influx of more than 6,000 people per annum since 1997. Current projections envisage Cornwall's population growth to continue to exceed the UK average over the coming years (Cornwall Council 2009).

Seasonal increases in population

During the summer months, the population of Cornwall increases significantly due to the influx of tourists. Cornwall and Isles of Scilly attract more than 5.5 million visitors a year, and in the peak of the summer about 300,000 tourists are staying at any one time, increasing the resident population by about 60% (The Global Travel & Tourism Partnership 2010). The existing and projected growth in tourism is an area that impacts on local health and well-being. It causes increased demand on healthcare and thus puts pressure on health and social care support services.

(Source: Wikipedia)

Higher retired population

A combination of the high popularity as a retirement destination and outward migration of younger residents to more economically diverse areas result in a big percentage of population of pensionable age in Cornwall. This figure is around 24.8% which is higher than the regional and national percentages (Harper 2013). Over the next twenty years, the number of retirees is projected to increase by 75% to one in three of the population. There will be more 'last time movers' than first time buyers.

Choosing to reside in Cornwall brings these retired people closer to the beauty of nature, which does improve their health and overall life quality. However, many of them are geographically

distant from family support structures and as a result are more reliant on community and social care when they are ill or have difficulties in self-sufficient living. This creates a growing need for beds in hospitals, carers and home care support.

Increasing and higher proportion of aging population

Cornwall's population has a higher proportion of elderly than in the rest of the country, which restricts the labour market and highlights demands for health and social care support services. In Cornwall and Isles of Scilly, for both sexes there are smaller proportions of the population under 45 years of age and a greater proportion over the age of 50 compared to England and Wales as a whole.

(Source: IEcool.com)

As with the rest of the UK, Cornwall's population continues to grow older with increases in the 60-74, 75-84 and 85+ age groups. To be more specific, the numbers of residents in the 5-14, 30-39 and 50-59 age groups have decreased in Cornwall over the last decade. Due to younger migration and more births the numbers of residents in the 0-4, 15-29 age groups have increased, along with those aged 40-49 (Cornwall Council 2012). Whereas in 2003 older people accounted for 20% of the population, by 2028 older people will account for 28.6% of the population which is one of the highest proportions in England (Waight and Owen 2009). Over the next two decades, the population of people aged 65 and older will reach 177,400 which is approximately a 60% increase. By 2028, almost 30% of Cornwall's population will be aged 65 years and over. In contrast, 21% of England's population are expected to be 65 and over by 2028. Whereas there were 13,200 people aged over 85 in 2003, by 2028 there will be 28,600 which is an approximately 117% growth or an average of over 600 people per annum. The percentage of people aged 85 and over in Cornwall and Isles of Scilly in 2010 was 2.8% compared with 2.0% nationally, and in 2030 is projected to be 5.5% compared with 4% nationally (Figure 2.2; Figure 2.3). People over the age of 85 are far more likely to require health and social care support services.

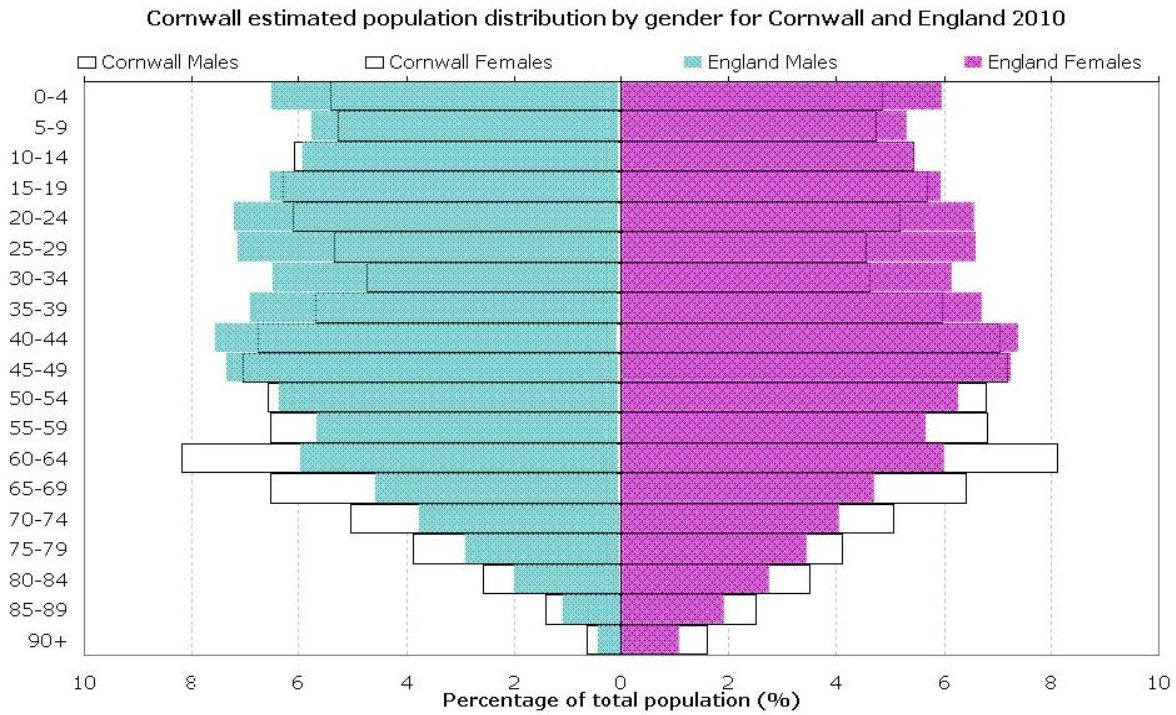

Figure 2.2 Population Estimate 2010 (Source: Community Intelligence, Chief Executives Department, Cornwall Council)

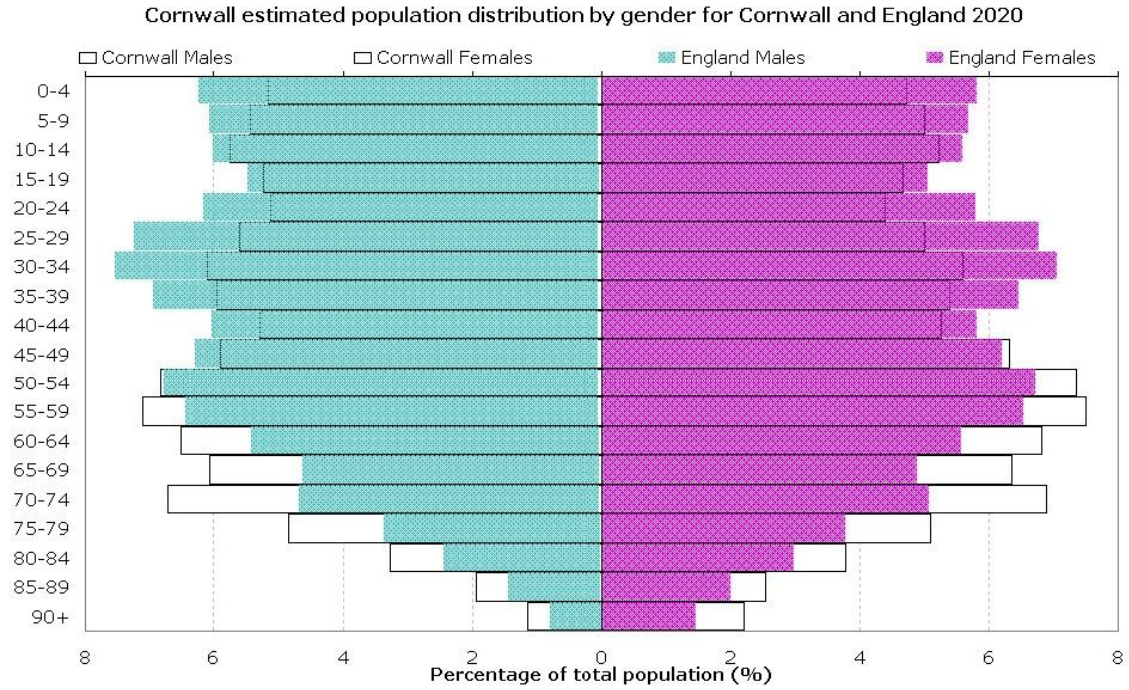

Figure 2.3 Population Estimate 2030 (Source: Community Intelligence, Chief Executives Department, Cornwall Council)

People with learning disability

The number of Cornish people with learning disabilities is increasing. Research conducted by South West Public Health Observatory (SWPHO) suggests there are around 15,000 – 20,000 people with moderate or mild learning disability and 3000 – 3,500 with severe learning disability in Cornwall (2010). What make the situation graver is that a high percentage of people with learning difficulties do not even realise that they have this problem (Cornwall

council 2011). Generally, people with learning difficulties are extremely vulnerable and in need of greater external support since they are likely to have troubles more frequently in life, for example, they may have difficulties in processing medicine instructions, contacting a surgery by phone or using a product which can be simple to most other people. Hence, good access to primary care and assistance in everyday life is vital to this group of people. In view of the fact that medical and social care and support resources are insufficient (Please refer to Chapter 2.4), HHCPs are expected to be an alternative solution which is cheaper but can be effective.

2.3.3 HEALTH AND WELL-BEING IN CORNWALL

Although there is a demographic shift towards the aged in Cornwall, the health of people in this area is generally better than other areas in Great Britain. Life expectancy for men and women is higher than average. Rates of early deaths from cancer and from heart disease and stroke are also better than the England average and have fallen over the last 10 years. In contrast, the rate of new cases of malignant melanoma skin cancer is worse than that of England.

The following are the key facts on health and well-being in Cornwall which are closely related to this project and HHCP provision:

Higher life expectancy

The average life expectancy in Cornwall is 81.9 years for women and 77.8 years for men, which is significantly better than in England and Wales where the figure is 81.1 for women and 76.9 for men (Waight and Owen 2009).

Life expectancy in Cornwall is increasing. The increase is faster for men than women, and the gap between those with the lowest life expectancy and the highest is widening.

Higher percentage of population with Long-term Limiting illness

Cornwall as a whole has a higher than average rate of chronic disease or limiting long- term illness than both England and the South West region, even when age structure are taken into account. While the average rate of long- term illness in England is 17.6%, the rate in Cornwall is 20.5% (Waight and Owen 2009). Considering that Cornwall's total population and the

proportion of elderly people are estimated to grow sustainably, the population with long-term limiting illness is estimated to increase significantly in the following years. For example, the over 65 Cornish population is expected to increase from 114,200 to 166,400 by 2025. Of this population 53,922 have a limiting long term illness and this is projected to increase by 29% to 69,373 by 2020 and by 59% to 85,704 by 2030 (Cornwall Council 2011).

(Source: IEcool.com)

Increasing prevalence of dementia

Dementia is a term used to describe various different brain disorders that have in common a loss of brain function that is usually progressive and eventually severe.

As shown by GP registers, there are approximately 3,000 people who have been formally diagnosed with dementia in Cornwall. Yet this number is significantly lower than the expected prevalence for the county - approximately 8,000. By comparing GP dementia registers with expected prevalence, this suggests that almost two thirds of people with dementia in Cornwall have not yet been diagnosed.

The prevalence of dementia is expected to increase by approximately 60% to 13,000 by 2025. The increase will be most significant amongst people aged 85 and over. While dementia prevalence is expected to increase by 29% for people aged 65-69, it is predicted to rise by 70% for those aged 85 and over during 2008 to 2025 (Community Intelligence, Chief Executive's department 2009) (Figure 2.4).The increase in dementia creates further pressure on health and social care services and increase the need for carers.

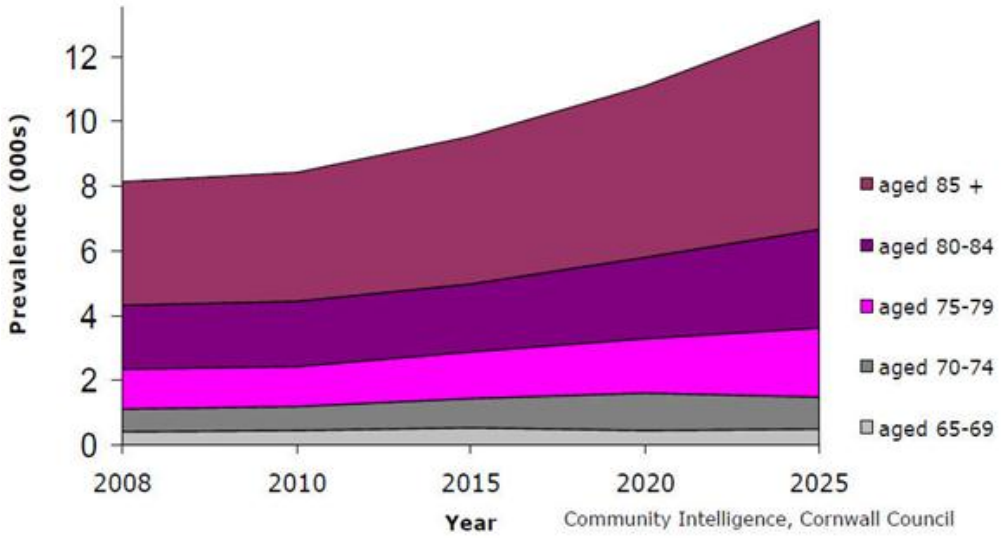

Figure 24 Estimated dementia prevalence in Cornwall and the Isles of Scilly

Bed availability and occupancy

Between 1987/88 and 2008/9, the average daily number of available beds in NHS hospitals in England fell by 46%, from 297,364 to 159,386 in. Over the same period the number of day only beds has increased by over 400 per cent from 2,000 day beds in 1987/88 to 10,959 in 2008/09 (Harker 2009) (Figure 2.4). This trend is estimated to continue for the cutting of funding by the UK government. Considering the pressure from the continuously growth of aging population which has been stated in foregoing chapters, this situation brings about a serious problem which is to ensure the all elderly people who need medical care and patients with long- term illness receive proper medical care. As a result, the market expansion for well-designed and affordable HHCPs which assist in patients' post operation recovery, adjuvant treatment, and health or illness monitoring is estimated to continue for long periods.

Year	All specialties (exc day only)	General & acute	Acute	Geriatric	Mental illness	Learning disability	Maternity	Day only
1987/88	297,364	180,889	127,616	53,273	67,122	33,421	15,932	2,000
1988/89	282,918	174,491	123,450	51,041	63,012	30,048	15,367	2,473
1989/90	270,301	169,901	121,170	48,731	59,288	26,406	14,706	2,861
1990/91	255,479	162,691	116,788	45,902	55,239	23,379	14,170	3,068
1991/92	242,677	157,247	115,140	42,107	50,278	21,383	13,770	3,399
1992/93	232,201	153,208	112,862	40,346	47,308	18,519	13,167	3,972
1993/94	219,476	147,153	109,713	37,440	43,532	16,269	12,521	4,908
1994/95	211,812	144,803	108,008	36,795	41,827	13,211	11,971	5,699
1995/96	206,136	142,624	108,296	34,328	39,477	12,676	11,358	6,541
1996/97	198,848	140,515	108,869	31,646	37,640	9,693	11,000	6,766
1997/98	193,625	138,047	107,807	30,240	36,601	8,197	10,781	7,125
1998/99	190,006	136,426	107,729	28,697	35,692	7,491	10,398	7,568
1999/00	186,290	135,080	107,218	27,862	34,173	6,834	10,203	7,938
2000/01	186,091	135,794	107,956	27,838	34,214	6,316	9,767	8,155
2001/02	184,871	136,583	108,535	28,047	32,783	5,694	9,812	8,036
2002/03	183,826	136,679	108,706	27,973	32,753	5,038	9,356	8,544
2003/04	184,019	137,247	109,793	27,454	32,252	5,212	9,309	8,813
2004/05	180,966	136,184	109,544	26,641	31,286	4,415	9,081	9,160
2005/06	175,646	133,033	108,113	24,920	29,802	3,927	8,883	9,726
2006/07	167,019	126,976	104,079	22,897	27,914	3,486	8,643	10,342
2007/08	160,297	121,780	101,080	20,700	26,929	3,147	8,441	10,511
2008/09	159,386	121,688	100,892	20,796	26,430	2,882	8,386	10,959

Source: *Department of Health, Hospital Activity Statistics*

Figure 2.4 Average daily number of available beds, by sector, England, 1987/88 to 2008/09

Carers are playing a more important role

Care is provided to different groups of vulnerable people: the elderly, those with a learning disability and a physical disability and those with mental health needs. The majority of care (70%) provided by the local authority is to those over 65 years of age and many will be over 75 years of age (NHS Cornwall and Isles of Scilly 2008).

Carers are a fundamental part of society and help to support social care services in the UK. They are playing a more important role as people continue to live longer and develop long-

term clinical conditions. The National Carer's Strategy outlines the importance of helping people to maintain independent living and this relies on support from carers. Those over the age of 85 are most likely to need care and over the next 20 years this figure is set to double (NHS Cornwall and Isles of Scilly 2008). In Cornwall, carers are most likely to be 45-64 years' old - of working age. And around 56,000 people give unpaid care to family and/or friends with illness and/or disability (Waight and Owen 2009).

The increasing demand to social carers can be seen as big consumption of human resources and social wealth. Also carers themselves require a significant amount of support to enable them to provide care and remain physically and mentally healthy. As a result, developing a more efficient healthcare delivery and support system which can help to improve the working efficiency of carers is a priority. When developing HHCP as a key part of the healthcare care delivery system, there is no doubt that the need and opinions of carers swill need to be taken into consideration.

2.4 CONCLUSION

The HHC sector is experiencing fast growth, whilst the potential for error and the accidents that may result is ever present. HHCPs, as one major component of the HHC system, not only contribute to the HHC systems quality but also to its complex nature. HHCPs can be improved in terms of both product usability and user safety.

Building on the existing knowledge, this research aims at generating a new approach for improving product innovation in the sector, the starting point of which is to understand the reality of developing HHCPs (Also refer to Chapter 1.1 & 1.2). To do so, the features of HHCP industry are explored (See Chapter 3.1 and 3.3), the NPD process and its various components are analysed (See Chapter 3.2, 3.3 and 3.4) and popular UCD techniques are reviewed (Refer to Chapter 3.4.5).

3 WHY THE PROBLEM EXISTS

3.1 PRODUCT INNOVATION IN THE HOME HEALTHCARE SECTOR

3.1.1 SUMMARY

On the one hand there is a pressing need for improved home healthcare products (HHCPs); on the other hand new product development in the sector is complex and challenging. Questions arise: 1) Are the home healthcare product suppliers capable of producing satisfactory solutions? 2) If not, what are the opportunities for improvement, and how can they be implemented?

To answer the two questions above, the features of HHCP innovation were explored, from the perspectives of the whole industry and individual companies. This chapter also categorizes HHCP suppliers, and identifies that there is an emergent need for support in terms of product innovation strategies and approaches.

3.1.2 THE CHARACTERISTICS OF THE MARKET

Business Drivers and Motivations

'… Frustration occurs as I am in the middle of the user views and company strategies …' - as per my conversation with service engineers of a HHCP supplier.

Business drivers are factors that direct business objectives and assist with the achievement of business goals. This study shows that HHCP innovations are driven mainly by customer demands, new technologies, and legislation and regulation changes. Among these factors, customer demands tend to be most common and influential. However, customer requirements do not necessarily reflect the end-user's real needs. Unlike other industries like automobile and electronics, the customer/buyer and the end-user of HHCPs are two distinct groups (Figure 3.1). For example, in the e-health and telemedicine market in the UK, the major buyers are public sector, such as local authorities and housing associations, which purchase products from suppliers and then provide them to end-users for free. The end-user does not buy the products but is sometimes charged for maintenance, including replacement and repair, as well as other product associated services, such as training, technical support, and health supervision. In this scenario, the supplier is not highly motivated to focus efforts on satisfying the end-user. For

example, the major influential factors determining the commercial success of telecare product and service suppliers, identified in interviews with ten project and product managers, were as follows: the company's relationship with the public sector and other key stakeholders in the supply chain; business flexibility; and added value and services to products. This list does not even mention end-users, unfortunately.

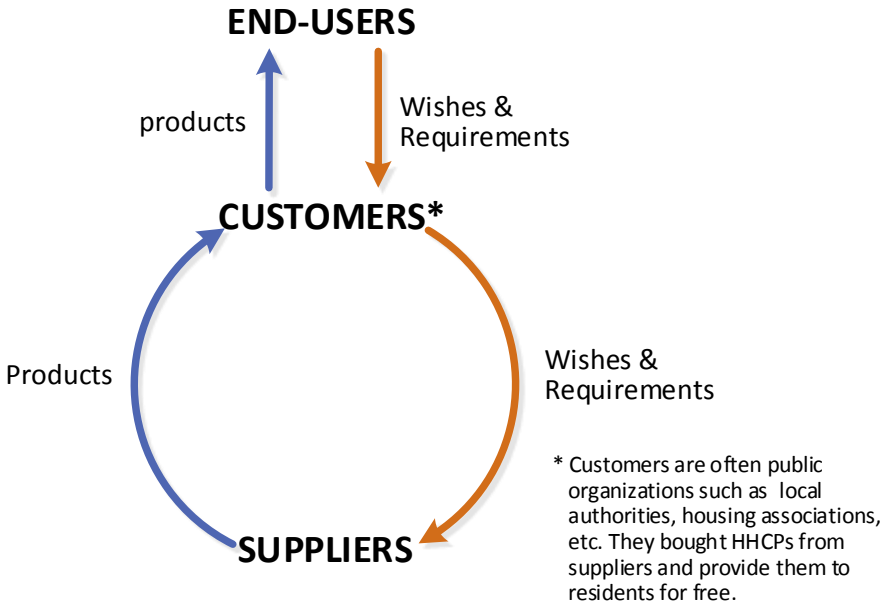

Figure 3.1 The discovery and delivery of user information when end-users are not buyers

This partly explains why there is a lack of systematic user research in FFE of projects, though it has been widely acknowledged that having a full awareness of users' needs and wishes upfront is a determinant of success in developing successful product or service solutions (e.g., Ottum and Moore, 1997; Rhea 2003; Callahan and Lasry 2004; Sleeswijk Visser 2005). While the customer/public sector can indeed broaden the suppliers' channels of collecting user data and information, it is essential to enable direct and two-way communication between the product supplier and the end-user (Figure 3.2).

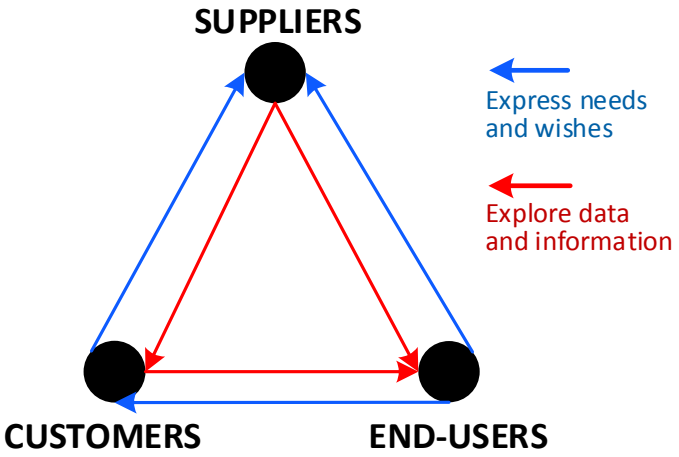

Figure 3.2 An ideal situation of discovering and delivering user data and information

The Current System of Acquiring and Communicating User Information

When the end-user plays the role of the customer, their needs and wants obviously figure higher on the product suppliers' list of priorities. However, even in this scenario, product suppliers do not frequently engage the end-user in forging business strategies, determining project directions, and generating solutions. Instead, many of them rely on the information collected and provided by hospitals, surgeries and other medical product distributers (Figure 3.3). The system of using medical institutions and organizations to learn about target groups' needs and wishes is effective for reflecting individual needs and providing quantitative information at low cost. However, these information providers do not place the job of collecting product innovation relevant information high on their priority list, nor are they specialised in this job. As a result, the 'user insights' that HHCP suppliers apply in NPD are often based on second-hand information, the quality and the accuracy of which cannot be guaranteed (Figure 3.4). It can lead to false information being used, whilst valuable information is missed out during the process of translation and transfer.

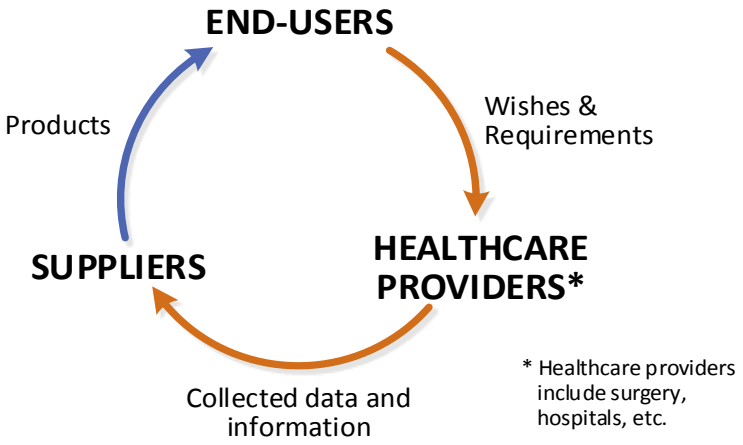

Figure 3.3 The discovery and delivery of user information in end-user product innovations

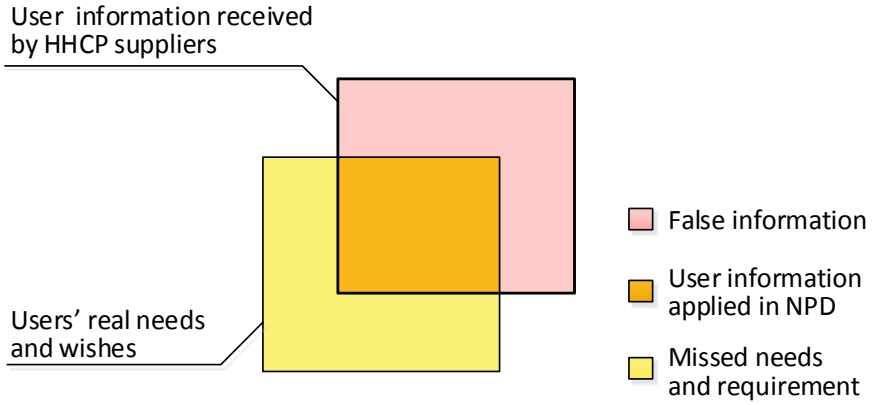

Figure 3.4 User data and information applied in HHCP innovations

Business Types – Product Based, Service Based, Or Product- Service Hybrid?

Home healthcare suppliers can be categorised into three types: product based, service based, and product-service hybrid. This study shows that most SMEs in the sector are based on delivering products; service-based suppliers are more frequently seen in the telemedicine area; and the product-service hybrid type is often taken by market leaders, and is also estimated to be the development trend of many up and coming SMEs.

In the sector, product and service are frequently present as two essential and interrelated components of realizing the intended functions. On the one hand, end users often need assistance in product use and maintenance. On the other hand, some HHCPs are required to be operated in certain stages of operations by other stakeholders such as medical institutions and monitoring centres, besides end users. These two features create opportunities for service development. Thus, one substantial step that small and medium sized product suppliers take on the path of business expansion is to supplement their existing products with services. These services include product replacement and repair; user training; technical support; remote health supervision and diagnosis; and product customization for a specific customer's needs. The association of product and service can address user and/or customer wishes and requirements that cannot be fulfilled by products alone. Product-service hybrid suppliers with experience and resources may go a step further and take over customer operations that relate to the use of products.

In most cases, HHCP suppliers do not necessarily transition to providing only healthcare services. However, with service provision becoming an increasing share in the overall business, a time comes for a supplier, especially an SME, to choose their business focus - on Product or on Services? It is wise to do so as the two innovation modes actually pull against each other - the relatively rigid and disciplined linear processes are usually applied in new product development while service innovations flourish in a more flexible, inclusive, and relational context. Running the two modes simultaneously is likely to create considerable challenges for many SMEs.

To decide whether to shift the business focus, a company needs to carefully assess both its internal and external challenges. If it decides to do so, it must revise or even replace its innovation management techniques, to adapt to the new business requirements (See more details in Section 3.4 & 5.6.2). Such a strategic level adjustment is likely to lead to further changes in diverse aspects of a company, including its driving force, culture, and organisational structure.

3.1.3 THE CHARACTERISTICS OF SUPPLIERS

The sector is dominated by small and medium sized enterprises (SMEs). For example, 90% of the UK's medical equipment suppliers employ under 50 employees (The Department for Business, Innovation and Skills 2009).

An Overview of SMEs

A small company, as described by the Bolton Committee described in its 1971 Report on Small Firms, is an independent business, managed by its owner or part-owners, and has a small market share. This report recognised that the size of an enterprise is relevant to its sector and stated that in some sectors it is appropriate to define the size according to the number of employees but in others it may be more appropriate to look at turnover (Lukacs 2005). Although the definition of SMEs is evolving, in general, statistical definitions of SMEs use at least one of the three measurement standards: number of employees, turnover, or the size of the balance sheet.

The European Commission (EU) revised its definition of SMEs in May 2003, taking into account the 'economic developments since 1996 and the lessons drawn from the application of the definition' with the aim to 'ensure that companies which are part of a larger grouping and could therefore benefit from a stronger economic backing than genuine SMEs, do not benefit from SME support schemes'. Companies qualify as micro, small, and medium-sized companies if they fulfil the criteria set out in the table below (Figure 3.5). In addition to the staff headcount ceiling, an enterprise qualifies as an SME if it meets either the turnover ceiling or the balance sheet ceiling, but not necessarily both (European Commission 2003).

Enterprise category	Headcount	Turnover	or	Balance sheet total
medium-sized	< 250	⩽ € 50 million		⩽ € 43 million
small	< 50	⩽ € 10 million		⩽ € 10 million
micro	< 10	⩽ € 2 million		⩽ € 2 million

Figure 3.5 Definition of SMEs (European Commission 2003)

SMEs are the lifeblood of almost every economy, and usually contribute well over half the total of all business revenues within the national gross domestic product (GDP). The SME sector is the Engine of Growth. It is the largest provider of employment in most countries, especially of

new jobs and a major source of technological innovations and new products. In the EU, approximately 98% of an estimated 19.3 million companies are defined as SMEs. The majority of these companies are of small size, with 18 million companies (93.2%) employing fewer than 10 people while only 35,000 companies employing more than 250 people (Lukacs 2005). Furthermore, most jobs in the EU are created by SMEs. Figures from EUROSTAT show that SMEs provide roughly two thirds of employment within the EU (with micro companies accounting for 34%, small companies accounting for 19% and medium-sized companies accounting for 13%). This percentage is predicted to rise largely with increased globalisation through the expansion of e-commerce and Internet usage. In the UK, Small businesses are recognised as the backbone of the UK's economy. In general, SMEs account for 99.9 % of all companies and half of the UK's turnover. According to Small and Medium-sized Enterprise (SME) Statistics for the UK and Regions 2009 (BIS 2010), there were an estimated 4.8 million private sector companies in the UK at the start of 2009, an increase of 51,000 (1.1 %) since the start of 2008. Almost all of these companies (99.3 %) were small (0 to 49 employees). Only 27,000 (0.6 %) were medium-sized (50 to 249 employees) and 6,000 (0.1 %) were large (250 or more employees). All these companies had an estimated combined annual turnover of £3,200 billion (Figure 3.6). Turnover in SMEs is estimated at £1,589 billion, £88 billion (5.8 %) higher than 2008. SMEs employed an estimated 22.8 million people, accounted for more than half of employment (59.8 per cent) and turnover (49.0 per cent) and Small companies alone (0 to 49 employees) accounted for 48.2 per cent of employment and 35.7 per cent of turnover (Figure 3.7).

Definition of SMEs in this thesis

SMEs in this thesis refers to small and medium–sized product and/or service suppliers which innovate. Please note that design companies, most of which can be categorized as SMEs, are not considered here.

	Number		
	Enterprises	Employment (/1,000)	Turnover[1] (/£ million)
All enterprises	4,834,045	22,819	3,240,329
SMEs (0-249 employees)	4,828,160	13,639	1,588,581
All employers	1,220,070	18,876	3,000,770
With no employees[2]	3,613,975	3,942	239,559
1-9	1,019,605	3,813	444,953
10-49	167,670	3,251	472,272
50-249	26,910	2,633	431,797
250 or more	5,885	9,179	1,651,748

Figure 3.6 Number of companies, employment and turnover by number of employees, UK private sector, start of 2009. (Source: BIS SME Statistics 2009)

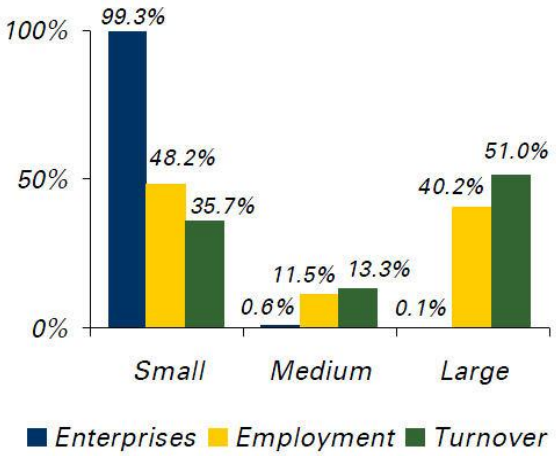

Figure 3.7 Share of companies, employment and turnover by size of enterprise UK private sector, start of 2009. (Source: BIS SME Statistics 2009)

SMES' Strategies

SMEs differ significantly from large companies and start-up companies with respect to their growth strategies.

Attitude

Responding to the pressure from competitors and powerful customers, is one common strategy adopted by SMEs in the sector to improve their operational efficiency. Techniques such as the Stage-Gate Innovation Process, the Product Development Funnel, and the Six-Sigma are widely employed for this purpose. However, the focus on operational efficiencies is not a strategy on which companies can always depend since it offers limited space for improvement, related to the actual product-service offer to end users. This is attributed to the fact that the average product life cycles are getting shorter, as a consequence of both the increasing rate of new product introductions and the faster development of new technologies. Therefore, product suppliers have to seek revenue growth from delivering new products and services which are different from competitors', to avoid being forced to significantly reduce the price, which is likely to lead to the low-margin trap.

However, SMEs tend to be more cautious about innovation – most of them have conservative management styles and are motivated to maintain stability rather than engage in innovative projects. This is proved by my primary research, as well as study from Nooteboom (1994), which suggests that only 20% of SMEs are interested in growth through acquisitions, geographical expansion or Innovation. As observed in this project, the majority of 'innovations' undertaken by SMEs in the sector can be categorized into three types: 1) providing variations on existing products to attract new customers; 2) offering existing customers improved and

more complete solutions to replace the existing ones; and 3) customizing their own products or services to meet the wishes and requirements of specific customers. Although developing a completely new product or service is rarely seen, SMEs which have gained a secure foothold and are expanding tend to be more interested in new product innovation. They also adopt the strategies of entering new regional or international markets, and extending their product line into new market segments.

Moreover, SMEs are limited by budget, technological reserve, project cycle, and market appeal to innovate. Thus, they are under resourced, or believe that they are under resourced, to carry out the (emergent) practice of front-end research on users, competitors, or market trends, which in turn limits their own abilities to innovate.

Collaboration and partnership

With regard to both the interdisciplinary nature of healthcare product/service innovation SMEs' relatively low capacity to innovate, collaboration across companies is often required in carrying out a substantial project to achieve a better result. Such collaborations may happen between product suppliers, or between a supplier and other companies which are specialized in a particular discipline, for example, a design consultancy. The collaboration pattern, which brings together a manufacturing focused supplier and one or multiple design and/or technical consultancies, is most frequently observed in this study.

Collaborations between SMEs are flexible and can be undertaken in various ways. A company that traditionally does not need to collaborate may have to do so in a particular project. As suggested by Rothwell and Dodgson (1991) SMEs may prefer to partner with other SMEs rather than with larger companies as the latter usually have a longer payback horizon and sometimes a bureaucratic culture. SMEs also worry about the increased risk of intellectual property loss when working with huge companies.

Types of innovation

My product literature review and study of 15 home healthcare product and service suppliers, such as Bath Institute of Medical Engineering, Mindray Medical International Limited and Peaks & Plains Housing Trust, S3 Group, and Firstar Healthcare suggests that innovations carried out by SMEs in this sector are generally incremental (Figure 3.8). They rarely offer new products or services which are significantly improved compared with the existing ones, or create new product categories or industries. This applies not only to new entrants to the market but also to those SMEs who have already established a strong foothold and even to leaders in specific areas. For example, in one company where they had a total of more than 1000 'projects' of

various sizes in the last ten years, they had developed only three main categories of product throughout this period.

Company	Product upgrades / Design modifications (2003-2013)	New products (2003-2013)	Deliver product related services	Size of company	Years on market	
					<10 years	>10years
C. 1	8	2	No	SME	●	
C. 2	22	7	Yes	Large		●
C. 3	9	3	No	SME		●
C. 4	6	4	No	SME	●	
C. 5	41	16	Yes	Large		●
C. 6	7	3	No	SME	●	
C. 7	5	1	No	SME	●	
C. 8	35	11	Yes	Large		●
C. 9	10	5	Yes	SME		●
C. 10	11	4	No	SME	●	
C. 11	7	3	No	SME	●	
C. 12	8	3	No	SME	●	
C. 13	12	4	No	SME		●
C. 14	21	6	Yes	SME		●
C. 15	15	7	No	SME	●	

Figure 3.8 Summary of the characteristics and behaviours of the companies in the literature review

The question then is should SMEs radically innovate or incrementally improve their market offer? Here I would like to highlight that there is no absolute distinction between the radical innovation and the incremental innovation, though the former is generally defined as an out-of-the-blue solution which creates new industries, new avenues and new markets. if projects are viewed from an in-house dimension the criteria of which is based on the knowledge, skills and resources involved, the nature of an innovation may transform when being carried out in different companies. That is to say, the completely new knowledge, skills and resources to one specific company, which is required in radical innovation projects, can be familiar to another. Even when similar products or services already exist in the market, a project can be viewed as highly innovative from an in-house perspective. Some authors have pointed out that the development processes that suits managing incremental innovation, often fail to manage the complex and uncertain environment of radical innovation projects, thus, it is essential for a company to define the constraints and challenges, and to review and adjust its own development management technique at the outset of a project (Williams 2005).

3.1.4 THE IMPACT OF CHANGING BUSINESS STRATEGY ON INNOVATION MANAGEMENT

Managing a company of any type is inherently difficult, but the challenges are much more evident in SMEs of product-service hybrid type. The more rigid and disciplined stage-gate processes generally suit new product development, especially projects with the aim of providing variations on existing products (incremental improvement) (See section 4.4.3 for more details). In contrast, developing new services requires a process which embraces a more flexible, inclusive and relational context, in which service innovation flourishes (Susman et al. 2007). In addition, the implementation of new innovation management techniques may demand adjustments in company operations, culture, organization structure, techniques and skills.

The considerations for managing product- focused, service- focused and product - service hybrid innovations have been summarized in the table below (Figure 3.8).

Business mode / Consi-derations	Product based	Product- service hybrid		Service based
		Product focused	Service focused	
Customer satisfaction	Customer satisfaction is based on the product.	Customer satisfaction is based on both the product and the service-correlated considerations. The weight of the product in determining customer satisfaction depends on specific market and business.	Customer satisfaction is based on both the product and the service-correlated considerations. Those factors determine the success of service development tend to have more significant influence.	Customer satisfaction is based on service delivery, added value, relationship and reputation, flexibility, customization, etc.
Modes of operation	The more rigid and disciplined stage-gate approaches.	A formal and adaptive overall process which is designed with full considerations of different innovation types.	A formal and adaptive overall process which is designed with full considerations of different innovation types.	A more flexible, inclusive and relational approach
Driving force and Culture	Show a high priority on new product development and time-to-market; Emphasize the end-user experience and performance	Show a high priority on product customization and providing product variations; Values time-to-market and relationship with customers	Values customer relationship, flexibility and customization; Eager to improve the product design to mitigate the cost of related services	Values customer relationship and satisfaction, flexibility, variety, responsiveness, speed and customization

Figure 3.9 Differences in innovation management considerations between product- focused, service-focused and product - service hybrid project

These differences require companies to employ different innovation approaches and strategies based on their business focus or to forge a flexible principle methodology addressing the

features and parameters of different innovation types. For example, Susman et al. (2007) proposed the 'Total Solution Development (TSD) Model' to manage both product innovations and service innovations.

3.1.5 TARGET AUDIENCE OF THIS PROJECT

Innovation is vital to any company wishing to grow. Numerous surveys over the past decade have shown that those which innovate consistently have higher performance in terms of profitability, market share or revenue than those that do not (Gilmore, 2011). However, companies are not equally well adapted to innovation. They can be categorized into diverse groups in terms of their features. A single strategy cannot equally address the requirements in improving product development from all these groups since new definitions can be easily given according to different criteria. Therefore, it is necessary to define and segment the SME population in the first instance, to ensure that this project focuses on the best able to benefit from assistance.

Figure 3.10 shows this trend and illustrates SMEs' distributions with reference to the factors of performance and innovation intensity. This figure was made based on the model from Rowan Gilmore (2011) (Figure 3.11).

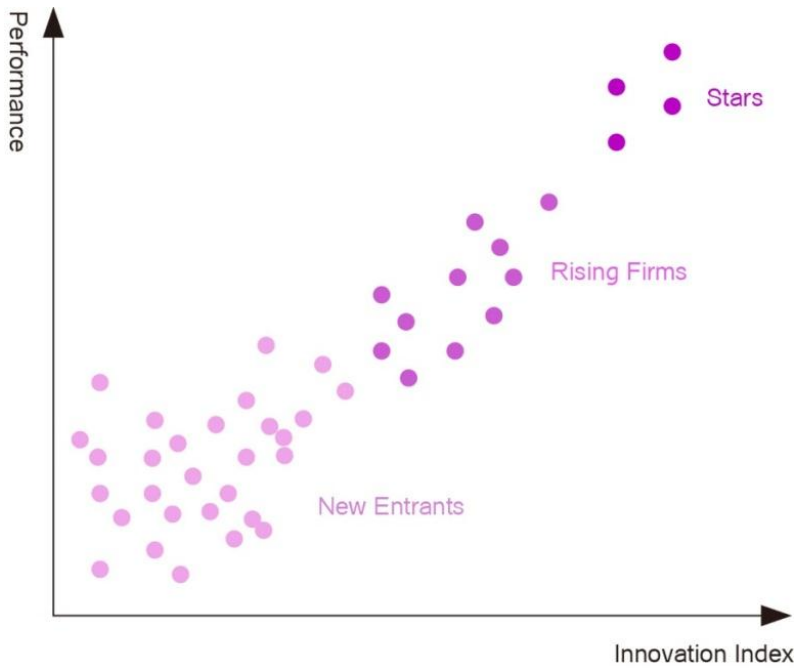

Figure 3.10 SMEs Distribution

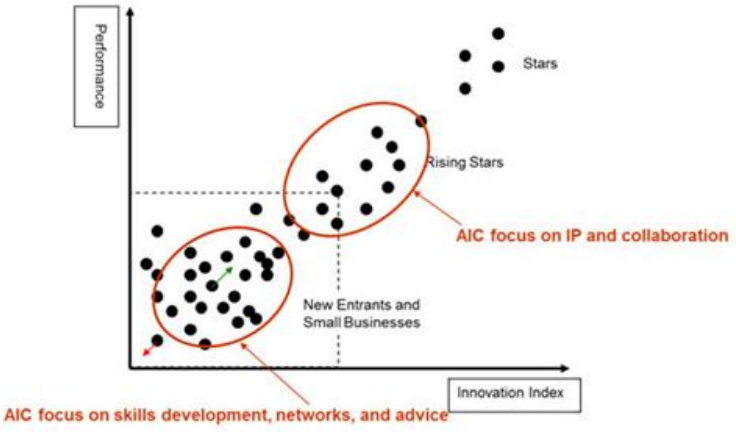

Figure 3.11 Model from Gilmore, R. (2010)

As illustrated in Figure 3.10, SMEs are categorized into three groups, new entrants, rising firms and stars. The overwhelming majority of new entrants at the low end of the plot lack the resources and skills to innovate and usually need to focus on achieving efficiencies in their finance, human resources and customer management systems to survive. However, building a sufficient awareness of innovation at this stage indicates the way forward for new entrants with potential and helps them avoid making strategic mistakes when reaching the next stage. Companies at the top end are the stars, the highest R&D spenders. They typically already know how to innovate independently, and normally will not require the services of an innovation intermediary. Rising firms in the middle are in a much more complex situation. After gaining a relatively secure foothold in their sectors, they often attempt to deliver innovative solutions or build partnerships with other companies in order to expand their market share and to consolidate their positions. Some of these attempts may fail but those with sufficient absorptive capacity and commitment are more likely to survive. In general, this young and rising group is inexperienced but is eager to learn. It has also acquired the ability to adopt and adapt in certain ways and thereby could most benefit from support or coaching on improving their product innovation strategies.

The foregoing elaboration has revealed the group of product suppliers in SMEs which could benefit most from the production of this project, the aim of which is to support SMEs by developing a new innovation management technique. As illustrated in Figure 3.12, this population embrace mainly the rising firms and new entrants which have gained a foothold in the market and have potential to innovate. Some firms at the top may also use the coming brief creation tool or process as reference to help themselves manage innovation and production.

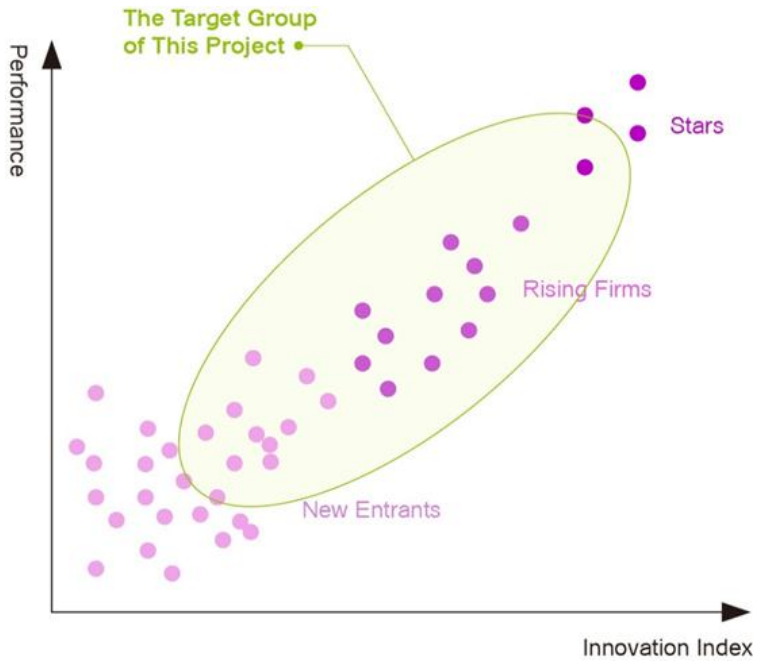

Figure 3.12 SMEs Distribution

3.1.6 CONCLUSIONS

The combination of the features of HHCP industry leads to the conclusion that there is a pressing need in supporting product suppliers in the sector to innovate:

1. The lack of valid early user input into the design process leads to the fact that the design and the user performance of many HHCPs and associated services are unsatisfactory (Refer to Chapter 2.2) (See an example of user-centred products in Chapter 3.3.2.3). The root causes are:

- The sector is dominated by SMEs which are neither highly motivated nor fully capable of discovering and addressing users' real needs and wishes in NPD (Refer to Figure 3.8 in Chapter 3.1.3.2).
- A large portion of HHCP do not often engage end-users in forging business strategies, determining project directions, and generating solutions; instead they rely on 'secondary information' in product innovations.

2. In the HHCP sector, product and service are frequently present as two essential and interrelated components of realizing the intended functions. Product suppliers often adopt the business growth strategy of supplementing their existing products with relative services, to fulfil user and/or customer wishes and requirements that cannot be addressed by product only. Transitioning from providing only products to the product-service hybrid type is identified in this study as one development trend for the SMEs which have gained a foothold in the market.

The adjustment on business strategy introduces new requirements on project management, and therefore requires a company to revise and even replace its present innovation management techniques.

3. Moreover, the suppliers generally lack skills and experience in developing innovative product solutions, particularly in the planning and the execution of front-end activities.

This study also reveals that among the SMEs, the rising companies and new entrants which have gained a foothold in the market and have potential to innovate could benefit most from a new innovation management technique. This population is identified as the target audience of this study.

3.2 NEW PRODUCT DEVELOPMENT PROCESSES

3.2.1 SUMMARY

Developing a new product is complex and time-consuming, and does not always turn out to be a success. For example, David and Earl (1971) found that 40% of new consumer products, 20% of new industrial products, and 18% of new service-related products have failed completely as products. As indicated by Cooper (2001) in a more recent book, 35% of products launched in the market are commercial failures which consume approximately 46% of resources devoted to product development and commercialization. All these imply that there had been no marked improvements in product/service innovation techniques, regarding to the dynamic changes in market challenges during those three decades (1971-2001). In addition, this present study has found no evidence demonstrating obvious improvement in the past ten years.

With the ultimate goal which is to establish strategies of improving product innovation in small and medium sized home healthcare suppliers, the major problems in new product development (NPD) were explored in this study. The task of problem identification was carried out following two stages: 1) desk research of NPD processes, and 2) case studies of home healthcare product suppliers, which is to evaluate and develop conclusions generated in stage one, and to gain a deeper understanding of real problems (Figure 3.13).

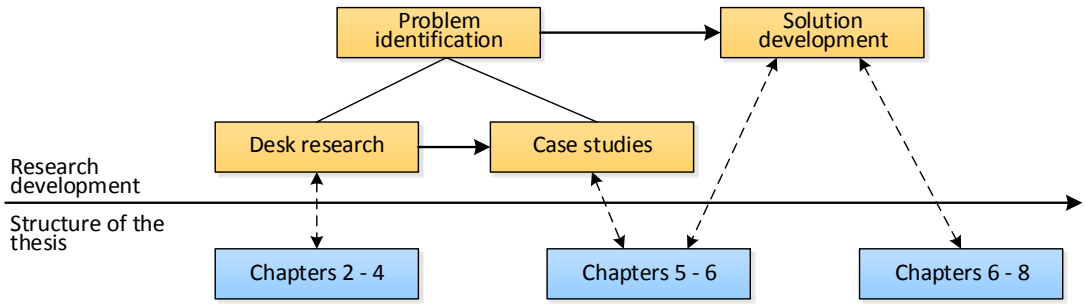

Figure 3.13 the relation between the thesis structure and the research development

3.2.2 WHAT IS NPD AND NPD PROCESS?

As a consequence of both the increasing rate of new product introductions and the fast development of new technologies, product life cycles are getting shorter. It implies that companies will have fewer opportunities to live on past successes. They have to bring more

and more products to market to remain competitive (See Section 3.3.3 for more details). Product suppliers, especially those of small and medium size, increasingly depend on revenues from new products (Australian Research Council 2005). Obviously, product suppliers best able to execute new product development (NPD) have a clear advantage over their competitors.

NPD can be viewed as a process, and like any other process, it can be managed by a formalized model which summarizes the activities in the process. Such a model is the NPD process.

Both the terms of 'NPD' and 'NPD process' have existed in the world of engineering, business strategy, and marketing for a long time. However, there is no universally accepted definition of either the two phrases or the activities in terms of the whole NPD process. For example, in engineering, NPD is often the term used to describe the complete process of bringing a new product to market, while marketers typically see NPD as the first stage in generating and commercializing new products within the overall strategic process of product life cycle. A general understanding is that the NPD process begins with market-oriented activities, such as determining the need from anticipated users and analysing the market; it then moves on to the concept phase, a basic drafting phase and a more detailed design phase, when the product idea is formulated; the process ends with production and sales. However, some other authors describe the front end of innovation and the stage of commercialization as two separated sections from the overall NPD process (e.g. Koen 2002) (Figure 3.14).

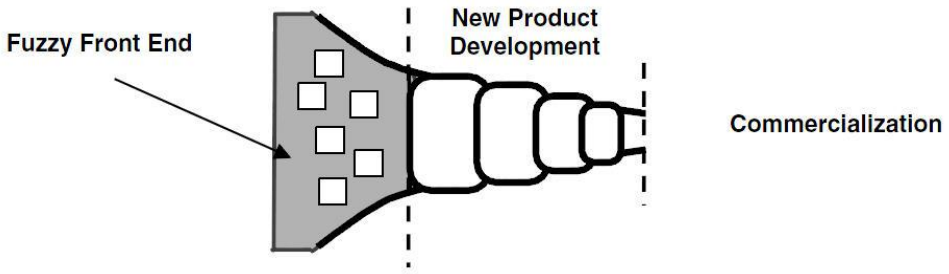

Figure 3.14 Peter A. Koen 's model of the entire innovation process

On a micro level, the definitions of some of the frequently used terms relative to specific stages and activities of the NPD and/or the links between these terms are vague and even confusing in some cases. These terms include: Fuzzy Front End (FFE), Commercialization, Predevelopment and Market Analysis.

Given that the terms above with their inherent connections are frequently discussed in this thesis, I have to offer my own definitions at the outset of this chapter.

3.2.3 DEFINITION OF NPD PROCESS AND ITS ASSOCIATED ACTIVITIES IN THIS PROJECT

Definition of NPD Process

In this study, the NPD process is viewed as an innovation technique for managing the development and marketing of new products. It is the complete process of bringing a new product through various stages to market launch. It involves stages of Market Analysis, Idea Generation, Screening, Concept Development, Development of Product and Commercialization. The front end stage is critical for great invention and innovation. It is recognised as covering Idea Generation, Screening and overlap Market Analysis of an overall NPD process. The term of Predevelopment incorporates all steps before the Development of the Product in the NPD processes (Figure 3.15).

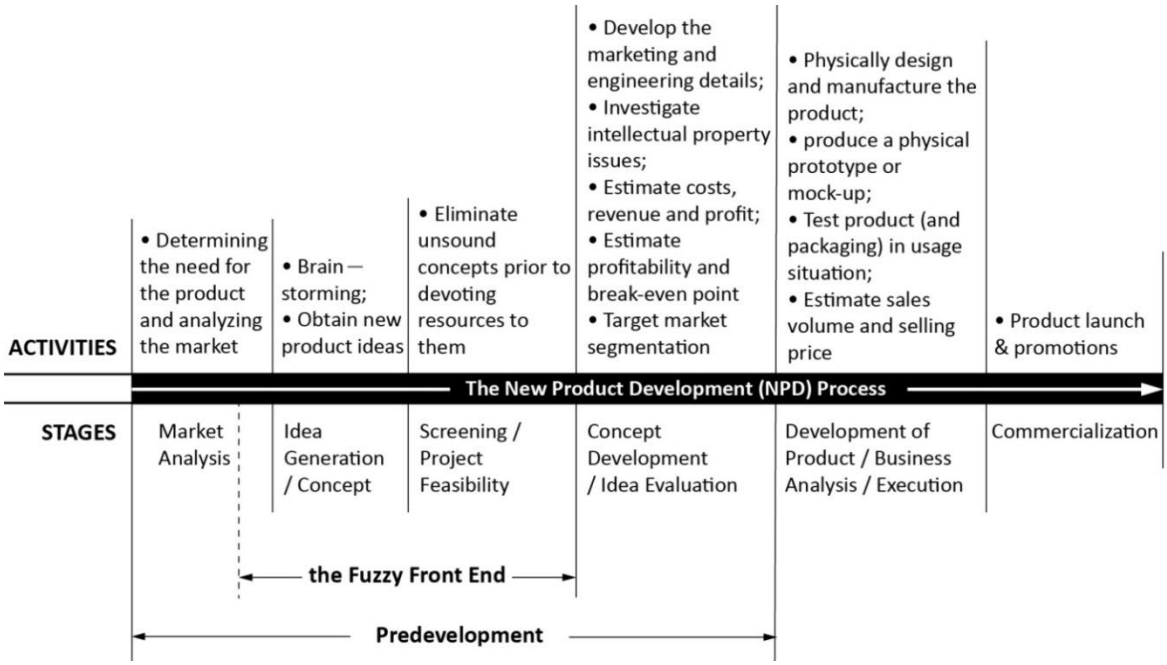

Figure 3.15 Clarifying NPD, FFE, Predevelopment, and Market Analysis, and the activities in various stages of the NPD process in this study

1. Market Analysis
    - Determining the need for the product and analysing the market
2. Idea Generation / Concept
    - Brainstorming - thinking about it
    - Creating a new product based on some observed need
    - Thinking of a new product based on some accident or chance circumstance

- Obtaining new product ideas on observed needs and opportunities

3. Idea Screening / Project Feasibility Stage

   - Eliminating unsound concepts prior to devoting resources to them:
   - What are the weaknesses of existing products that are similar?
   - Is there any competition for a new product?
   - What are the industry sales and market trends the product idea is based on?

4. Idea Evaluation / Concept Development and Testing

   - Developing the marketing and engineering details
   - Investigating intellectual property issues
   - Estimating costs, revenue and profit
   - Estimating profitability and break-even point
   - Segmenting the target market

5. Development of Product / Business Analysis

   - Physically design and manufacture the product
   - Producing a physical prototype or mock-up
   - Estimating likely selling price based upon competition and customer feedback
   - Estimating sales volume based upon size of market
   - Testing the maintainability of the product
   - Developing a scheme for the ethical disposal/recycling of the product at the end of its life

6. Commercialization

   - Product launch & promotions

Definition of The 'Fuzzy Front End' Stage

There is neither a universally acceptable definition of the front-end stage, nor a dominant framework so far (Hüsig and Kohn 2003). Some other authors also use 'Phase 0', 'Stage 0', 'Front End of Innovation', or 'Pre-Project-Activities' to make the same point. The front-end stage is defined by many authors to begin when the project opportunity is first considered worthy of further ideation, exploration, and assessment, and to end when it is signed off to enter the structured development process (e.g., Smith & Reinertsen 1992, Cooper 1993; Khurana & Rosenthal 1998, Koen et al. 2001, Kim & Wilemon 2002). This definition is adopted in this thesis. To further clarify the FFE of the NPD process, this thesis also defines the stage to consist common NPD activities including: opportunity identification, selection and assessment;

project planning; product definition, strategy formulation and communication; design idea generation; and design concept development (Figure 3.16).

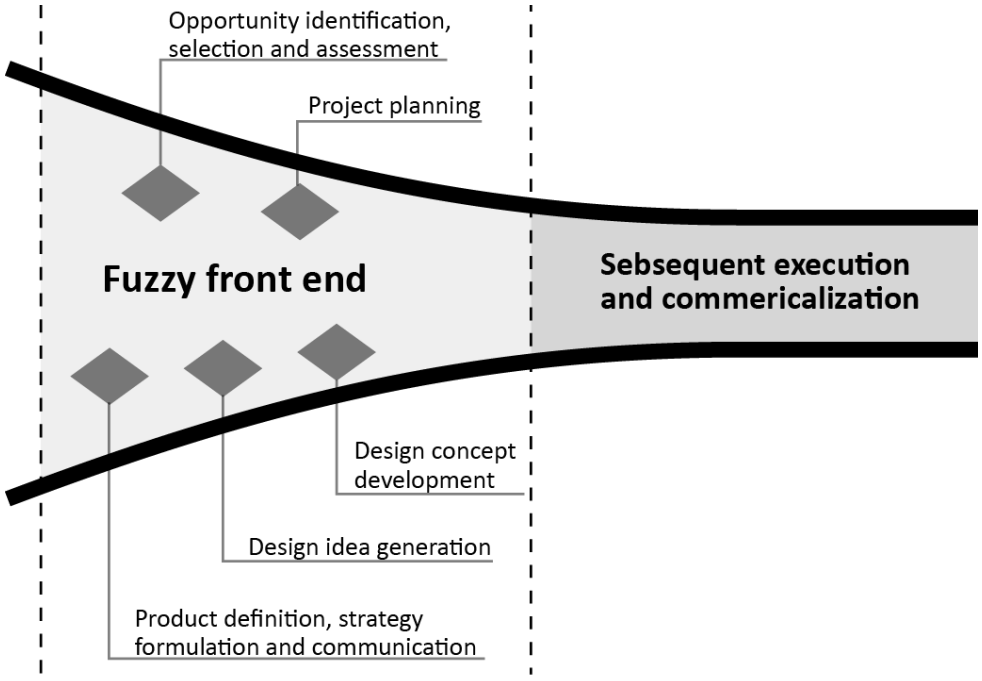

Figure 3.16 Definition of FFE

The 'fuzzy' feature of the front-end stage

The front end of the NPD process is routinely described as 'fuzzy front end' (FFE) since it is hardly ever being addressed by a structured process, and there is also a lack of consensus on what activities should be undertaken and who should participant in this stage. In literature, the term 'fuzzy front end (FFE)' was early popularized by Smith & Reinertsen (1991) in their book 'Developing products in half the time', and has been more widely recognized in recent years.

Constant iteration and flow is the hallmark of activities in this stage (koen et al. 2002). Frequently, companies begin the FFE stage without a clear definition or analysis of the process to go from opportunity identification to concepts (Achiche and Appio 2010). A team embarking on innovation is unsure of its destination as well as the path it is taking. Along the way, it will uncover new information that requires changing direction and often backtracking. FFE activities therefore involve a complex, intuitive and reflective process with many interactions, which leads on to the chaotic, unpredictable and unstructured stage in contrast with the typically structured and predictable subsequent NPD process. Iteration and loop-backs are part of FFE activities.

The Significance of Strengthening FFE Management

While the inherent looping back within FFE may delay the progress and increase cost, it typically shortens the total cycle time of product development and commercialization and avoids making critical mistakes later (Koen et al., 2002). The management of FFE activities is critical for great invention and innovation. It sets the course for both the entire project and the final end product. This stage may consume up to 50% of development time (Smith and Reinertsen 1998); and the decisions made during this phase are pointed out to affect 70% of the overall project costs (e.g., Koen et al. 2002). Unfortunately, new product development management (NPD) techniques that are widely used by small and medium-sized product suppliers, such as the Stage-Gate® Innovation process and the PACE® method, tend to focus only on NPD activities after the generation of invention, and therefore do little to help the FFE management. It has also been pointed out that linear and sequenced systems are inappropriate to manage FFE activities – they may interfere with creativity and do not adapt to the 'fuzzy' feature of the front end stages of product innovations.

Furthermore, FFE is the best opportunity for the designer to influence the product itself (Koen et al. 2002). Design activities in the FFE include gathering information, idea generation and conceptualisation. Several tools and techniques, such as Brain Storming, Scenarios, Experiential prototyping, Mind mapping, Role-playing and Storyboards can be used by designers to discover opportunities; to examine and represent ideas; and to improve, structure and organize their work in the FFE context. Unfortunately, these techniques are rarely adopted by product suppliers in the sector (Refer to Chapter 3.3 & 3.4). To define root causes of this problem and to establish a resolution is significant in delivering innovative solutions.

To achieve a high performance in FFE, it is vital to ensure that each major activity in this phase is well executed. For example, it is widely acknowledged that having a full awareness of user/customer needs and wishes upfront is a determinant of success in developing successful product or service solutions (e.g., Ottum and Moore, 1997; Rhea 2003; Callahan and Lasry 2004; Sleeswijk Visser et al. 2005). This study has found that some FFE activities are often performed poorly by SMEs in the sector. Apart from a strong NPD process, there is also an obvious need to reinforce FFE management by assisting suppliers in carrying out specific NPD activities.

3.2.4 A REVIEW OF WIDELY-USED NPD MANAGEMENT TECHNIQUES

As a consequence of both the increasing rate of new product introductions and the fast development of new technologies, product life cycles are getting shorter. It implies that companies will have fewer opportunities to live on past successes. They have to bring more and more products to market to remain competitive (See section 3.3.3 for more details). Product suppliers, especially those of small and medium size, increasingly depend on revenues from new products (Australian Research Council 2005). Obviously, product suppliers best able to execute NPD have a clear advantage over their competitors.

There has been extensive research on new product development (NPD) management techniques. For example, one of the most widespread conceptual descriptions of the NPD process is the framework from Clark and Fujimoto (1991). This framework is specified to incorporate five successive but overlapping steps: 1) Idea generation; 2) screening; 3) idea evaluation/Concept development; 4) development of product/business analysis; and 5) commercialization. A more detailed thirteen-stage-model was proposed by Cooper and Kleinschmidt (1986). In general, NPD management techniques adopted by SMEs in the home healthcare filed can be categorized into two categories: stage-gate process and agile process. Their features, advantages, and drawbacks are explored below.

3.2.4.1 STAGE-GATE METHODS

Although alternative approaches exist, stage-gate methods have become one of the most omnipresent types of tools in the new product developer's arsenal over the last few decades (Shaeffer & Zikle 2003). Stage-gate methods, in general, manage NPD/NSD by segmenting an overall set of activities in the development process into 'phases' with intervening decision points/gates. The most familiar examples among this population are Robert Cooper's Stage-Gate® Product Innovation Process and PRTM's PACE® (Product and Cycle Time Excellence) approach (McGrath 1996, Cooper 2001). These two techniques are discussed more in detail below.

The Stage-Gate® Product Innovation Process

The Stage-Gate® Product Innovation Process (Stage-Gate® is a registered trademark of Product Development Institute Inc.), also referred to as a Stage-gate process, is a project management technique which was pioneered by Robert G. Cooper in his book 'Winning at New Products' (1986). A Stage-Gate® process is a conceptual and operational map for moving new product

projects from idea to launch and beyond – a blueprint for managing the NPD process to improve effectiveness and efficiency (Cooper 2008). This approach is, as described by its developer, ‘‘a carefully designed business process’’ and the result of comprehensive research into understanding the reasons behind product success and failure (Brands 2010). It is now widely used and trusted by companies around the world. According to the Product Development & Management Association (PDMA), 68% of leading U.S. product developers use some type of Stage-Gate® process (Cooper 2001).

The Stage-Gate® Product Innovation Process divides an initiative or project into a number of stages or work stations. Between each work station or stage, there is a quality control checkpoint or gate. A set of deliverables is specified for each gate, as is a set of quality criteria that the product must pass before moving to the next work station. The stages are where the work is done and the gates ensure that the quality is sufficient (Cooper 1990) (Figure 3.17).

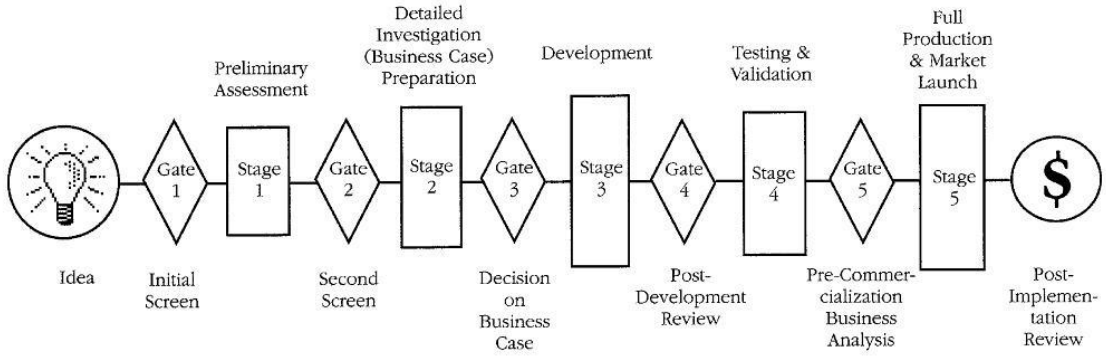

Figure 3.17 An Overview of a Stage-Gate System (Source: Cooper 1990)

Primary benefits of using the Stage-Gate® Model**:**

When implemented properly, Stage-Gate is designed to deliver as follows:

- Accelerates speed-to-market
- Increases likelihood of product success
- Introduces discipline into an ordinarily chaotic process
- Reduces re-work and other forms of waste
- Improves focus via gates where poor projects are killed
- Achieves efficient and effective allocation of scarce resources
- Ensures a complete process – no critical steps are omitted

(Points summarized from www.stage-gate.com)

The PACE (Product and Cycle Time Excellence) technique

The PACE technique follows the well-known Product Development Funnel structure. This structure provides a graphic structure on the interrelations between customer need & technological possibilities and concept generation & screening. A variety of different product and process ideas enter the funnel for investigation, only a fraction evolves through the subsequent steps and become part of a full-fledged development project.

Below are the two dominant models of the development funnel designed respectively for large companies (Model A) and SMEs and start-up companies (Model B). As illustrated in the two models, SMEs usually adopt a simpler version of the development funnel structure (Figure 3.18 & 3.19).

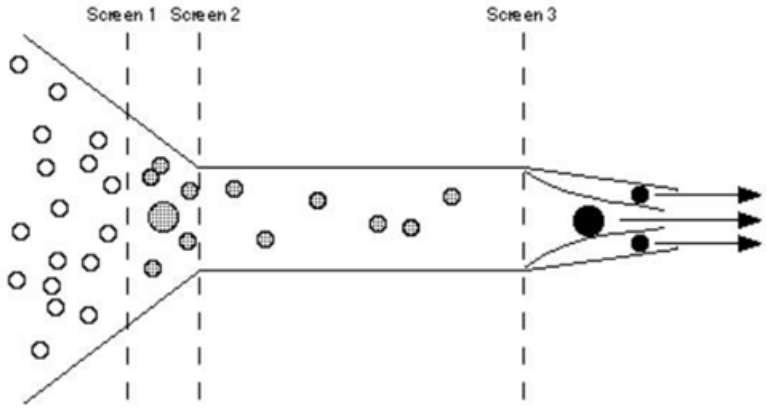

Figure 3.18 The development funnel model A
(Source: http://www2.ifm.eng.cam.ac.uk/dstools/paradigm/innova.html)

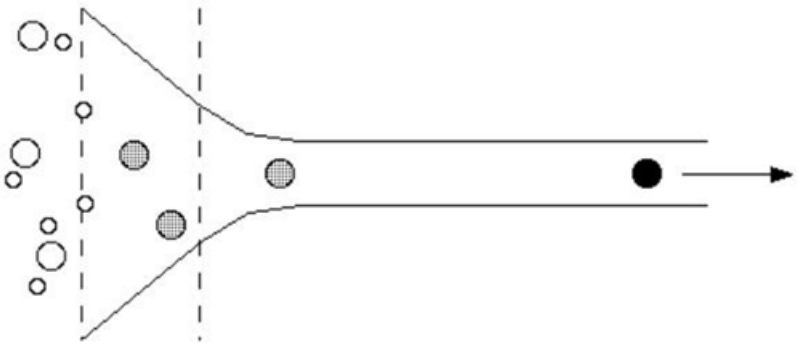

Figure 3.19 The development funnel model B
(Source: http://www2.ifm.eng.cam.ac.uk/dstools/paradigm/innova.html)

The PACE process provides companies with a multi-disciplinary approach to innovation. It has been proven to be successful and has been widely used in well-known companies such as IBM and Motorola. The achievements from implementing the PACE process includes: 1) higher

product development productivity; 2) higher customer satisfaction; 3) design for excellence; and 4) a decrease of time-to-market.

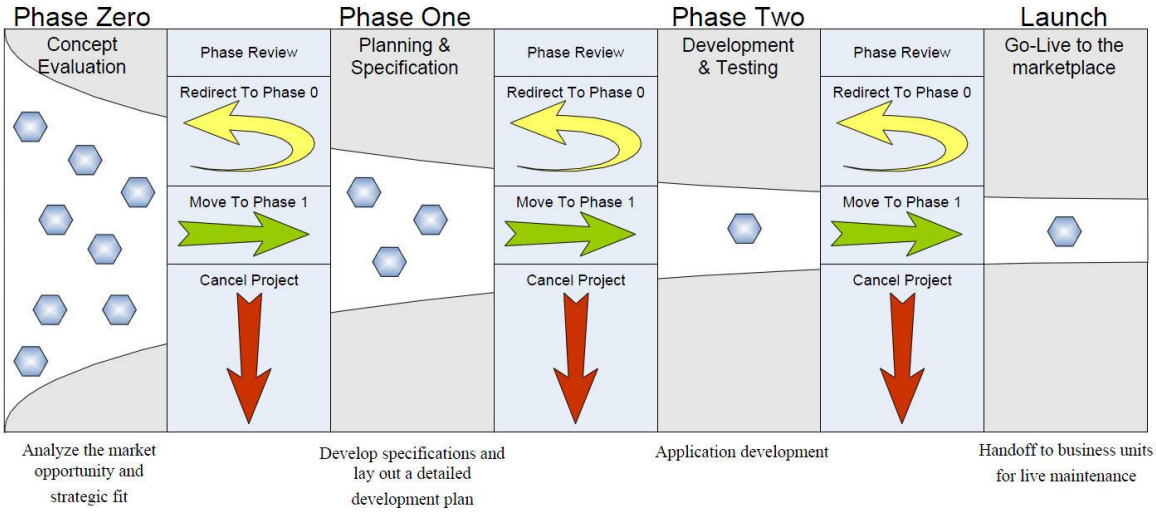

Figure 3.20 The PACE Process (Source: Metcalf 2007, page 4)

The PACE process can be viewed as a funnel which provides companies with a clear and consistent process for making major decisions in product/service development. When undertaking this approach, many ideas enter at the concept phase; go through a series of screening decisions over the course of development; and then being narrowed to a few appropriately resourced projects with a high likelihood of market success (Metcalf 2007) (Figure 3.20). Throughout this process, key activities of variable stages are linked and the progress is monitored and is measurable by applying evaluation at checkpoints.

3.2.4.2 FEATURES OF STAGE-GATE TECHNIQUES

Strengths

Stage-gate methods have been widely used, and have shown positive influence on product development (Huber 2002). In general, they are 1) an effective way to bring structure and discipline to a chaotic environment; 2) help the team to monitor its progress and ensure tasks are completed properly; 3) provide upper management with visibility and control; and 4) provide a defined path for getting from an opportunity to commercialization with checkpoints along the way.

As indicated by Woodcock et al. (2000), SMEs often carry out the NPD process less completely or thoroughly than do larger companies. Most SMEs do not use all of the 'stage-gates' of the Stage-Gate® Product Innovation Process as recommended by Cooper (1999). As indicated by

March-Chorda et al. (2002), for example, 54% of Spanish firms use nine or less of the thirteen stage-gates.

Weaknesses

Stage-gate techniques, such as the Stage-Gate® process and the PACE process, tend to be linear and sequential: project teams moves through variable stages in sequences after passing gate reviews between each stage. Such a linear process is effective under the condition that project management in a low-uncertainty situation - when team members are familiar with the destination and the path to get there, and with the associated technologies to be utilized. Thus, stage-gate methods usually perform well in managing project types such as an existing product extension. In managing a platform or a breakthrough project as well as front-end activities of all types of projects, however, deploying stage-gate techniques has been pointed out to be less effective (e.g., Koen 2004, Shaeffer & Zirkle 2008). This is because platform and breakthrough projects, and the front-end stages of all project types share the hallmark of uncertainty. This nature is emphasized even more by the 'Universal Design' or 'Design for all' discipline in home healthcare field, as well as the trend that customers tend to be more demanding for new solutions, and competitors move faster.

In addition, stage-gate techniques sometimes ignore the links between technology and business opportunities (Achiche and Appio 2010). There are also worries that a very structural and sequenced system may interfere with creativity. For example, Engineers, can be directed at times with good intentions to ignore the front end and focus on the development stages of a stage gate process (Coats 2008).

3.2.4.3 COMPARING STAGE-GATE METHODS WITH AGILE METHODS

Stage-gate methods regularly evaluate project progress against the business criteria and the portfolio. This feature can be viewed as both stage-gate techniques' advantage and disadvantage. On the one hand, it ensures that decisions and output are generated in projects with firm financial and market justification, aligned with the original objectives. On the other hand, the need for reviews at each stage may consume enormous time and slow up work; and it is hard to change anything that was developed at an earlier stage once a gate has been passed. Agile is intended to overcome these problems. It is a methodology which incorporates numerous methods of 'Agile' development. We hear the terms 'Agile' and 'Agile process' increasingly often these days.

Compared with stage-gate process, the agile process has a number of benefits: 1) it speeds up the development cycle; 2) it postpones decision making to allow the production of some early results – to contribute to the progress of a project; 3) it saves the time consumed in meetings and review, and their preparation in a stage-gate project; 4) it also creates a more flexible environment which restores power to development teams.

Agile has been successfully deployed in small projects, but is frequently pointed out to fail in managing medium and large-sized projects (Product Focus 2013). This is attributed to the fact that agile process frequently ignore the practical problems of development, regardless of the project scale. Without a level of structure and control, projects can easily go over budget and time. In contrast, Stage-gate process tend to be more supportive of the longer cycles of field research and domain understanding that are required in more complex applications, and therefore usually perform better on managing complex product/service innovations, and on managing risks throughout a project cycle.

> "*With large projects, with hundreds or even thousands of developers who work for many years, stage gate is the only method that works."*
>
> - *as per my conversion with a project manager during the workplace study (See Chapter 3.3.3)*

Although a too rigid design process is considered to strangle creativity (see Section 3.4.2.2 for more details), the agile project management does not necessarily lead to design excellence. Agile teams tend to start to work immediately after receiving a task, and are often resistant to incorporate proper design principles into the development process. It has also been pointed out that design research and planning are difficult to be integrated into the hectic cycle of a project adopting agile process (Norman 2012). Previous sections of this thesis have revealed that the design of successful home healthcare products is generally required to be based on comprehensive front-end research – to deeply and accurately understand what the real problem is to be solved, and to adequately address needs and wants from diverse functional groups upfront (see Chapters3.4.2.2 & 3.4.4.1 for more details). Agile, therefore, presents a real challenge to the design team.

3.2.4.4 EVALUATING NPD METHODS AGAINST TARGET COMPANIES' FEATURES

Clarify the FFE stage of the NPD process

While the Stage-Gate approach and the PACE approach are widely adopted in SMEs, there is a lack of specification of the NPD activities in the front-end stage in both of the two project

management techniques (Refer to Chapters 3.2.4.1 and 3.2.4.2). This partly explains why critical front-end activities of the company partners' NPD projects were found in this study to be often poorly enforced or even missed out, considering that the company partners' principal NPD process was created based on the stage-gate mode. Therefore, FFE is the greatest opportunity of improving innovation capacity of the company partner.

The significance of FFE and the lack of a strong FFE activity management tool lead to the creation of the new NPD process which gives a level of structure and better control of this particular stage (Refer to Chapter 3.2.5).

Combine Stage-Gate and Agile

Although many designers and design researchers dislike the stage-gate methods, they are very widely used and enforced by small and medium sized-product suppliers. The success and the failure of both stage-gate projects and agile projects in working environments has been observed during the workplace research (See Chapter 3.3). The management team of the company partner pointed out that their principal stage-gate NPD process was often poorly implemented in practice: some key activities planned in the process were omitted; and the outputs were often generated at the wrong time (See Appendix E & G). The Agile process, as discussed Chapter 3.2.4.3, can promote creativity but may not be appropriate to be undertaken in complex home healthcare product innovations. The company partner and many other SMEs also lack experience in deploying Agile in projects. Their employees need to be trained and supported to ensure success when trying this mode.

While there has been much debate about the conflict between Agile and Stage-gate, the combination of the two modes to an appropriate level is both highly beneficial and feasible in HHCP development, in view of the very close connection between home healthcare products and services and of the multidisciplinary nature of the sector. Thus, this thesis suggests applying Agile principles in certain stages of a common Stage-gate NPD process, as required by specific projects or companies. This strategy should be easier, less risky and cheaper for the SMEs presently using Stag-gate processes, compared with deploying a completely new approach throughout.

3.2.5 A NEW NPD PROCESS (V.1)

Following the study of the current NPD management techniques above, a new NPD process was generated (Figure 3.21).

At the top of the flow diagram is a box relating to the tasks of Information Collection. Key here is the importance of gathering and aligning information from users and competitors with the available resources within a company. This collected information is then passed to a development team for processing, to determine the best NPD opportunity within the parameters such as time, budget and company strategy. Based on the type of innovation (incremental or radical), the development team should forge and deploy different innovation strategies. If it is an incremental innovation project, the flow diagram suggests 4 steps to achieve a product design concept: idea and requirement generation, idea screen, concept generation, and concept evaluation. If it is a radical innovation, there are 5 steps: new technology exploration, technology transformation, idea generation, idea screening, and concept evaluation. The diagram also proposes the main activities to be undertaken in each step. For example, in Idea Screening, the development team should weight innovation ideas based on 4 criteria: market fit, users fit, cultural fit and business fit; and then choose 2-4 ideas for further development. The approved product design concept is then passed for engineering, testing and production.

Compared with the common stage-gate processes, this new process:

- focuses on the fuzzy front end (FFE) of an innovation project cycle and gives more detailed solutions than many of the widely-used NPD management techniques discussed in Section 3.2.4.
- addresses the characteristics of both incremental innovations and radical innovations
- suggests an intimate collaboration with anticipated users with continuous exchange of bi-directional information. This is to reinforce the cooperation across teams. Not only company employees, a broader range of stakeholders including medical practitioners, carers of the users, supply chain members, product maintainers and potential partners are encouraged are encouraged to participate in the development process.
- defines when should the stakeholders get involved and for what purposes. For example, designers, engineers, market researchers and anticipated users are recommended to work together in the stage of idea screen. Users and carers can weight product ideas based on their needs and wants. Carers can also add valuable user information that users themselves may ignore. The participation of market researchers helps to address both competitor and business resource information. Supply chain members may forecast potential problems that could happen in later stages. Engineers will help address the technological parameters and technical capacities.

However, this process is generated based mainly on the output of secondary research, and needs to be assessed and further improved in the field. The creation of this process is the first step to develop a new technique, to improve product innovation management.

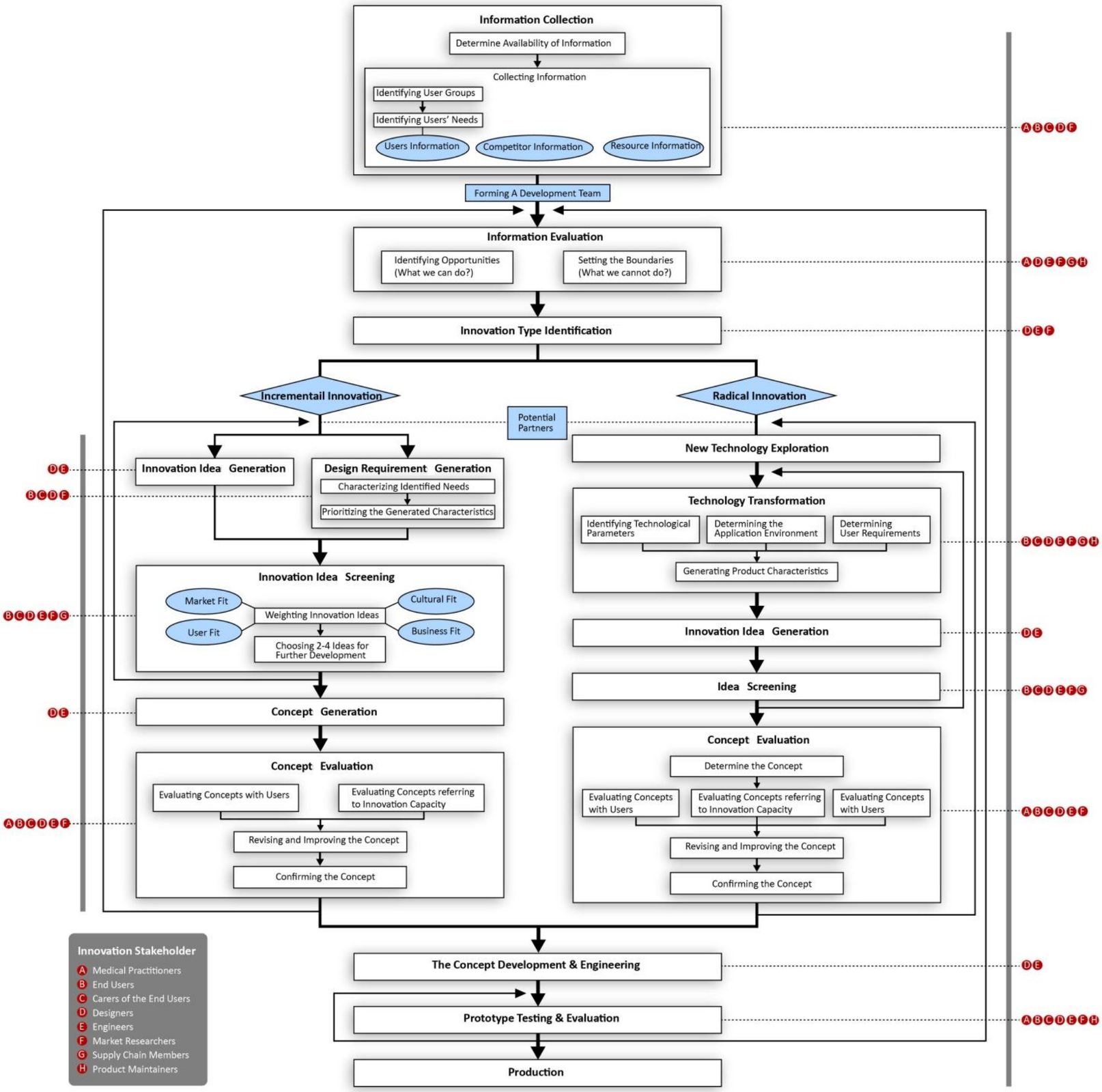

Figure 3.21 A new NPD process

3.2.6 CONCLUSION

This chapter has defined NPD and what an NPD process is. It concludes that adopting an appropriate NPD process is significant in product innovation. At present stage-gate processes are most widely deployed by companies in the sector. However, despite their obvious merits, these processes do not always perform well in promoting the generation of innovative solutions. In the front-end phase lies the crux of the matter. It is cheaper, less risky, more efficient, and more easily accepted to revise the current process, for example by blending the features of agile processes with individual stages of a stage-gate process, than to introduce a completely new technique. Developing an innovative fuzzy front end tool which supports the overall NPD process management has been confirmed as the target of my further research.

Outline requirements for the development of a new innovation technique are:

- To enable product specification for an HHCP which properly reflects the requirements of the multiple stakeholders and thereby facilitates manufacture of devices which are truly fit for purpose to be developed
- To effectively engage all stakeholders in the product/service development
- To fully consider and properly reflect the features of the HHCP sector
- To be time and money effective and affordable in practices by the SMES
- To perform in harmony with the target companies' current NPD procedures, to make the approach easier to be adopted

The desktop research concludes that direct input from target companies is necessary in developing a new innovation technique. This led on to the workplace research in the next phase of my doctoral research.

3.3 CASE STUDY PLANNING, OBSERVATIONS, EVENTS AND EXPERIENCES

3.3.1 SUMMARY

A general understanding of new product development (NPD) processes has been established in Chapter 3.2, through analysing the existing NPD techniques. To test and to develop the insights, and to gain a deeper understanding of real issues in NPD processes, case studies were carried out with a focus on a carefully selected home healthcare product supplier for reasons of confidentiality agreements, the identity of the product supplier is not given. Thereafter the supplier is referred to as the 'company partner'. It produced first-hand information in context, and enabled the engagement of comprehensive research activities, as needed for generating solutions to the identified issues. This chapter introduces the work placement with the 'company partner' and experiences, as well as the approaches, methodologies and procedures supplied.

3.3.2 CONTEXT

3.3.2.1 OBJECTIVES

Case studies were carried out to assess and further develop the knowledge generated in previous research stages, and to experience the industry in context and collect first-hand information for generating solutions. Specifically, there were four predefined research areas:

1. To assess the conclusions of earlier research

Key conclusions drawn from the earlier research (Refer to Chapters 2.1 - 3.2) are:

- Applying a formal and adaptive new product development (NPD) process is substantial to improve HHCP innovation outcomes (Refer to Section 3.1.4 & 3.2).
- The efforts of improving the NPD process should be focused on the fuzzy front-end (FFE) stage, to give a level of structure and better control of the related NPD activities (Refer to Chapter 3.2.3).
- The general absence of valid user input is another serious concern in HHCP innovations (Refer to Chapter 3.1.2-3.1.3).

- The rising companies and new entrants which have gained a foothold in the market and have potential to innovate could benefit most from assistance in innovation management techniques (Refer to Chapter 3.1.5).

The validity of these points was assessed in the case studies to determine the course of new knowledge generation (Refer to Chapter 3.3).

2. To define the best opportunities for improving the NPD process

- To determine the innovation drivers of this industrial sector
- To analyse the product/services development methods that are currently employed and to identify their strengths and weaknesses as well as opportunities for improvement
- To analyse the influence of product development methods upon new home healthcare products' commercial success
- To investigate an affordable methodology for project management which highlights the target audience's real needs and wishes
- To assess the development process and identify any weaknesses
- To explore how to effectively involve a wide range of stakeholders in the development process

3. To encourage effective user engagement

- To observe the real level of user engagement in new product/service development projects in the sector
- To analyse the influence of product development approaches upon new home healthcare products' user performance
- To further explore the interrelations between user performance and commercial success in home healthcare product development

4. To develop a new NPD approach

- To test and improve the development process concept model produced previously
- To generate improved framework for managing individual NPD activity
- To review the interactions of the intended project outcome, and to see if it is fit for purpose
- To explore new delivery methods for the NPD approach

3.3.2.2 PLAN

Case studies were carried out with six companies, from a large multi-national to very small, in the UK and overseas (Figure 3.21).

As set out in Figure 3.21 and 3.22, four of the companies are HHCP suppliers. Workplace research was undertaken within one carefully selected Telecare & Telehealth [1] supplier (company A in the table) for eight months. I worked in their project management office to immerse myself in their NPD process, to study the details of their methods, procedures and activities, and to identify critical areas and opportunities for improvement. For reasons of confidentiality agreements, this thesis will not name or otherwise identify the host company, its business partners or sub-suppliers, its projects or any individual employed by them. The company is hereafter referred to as the 'company partner'.

As no one company presents the norm for an industrial sector, I also investigated the other three other HHCP suppliers (companies B, C, D), to expand the sample size, and to complement the in-depth investigation of the first company.

Companies E and F are suppliers of the 'company partner'. They provided product design and software engineering services in the company partner's NPD projects. Interviews of the two companies aid an understanding of the company partner's present status, and in further evaluating some of the information acquired when working with the company partner.

1. Telehealth covers the remote monitoring of physiological data e.g. temperature and blood pressure that can be used by health professionals for diagnosis or disease management (Royal College of Nursing 2010). Telecare is the delivery of remote care of elderly and physically less able people, providing the care and reassurance needed to allow them to remain living in their own homes. Compared with telehealth, telecare refers to the idea of helping people live more independently in their own homes by providing person-centred technologies to support the individual or their carers.

Corp	Type	Size	Location	Products	Approach	Individuals Consulted
A	HHCP and service supplier	Medium	Leeds	Telecare & Telehealth products and services	Workplace research	25 key team members from all divisions and 43 product users (See Chapter 3.3.3.4)
B	HHCP supplier	small	Cornwall	Assisted living products and other medical technologies	Face-to-face interview	Company manager
C	HHCP supplier	small	Cornwall	Assisted living Products and other medical technologies	Face-to-face interview	Project manager
D	HHCP supplier	large	Chengdu, China	Assisted living products and other medical technologies	Skype interview	Project manager
E	Software programming	small	London	Software solutions	Face-to-face interview	Chief engineer Project manager
F	Design consultancy	small	London	Product and interface design solutions	Face-to-face interview	Project manager Interface designer

Figure 3.21 Company details

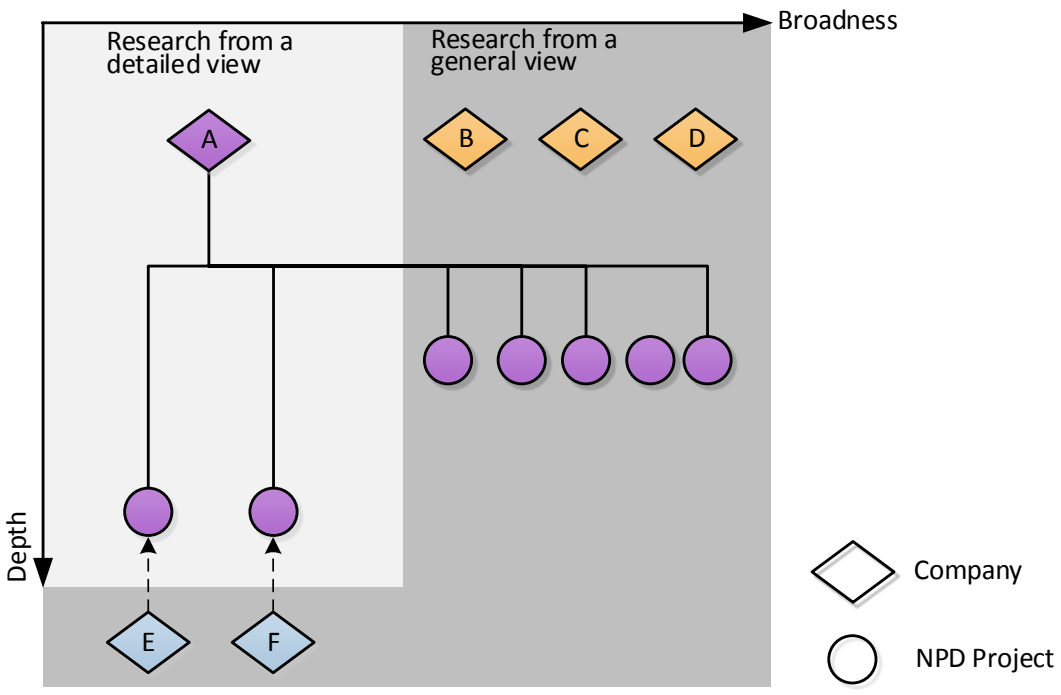

Figure 3.22 An illustration of the relation between companies involved in case studies

3.3.2.3 METHODS

Research activities were carried out following the Empathic Design and Contextual Design principles, which were adapted to the predefined aims and requirements of the project (Refer to Chapter 3.3.2.1).

1. Empathic Design

Empathic Design (ED) is a user centric approach that pays particular attention to the audiences' feelings toward a product (Lebbon & McDonagh-Philp 2000, Fulton-Suri 2003). Building empathy means understanding research targets' behaviour and what motivates them, the aim of which is to identify physical, cognitive, social, and/or cultural needs they meet through products, services, and experiences that designers have created (IDEO 2009). By understanding people deeply, ED can lead to more appropriate and more breakthrough solutions (IDEO 2009), and is therefore applicable to the challenging task of developing a new fuzzy front end tool supporting NPD in SMEs.

As described by Leonard and Rayport (1997), ED comprises five main steps:

1. Observing
2. Capturing data
3. Reflecting and Analysing
4. Brainstorming for solutions
5. Developing prototypes of possible solution

A practice example:

Researchers found tender gestures in the bottle feeding rituals after observing the children's activities in the garden and with their mothers at home, the insight of which was applied in the redesign of the Chicco Baby Bottle experience which breaks away from tradition (Figure 3.23). The new design is responsive to the changing feeding styles - three distinct nipple shapes adapt to the specific needs of growing babies as their natural suck-swallow action develops (Figure 3.24). For new born through 4 months, the natural shape and texture are designed for the easy transition between breast and bottle, and the angle of the nipple helps to reduce the chance of baby swallowing air.

Figure 3.23 The Chicco Baby Bottle fits the feeding ritual better (Source: http://www.chicco.com/)

For 4 through 6 months, the angled nipple is replaced with a more upright nipple as babies in this stage generally have better control of head and neck. The milk flow rate is adjustable depending on how the user position the nipple in a baby's mouth, which is to adapt to babies' growing appetite and strength of sucking action. For beyond 6 months, the tip of the nipple is elongated and elastic to support stronger sucking motion and bigger appetite, and the base is smaller and less rounded for tighter lip support which is required for good sucking action.

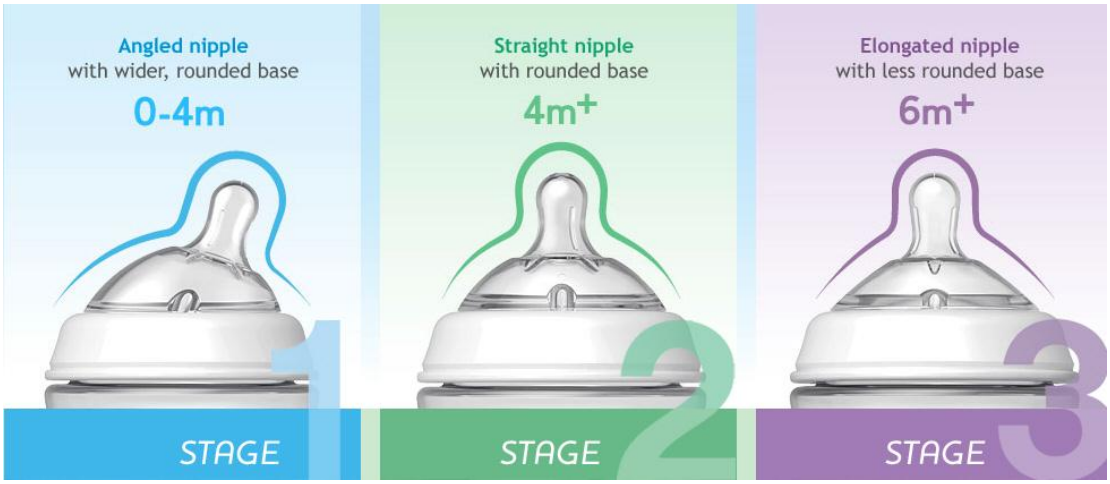

Figure 3.24 The new design adapts to the needs of babies as their natural suck-swallow action develops. (Source: http://www.chicco.com/)

2. Contextual Design

Contextual Design (CD) is a user centred design method for integrating data from existing work contexts and practices into a development (Barn and Clark 2010). Besides ED, CD was viewed as a general principle and was used throughout the case studies.

According to CD, data gathered from the target audience is the base criterion for deciding which needs are to be addressed, what a system should do, and how it should be structured. It requires team members to be involved in the activities of data collection and interpretation (Figure 3.25). This principle contributed to my decision of researching inside a carefully selected company (Refer to Chapter 3.3.2.2 & 3.3.2.3).

Commonly accepted, CD consists of the following top-level steps: 1) Data Collection, 2) Interpretation, 3) Data Consolidation, 4) Visioning, 5) Storyboarding, 6) User Environment Design, and 7) Prototyping (Beyer and Holtzblatt 1998; Roger et al. 2002). This structure produced a number of artefacts such as customer/user information, intuitive environment elements and culture model, and therefore set the base of the knowledge generation process in the case studies.

Furthermore, CD influenced the detailed activities throughout the workplace research journey. For example, to field test the company's products, I partnered the users and their families and let their behaviours and the issues they encountered guide the interview/discussion process (Refer to Chapter 3.3.2.3).

CD was not only part of my research methodology, but also contributed to the result directly. It was absorbed in the new innovation techniques created in this study, because:

- It provides a solution to manage and to transform contextual information, which links design research with the fuzzy front-end (FFE) stage of the overall NPD cycle,
- And it can also consolidate decision making and the interactions in the process, which helps a cross-functional team come to agreement on what their customers need and how to design a system for them (Holtzblatt 2001).

Figure 3.25 A workshop I organized to explore how to balance the 'usability' and 'desirability' in product design. The participants include marketers and project managers. As shown in the photos, the participants were immersed in data of

Following Empathic Design and Contextual Design principles, research methods including Experimental Interview, Contextual Inquiry, Expert Interview, Focus Group, Inclusion of Lead Users, Conjoint Analysis, Storytelling, Observation, Persona, Affinity Diagram and Process Mapping were applied in individual activities. A summary of these methods is given in Appendix G.

3.3.3 THE WORKPLACE RESEARCH

For reasons of confidentiality agreements, this thesis will not name or otherwise identify the company involved, its business partners or sub-suppliers, its projects or any individual employed by them. The company is thereafter referred as 'company partner'.

3.3.3.1 WHY UNDERTAKE WORKPLACE RESEARCH?

It has been concluded in Chapter 2.4 that understanding the reality of HHCP innovations is the starting point for developing effective improvement strategies. The challenge arises how to achieve rich and effective information to support the analysis since NPD relative information such as the reasons for product success and failure, market strategy and user insights, is often business sensitive, latent, tacit, and/or unarticulated [1]. Thus, adopting only inquiry methods such as interview or questionnaire can hardly unveil the real situation of the target company and to gain an in-depth understanding of all relative factors.

Workplace research was adopted as the solution as it provided space and time to analyse a question from various angles, to study the target company and its business in depth by engaging multiple research methods, and to flexibly reflect upon the new questions produced as a result of the procedures.

3.3.3.2 THE COMPANY PARTNER'S PRESENT STATUS

The 'company partner' was a medium-sized British home healthcare product and service supplier offering end-to-end solutions encompassing software and hardware development, installation, maintenance and customer service (Refer to Appendix B). With over fifty years in product development, it was one of the leading supplier in the Tele-care and Tele-health markets in the UK and had a presence in over ten countries. Respectable reputation, long-term cooperation with governmental organizations and wide sales channels were its major competitive advantages.

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1. Latent, tacit, and/or unarticulated information, from a user research perspective, refers to the wishes and needs users themselves may not be aware of, and future needs they cannot recognize, due to a lack of exposure to new technologies or being locked in the mind-set of using existing products. From the NPD process research perspective, it refers to the knowledge that a team member is not aware of, or reluctant to tell, due to a lack of awareness of what other team members are doing, or the 'blame culture' between departments or groups.

However, as a market leader the company partner has a relatively low innovation capacity being instead traditionally led by manufacturing. This is despite a larger employee number than what is traditionally defined as an SME. It has hundreds of installation and service engineers but only a very small team working on front-end research and on developing new product solutions. There is no in-house design team so the design process is subcontracted to independent design consultancies. Its marketing team is also small with fewer than eight people, who focus on promoting sales rather than analysing market requirements or forecasting future trends.

"… We have worked with the 'company partner' for over 10 years … In general, it is weak at transferring design solutions into working products."
– as per my conversation with the project manager of the design company (Company D in Figure 3.21 & 3.22).

According to the quality manager, there had been more than 'one thousand projects' of various sizes and types of which only three were completely new products. The remainder was either redesigned or upgraded products, or projects that failed to become products, because of changes of business plan, lack of technical resources, or shortage of funding. For this study a company's size is related more to its innovation capacity and the size of its innovation teams than to the number of employees, and therefore it classifies the company as an SME.

This company is on a transition path in terms of both working practices and overall business strategy. Its management board has shown strong interest in developing innovation and increasing the role of design in the development process. Its teams are working more closely on the most recent project and the business focus is transitioning from delivering products to delivering product associated services, which is a major development trend in the sector as pointed out in Chapter 3.1.2. This transition calls for changes in areas such as product delivery process, organizational structure, working culture, and team members' skills all of which have been identified in this study as challenges for the company.

"… It is a better strategy to sell the products at low price and earn profits from after sale services such as monitoring services."
"We are thinking about selling the product and services as a package. The product will be given to the residents for free and we will charge for the services."
- as per my conversation with the company partner's product director

3.3.3.3 RESEARCH PROCESS

Three main stages

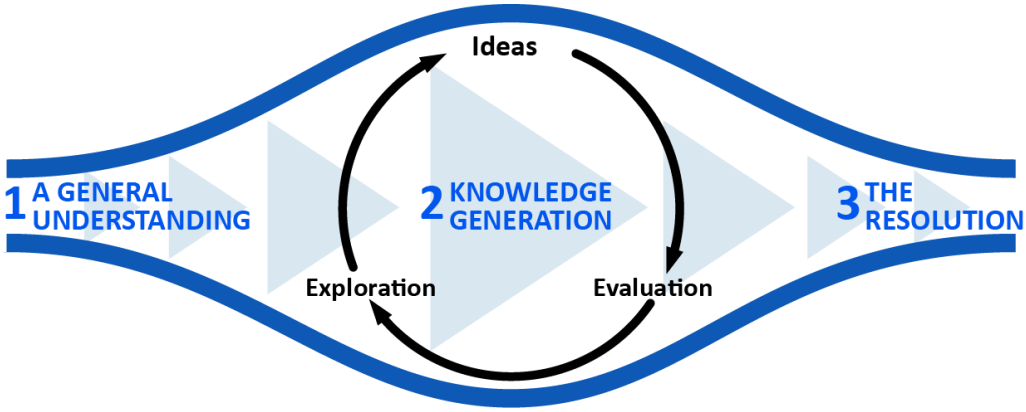


Figure 3.26 The general process of workplace research

Figure 3.26 sets out the general processes of the workplace study, which incorporates 3 main stages:

Stage 1 **A general understanding**	A general understanding of the company partner's current status and success or failure in product innovations was established via desktop research of their project archives in last ten years, and interviews to the Group Product Director and four project managers.
Stage 2 **knowledge generation**	The above insight was revised and developed, and the details of the company's NPD approaches were explored via focusing on two on-going cases (Refer to Appendix H). In each case study, I followed the five steps of the Empathic Design approach (Leonard & Rayport 1997) (Refer to Appendix G), among which 'observing' is the foundation of unfolding objective and latent information. Specifically, I interviewed the key team members of the two projects; studied the project documents; passively observed the interactions among in-house team members, and between the in-house development teams and the external designers; attended and contributed in project meetings; and assisted the project team members in arranging and undertaking researches on users and competitors. Being immersed in the two selected projects allowed me not only to gather and to process qualitative data, but also to reflect on the conclusions and knowledge that had been generated in the procedures.

	In knowledge generation, particular attention was paid to the company partner's needs and features, which produces output of two types: for the specific company and for the whole sector. The two types largely overlapped while some differences exist.
Stage 3 **The resolution**	The generated knowledge was then refined and combined into a fuzzy front-end tool (Refer to Section 4) for supporting HHCP suppliers.

Structure of the process

The course of the workplace research was both a learning process and a knowledge generation process. It could be viewed as an action-reflection cycle of learning in which the output of each specific study was added to the overall framework - what had been learned from previous actions was validated, and the plan for the next step was amended as required (Figure 3.27). This structure was in line with the social constructivism paradigm, which involves a large amount of researcher participation and active interactions with research participants.

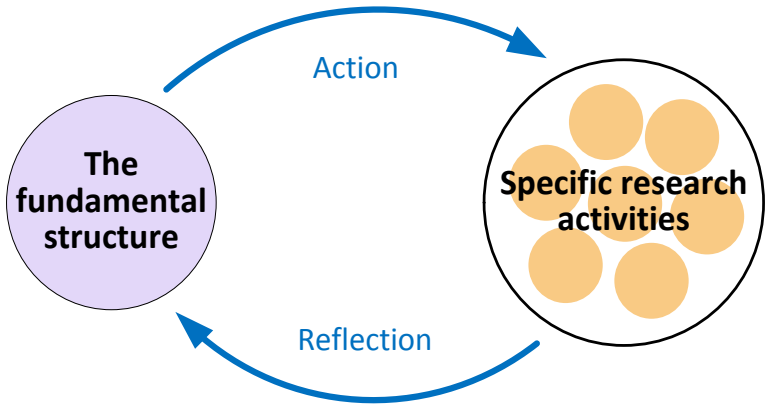


Figure 3.27 The action-reflection cycle of the fundamental structure

My roles in the process

Throughout the workplace research, I took three roles: a researcher, a spectator, and a designer.

As a researcher, I defined the research objectives and questions (Refer to Chapter 3.3.2.1); forged the research process; collected and processed the data; and generated conclusions and new knowledge. I engaged in the following research activities:

- One-on-one discussions with all key members from each functional group

- Face-to-face interviews with business partners and sub-suppliers
- Attended their project meetings and contributed with ideas for improving the company partner's current NPD approaches
- Analysed the achievements of the company projects
- Worked together with its teams in projects
- Interviewed product users

As a spectator, I passively observed the progress of the company's on-going projects. For example, in some meetings between the in-house teams and sub-suppliers, I focused on capturing and translating the information relative to the questions prepared beforehand, rather than providing my own opinions. This allowed me to more objectively examine their NPD procedures, and validate and enrich some of the output from the desktop study (Refer to Chapter 3.2) and other research activities during the placement.

As a designer, I translated the gathered information into solutions, which included: improvement strategies for the particular company's various NPD components and NPD process, and a new NPD approach for the SMEs in the home healthcare sector.

3.3.3.4 STAGE 1 - A GENERAL UNDERSTANDING

Desktop research:

To gain a general understanding of the company's methods and culture, I collected and studied NPD relative documents including the company's portfolio (Refer to Appendix B), product delivery process map (Refer to Appendix C), organizational chart, project briefing documents, templates of the briefs, and group meeting reports, to learn about how the company innovated and what factors had significant influence on product innovation outcomes, and also to validate the data and information received from interviewing NPD stakeholders.

I reviewed the company's main competitors, such as their market share, organizational structure, size, marketing strategies and portfolios, with the support of the company's sales department, to gain a general understanding of the whole industry.

Interview & Discussion:

I interviewed and/or held discussions with the stakeholders of the NPD process:

Inside the company, there were over 60 face-to-face meetings (Refer to Appendix D) with the key members of all functional groups, including Marketing, R&D, Product Management, Project Management, Quality Management, Business Development, Options, Sales, Service,

Installation, and Human Resources (Figure 3.28). These meetings were semi-structured, and had an emphasis on two-way communication and in-depth conversation.

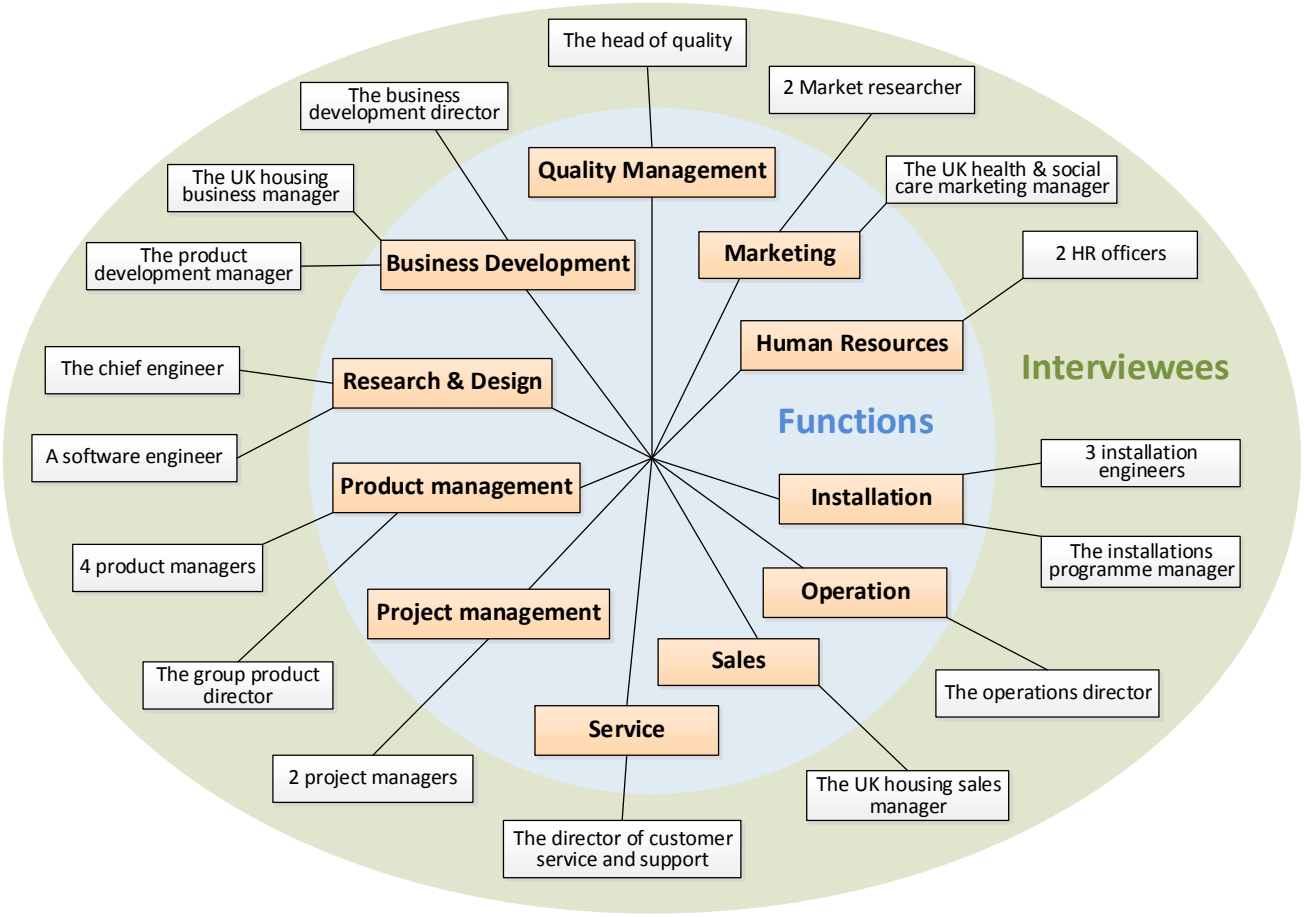


Figure 3.28 The company's employees who I interviewed during the exploration process

I had multiple meetings with the majority of the team members. A question bank (Figure 3.29) was used for the 1st round interviews, from which appropriate questions for discussion were selected according to an individual interviewee's background and responsibility. This was to allow for a comparison of feedback, which aided in unveiling the present status of the company. The subsequent meetings were organised more flexibly - multiple methods were applied; various styles were followed; and pre-planned questions might be skipped or revised and new questions might be added. The linchpin was to achieve effective and in-depth answers of quality and meaningfulness.

Figure 3.29 The question bank for the 1st round interviews:

BACKGROUND

How many new products have the company developed in the last 10 years? In which project(s) were you involved? Can you please give a short introduction of the projects?
○ What is the general performance of the company's products? Do they often match the expectations of the company? If not, what do you think are the major causes?
○ As a leading product supplier on the market, what is the advantage of the company compared with its competitors?
○ Who are the customers of the company, e.g., individuals or government? Who is/are the company's main customer(s)?
○ What is the company's board level strategy? Has this strategy been changed in the last ten years? If yes, for what purpose?
NPD PROCESSES
○ Do you/Does your team follow a formal and structured process in product innovations? If yes, what type of process it is, e.g., stage-gate or agile?
○ Have the company formalized its own NPD process? ○ (If yes) What is the focus of this process, e.g., reducing production cost, or customer satisfaction? What are the other features of this process? Who established this process? How often is the process updated? Are you aware of the details of the process? Was/Is this process employed in the projects in which you were/are involved? ○ (If yes) How will you rate the performance of the process? What are its strengths/weaknesses? How can this process be further improved?
○ Do you agree that engaging a formalized process aids in achieving better NPD results?
STAKEHOLDER ENGAGEMENT
○ What is the real function of you/your team in NPD?
○ Are you/your team engaged in the NPD projects? ○ (If yes) In which stage of an overall project cycle? Do you think you/your team can contribute more in generating more innovative/successful product solutions? ○ (If yes) What are the barriers to active participation, e.g., information transfer, departmental barriers?
○ Are the customers and/or users engaged in NPD in the company? ○ (If yes) In which stage(s) and for what purpose(s) do they get involved, e.g., new product promotion, prototype testing? How do you/your team engage users in NPD relative activities, e.g., visiting users at home, organising workshops with leading users? Have you/ your team ever participated in user study in previous projects?

- (If yes) What are the challenges in the experiences? Is there any common issue identified in various user studies? Do you/your team need support to improve user research activities?

Figure 3.29 The question bank for the 1st round interviews

I also interviewed the company's design partners and sub-suppliers – a design agency to which the company had outsourced its product design processes, and a software engineering company which designed user interface and system infrastructure of the company's web solutions. They were involved in the two projects on which I focused my research. This allowed me to verify some conclusions extracted from internal interviews introduced above, and to understand NPD processes in various scenarios.

Multiple research methods such as experimental interview, contextual inquiry and inclusion of lead users were employed in all the interviews (Refer to Appendix D – H for the key points withdrawn from the interviews) above. Their features and application are introduced in Chapter 3.3.2.3 and 5.5.4.

3.3.3.5 STAGE 2 - KNOWLEDGE GENERATION

The knowledge generation stage is a loop of **exploration**, **knowledge generation**, and **evaluation**, to reflect the multidisciplinary, open-end, and ever-changing nature of the research (Figure 3.30) (See more details in Section 3.3.3.5).

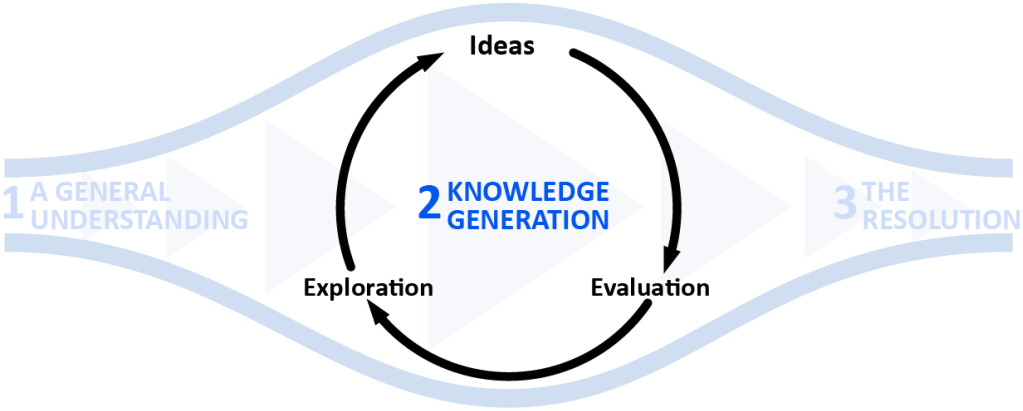


Figure 3.30 The structure of the knowledge generation procedure

Methods applied in Knowledge Generation

In the interviews and discussions, some interviewees gave a great deal of information, much of which was not directly relevant to the questions, while some of the others were reluctant to give much detail or even a firm answer. To obtain robust information, techniques including experimental interview, contextual interview, expert interview, focus group, inclusion of lead

users, conjoint analysis, and storytelling were adopted as needed in the meetings with the company divisions and their design partners and product users (Figure 3.31).

Persona, Affinity Diagram and Process Mapping were adopted in data processing for generating problem resolutions:

The features of these techniques and their applications in the workplace study are introduced in Appendix G.

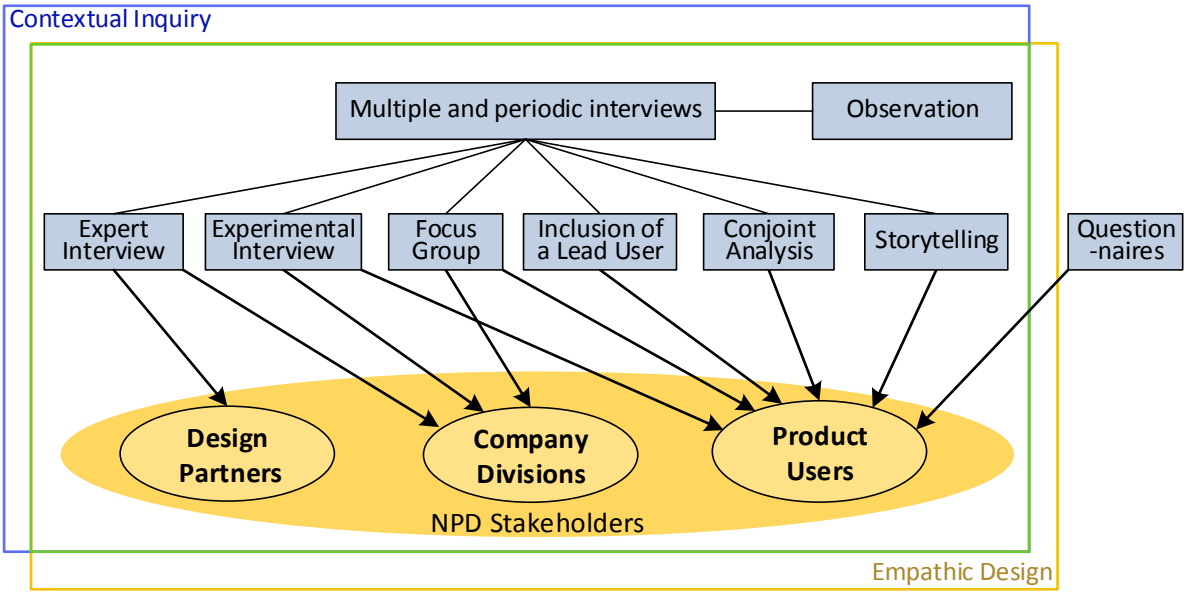


Figure 3.31 Methods for exploration and evaluation

Research activities in 'Exploration'

To gain deep insights into the company's present NPD approaches:

I focused on two on-going product innovation projects of different types. One was about developing a new model to replace an existing telecare product in market (incremental innovation). The other was to develop a web application for the future (radical innovation). Being immersed in these two projects (Refer to Appendix H), I attended the project meetings, interviewed key team members, had regular discussions with the project leaders, and studied the projects' historical documents including business contracts, presentation documents, and key emails. The collected data and information and the generated knowledge was classified and saved in my research archive (Figure 3.32), which contributed to the design of my proposed NPD improvement strategy, and also allowed me to reflect on specific research activities in the design process (Refer to Appendix A for more details).

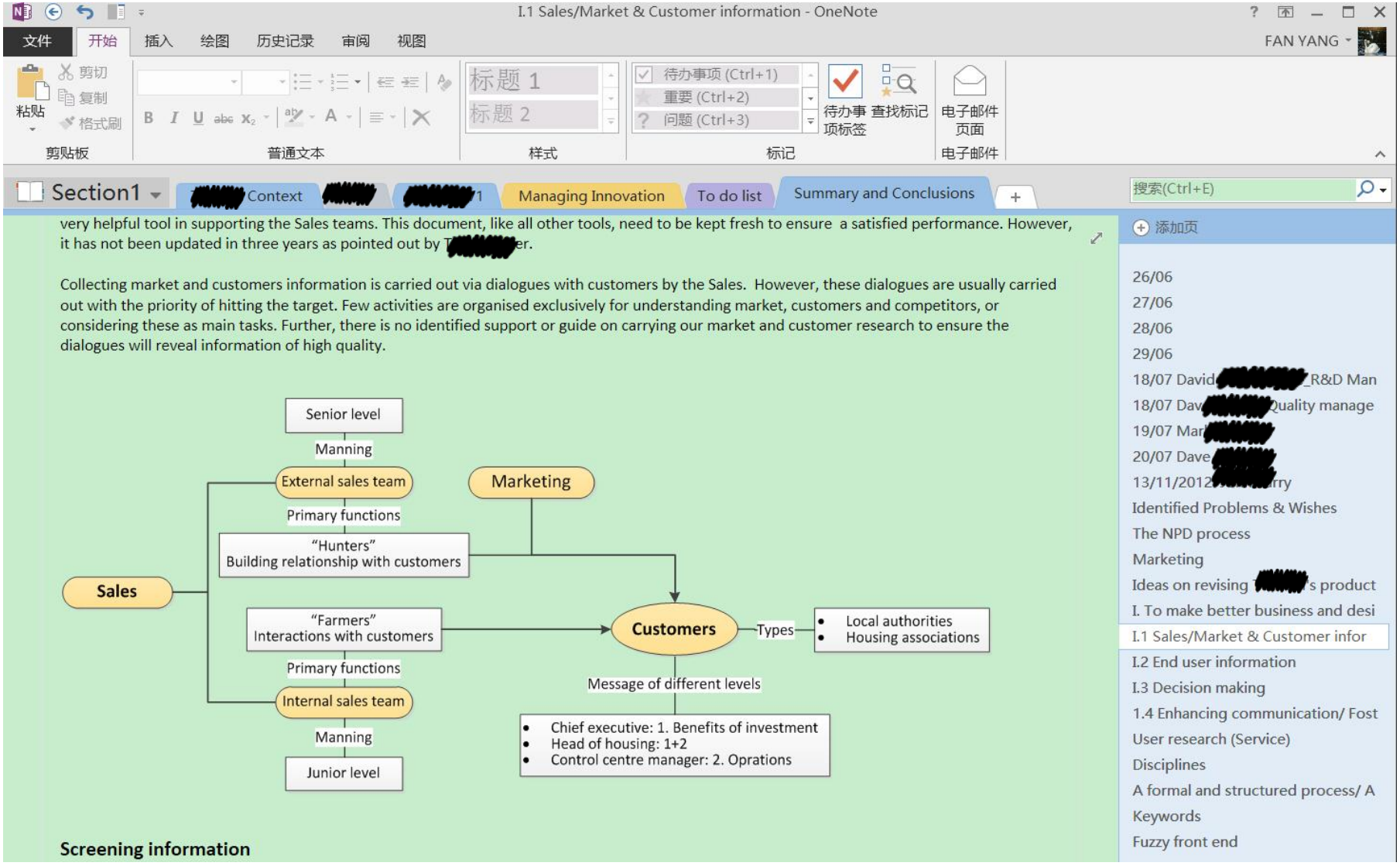


Figure 3.32 Screenshot of the research archive created in OneNote (Refer to Appendix A)

To explore how to effectively engage users in NPD, I researched a group of 41 users of the company partner's existing telecare devices (Figure 3.33) (Refer to Appendix F), who were also from the target user group of the new telecare product development project on which I focused. This filed trial supported both the company's business objectives and my own research. For the company, it was to evaluate and confirm the performance of the new product, which was required before it could be brought into launch and sales. For my own research, it was also to establish the user experience and impression of the company's previous products, and to explore whether the product design could be improved if the target users could be involved in the front end of the NPD process.

Figure 3.33 Visiting the user group in their homes

More specifically, I teamed up with an installation engineer to visit each research participant in his/her home, which was the specified operating environment of the new device. Before the visits, I prepared a question sheet (Figure 3.34) (See the filled question sheets in Appendix F) together with the product manager. It contains 2 sections:

Section 1. User Context

Business purpose: to know more about the user group's characteristics

Research purpose: to assess whether the design of the product meets the needs of the users properly

Section 2. Installation position

Business purpose: to make it easier to find causes of errors if a false alarm was triggered and monitored during the two weeks' trial of the product (environmental factors such as temperature, wind and other digital equipment could cause interference)

Research purpose: also to assess whether the cause of errors could be avoided or decreased through improving the NPD process; and to find whether the operating environment was properly considered in the design

Installation of the [redacted] for the field trial

14/06/2012 - 15/06/2012

Unit ID _____ Photo number _____

User Context

Age Band ☐ 40- ☐ 40-49 ☐ 50-59 ☐ 60-69 ☐ 70-79 ☐ 80-85 ☐ 85+

Gender ☐ Male ☐ Female

Occupation ☐ Full-time work ☐ Part-time work ☐ Retired Other _____

Household Number _____

Accommodation Types

☐ Bungalow ☐ Terrace ☐ Detached house ☐ Semi-detached house ☐ Flat

Installation Position

How many times and how often did the users activate the [redacted]?

_____

How many times and how often did the users use the pendant?

_____

Whether the installation position of the unit is the representative of the house temperature?

☐ Lower than the house's average temperature

☐ Higher than the house's average temperature

Is there any other digital equipment within 3 meters?

☐ Yes ☐ No

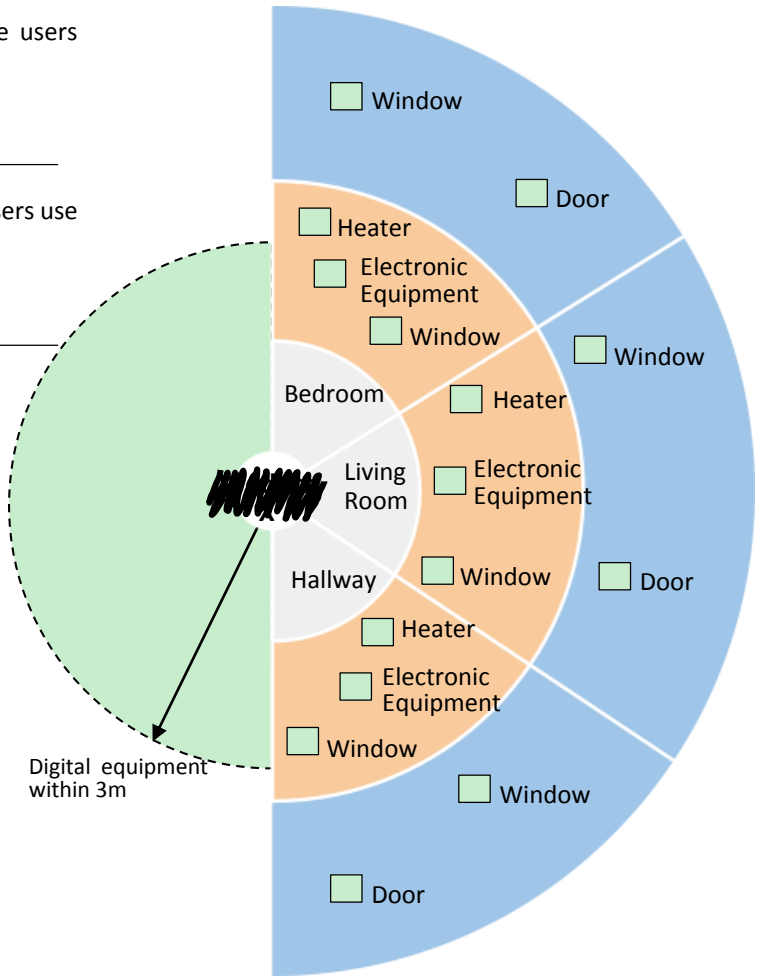


Figure 3.34 The question sheet for the 1st round user visits

Each visit took 25 – 35 minutes. As set out in Figure 3.35, the engineer installed the new product where the research participant preferred, whilst I introduced its features and functions. Subsequently, I took a photo (Refer to Appendix F) of the product in the environment, observed the research participant use it following the instructions from the engineer, and took notes of anything important. I filled the question sheet during or after a visit. The new product was left to be evaluated by the user further in daily life for two weeks.

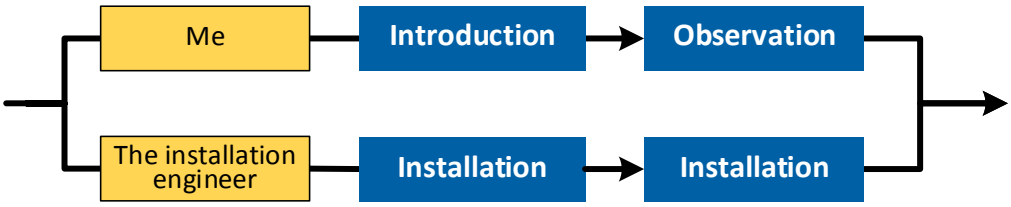


Figure 3.35 The course of the 1st round of user visits

We returned to the user group 2 weeks later to add to the initial investigation. Each visit also took around 30 minutes, during which the installation engineer detached the trial product, reinstalled the user's current device at its original position, and tested it to ensure it was fully functional (Figure 3.36). Meanwhile, I interviewed the user about their experience and impression on the product's functions, visual appearance, product-user interaction and ergonomics following a premade question sheet (Figure 3.37) (See the completed question sheets in Appendix F). When structuring the question sheet, the business requirement of product promotion was taken into consideration. As a result, open questions for exploring the users' tacit needs and wants towards an 'ideal' solution and for assessing the NPD process were not incorporated in the question sheet, and were asked in the end of an interview.

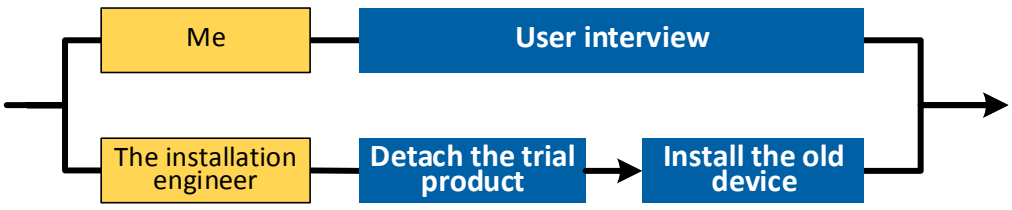


Figure 3.36 The course of the 2nd round of user visits

Besides the investigation on the users, I held discussions with product/project managers who were responsible for planning and controlling the overall processes of projects; and installation/service engineers who met customers/users most frequently among the company's divisions to discover better channels and approaches to user engagement in NPD.

The question sheet for the 2nd round user visits:

Information Collection from the Field Trial of [redacted]

Unit ID _____ Current [redacted]nit _____ ☐ 4/07/2012 ☐ 4/07/2012 ☐ 6/07/2012

Household temperature

1. What is the temperature in the home (thermometer)?

_____

2. What is the temperature of the [redacted]i plastics?

_____

3. What is the temperature reading on the L[redacted] using the installer keypad?

_____

[redacted]

1. Do you like the look of the [redacted]?

	1	2	3	4	5	
Do not like it	☐	☐	☐	☐	☐	Like it very much

2. How easy is it to press the buttons on the [redacted]?

		1	2	3	4	5	
2.1 Home/Away (Yellow)	Very difficult	☐	☐	☐	☐	☐	Very easy
2.2 Cancel button(Green)	Very difficult	☐	☐	☐	☐	☐	Very easy
2.3 Help Button (Red)	Very difficult	☐	☐	☐	☐	☐	Very easy

Other _____

3. Can you read the words underneath the button on the unit?

Yes ☐ No ☐

4. Do you think having words underneath the buttons is a good idea?

Yes ☐ No ☐ Other _____

5. Can you see the LEDs ok?

Yes ☐ No ☐

6. Is the help button LED bright enough?

Yes ☐ No ☐ Other _____

7. How would you rate the speech quality when speaking to the monitoring centre?

	1	2	3	4	5	
Poor	☐	☐	☐	☐	☐	Very good

8. How is the speech quality compared to your current [redacted]

	1	2	3	4	5	
Worse	☐	☐	☐	☐	☐	Better

9. How useful was the pendant test reminder feature?

	1	2	3	4	5	
Useless	☐	☐	☐	☐	☐	Very useful

10. How easy was the pendant test reminder feature to use?

	1	2	3	4	5	
Very difficult	☐	☐	☐	☐	☐	Very easy

11. Did you have any problems with the pendant reminder feature?

_____

12. Are the voice announcements clear to understand?

	1	2	3	4	5	
Very poor	☐	☐	☐	☐	☐	Very clear

User guide

1. Have you read the user guide?

Yes ☐ No ☐

2. Was the user guide easy to understand?

	1	2	3	4	5	
Very difficult	☐	☐	☐	☐	☐	Very easy

Figure 3.37 The question sheet for the 2nd round user visits

Summary of the findings from the field trials

1. People who live alone need HHCPs more than those living with families

The interviewees who live with the loved ones or other family members tend to be more confident in life. 3 of such interviewees said that they can live well without the aids from HHCPs, and would not need such products in the near future. It should be noted that all of these 3 residents are over 60 years old. In contrast, the interviewees who live alone tend to depend more on HHCPs in life. They are also more interested in trying new HHCPs. This group of people can be the target group for future product development.

The engagement of formal user research is required for achieving valid user information

The interviews in the field test show that using only traditional yes/no questions cannot provide useful information in research on HHCP users. The majority of the interviewees are reluctant to give opinions on questions related to product improvement. Many of the interviewees do not recognize their future needs or the better services that could be provided by better products, due to a lack of exposure to new technologies or being locked in the mind-set of using existing products. Time and skills are essential in discovering valid information from the users of HHCPs.

2. User research in the filed can provide extra information supporting HHCP innovation

Studying the user in the home environment can provide more information than purely user insights. For example, environmental factors such as temperature, wind and other digital equipment could raise issues that may not be recognized by the designers. Besides, observing the process of operating a product in the real environment can provide tacit information that a research participant himself/herself is not aware of or does not want to give. Such detail is most necessary for spurring the generation of innovative design ideas.

3. Difficulty in HHCP use is not strongly related to patient age

Age of the user is commonly recognised as a key influence factor in product design. However, this research shows that this may not be an important issue in improving the HHCP design. Most of the research participants who are over 60 years old can learn how to use the prototype product within 10 minutes. More than 1/3 of these people use digital equipment such as computers and tablets in daily life. It was interesting to see a gentleman over 80 years old put a computer in the centre of his living room.

4. Simplicity is essential

Although some research participants were fascinated when being introduced to the new added functions of the new prototype product, most of them did not show much interest. More importantly, the interviews show that most users tend to establish their own ritual of using products in daily life. They tend to demand a product to solve 1-2 key problems rather than a product provides 10 functions, many of which they cannot even remember. This finding implies that even a small improvement on a basic function, such as clearer voice, can lead to a successful new product. The product supplier needs to communicate directly with the user to find their real needs and wants.

Research activities in 'Ideas'

In terms of the knowledge generation stage, the output can be categorised into: improvement ideas for various components of NPD processes (Refer to Chapter 3.4), and a new NPD approach (Refer to Chapter 4.1) (Figure 3.38).

Various components of NPD, such as organizational structure, partner relationship management, project planning, data and information management, research and design methods, and quality control strategy were explored, to generate improvement ideas. The 'effectiveness & feasibility' filter was applied to select the most appropriate ideas for developing a new NPD approach (Figure 3.38). This is because being effective and feasible is both the key and a critical challenge (Refer to Chapter 3.3.3.1) - major modification on a company's present NPD process can lead to changes on several or even all of the above factors, which cannot be easily accepted and/or afforded by companies, not to mention the SMEs which are often heavily stressed by time and funding. Thus, the research aim was providing a resolution to the most critical issue, rather than replacing the whole NPD process.

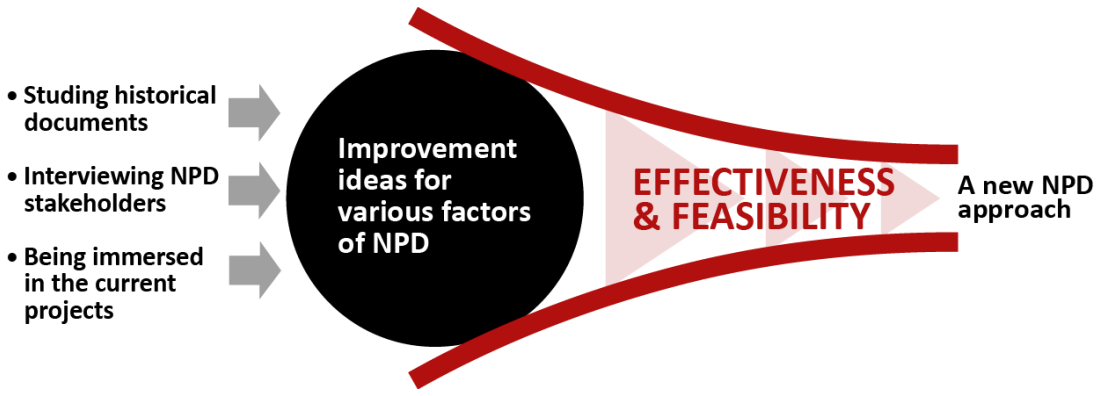


Figure 3.38 The process of knowledge generation and outputs

Research activities in 'Evaluation'

In general, there were 3 targets of the evaluation process: the data and information achieved from exploration, the insights drawn from the translation of the data and information, and the new improvement ideas produced during the research.

As introduced at the outset of Chapter 3.3.3, the workplace research process is a loop of exploration, knowledge generation, and evaluation (Figure 3.26 in Chapter 3.3.3). There was not a specific testing stage, and the output was evaluated with the progress of the research.

In exploration, the desktop study of the 'company bible' and the original documents produced in previous projects, and the interviews with the key players of all functional groups were combined, to ensure the objectivity. There were one-to-one interviews with each interviewee, to avoid distractions from others and to validate the data/information on one topic from various channels. I also went back to most interviewees (Refer to Appendix D), to reflect on the new input from other sources, if there was any, as well as the gained insights (Figure 3.38).

The improvement ideas on the NPD relative factors were assessed through experiments and discussion with experts. I arranged an expert group which involved the company's group product director and 3 product managers. I had weekly meetings with each expert respectively, to allow for quick evaluation of previous findings (Figure 3.39).

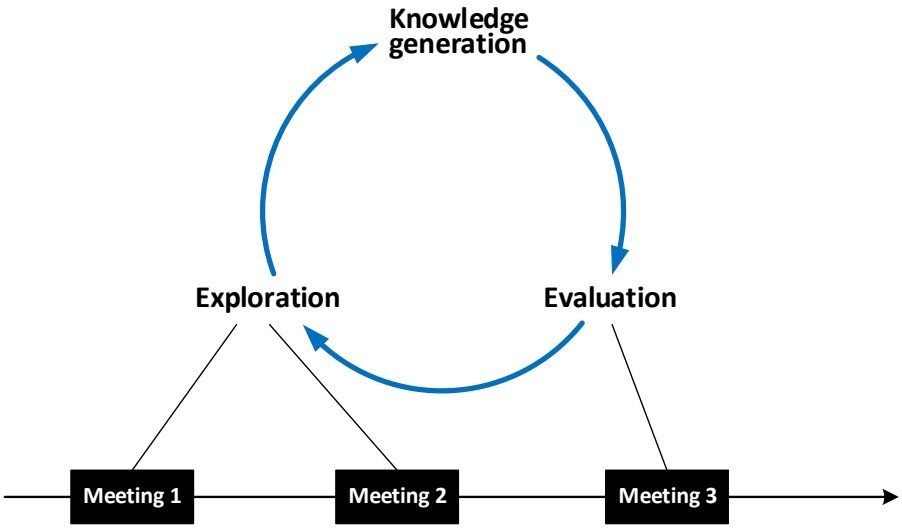


Figure 3.39 The meetings with the NPD stakeholders were organised under a multiple and periodic structure, to allow for quick evaluation of the knowledge generated

The experiments were carried out within the two focused projects. For example, I found that the company did not properly engage users in the front-end of NPD, and suggested that building a connection between the project management group and the installation group could be an easy resolution (the company did not have their own product design group and user research group). To validate the idea's practicability, I participated in the field trial of the new Telecare product, representing the product management function. I teamed up with an installation engineer to test the product with the users. During this process, I evaluated whether this team structure is effective; what research methods could be applied in such a visit; and how could I achieve contribution from the installation engineers in designing a better product (Refer to Chapter 5.5.4.2).

3.3.4 RESULTS AND CONCLUSIONS

The 'company partner' has forged its own NPD process. It was found to be linear, comprising of six major phases and over eighty detailed steps (Refer to Appendix E for the simplified version of the process map and other relevant information). The process has been translated and summarized in Figure 3.40 to assist the reader.

Major issues

This NPD process had been adopted in many previous projects. However, by using questionnaires (Refer to Chapter 3.3.3.4) and interviews (Refer to Appendices D, E and H), four major issues were identified with this process when surveying with key team members:

1) It is not adapted to the company's current situation
2) It is inefficient for managing innovative projects which deliver completely new products.
3) There is a lack of satisfactory solutions for managing the variables throughout a project cycle. (The design of a new product often needs to be modified based on unpredicted requirements from customers or markets. The company is weak at managing design changes after the product launch.)
4) Some key activities planned in the process are often missed out in practice.

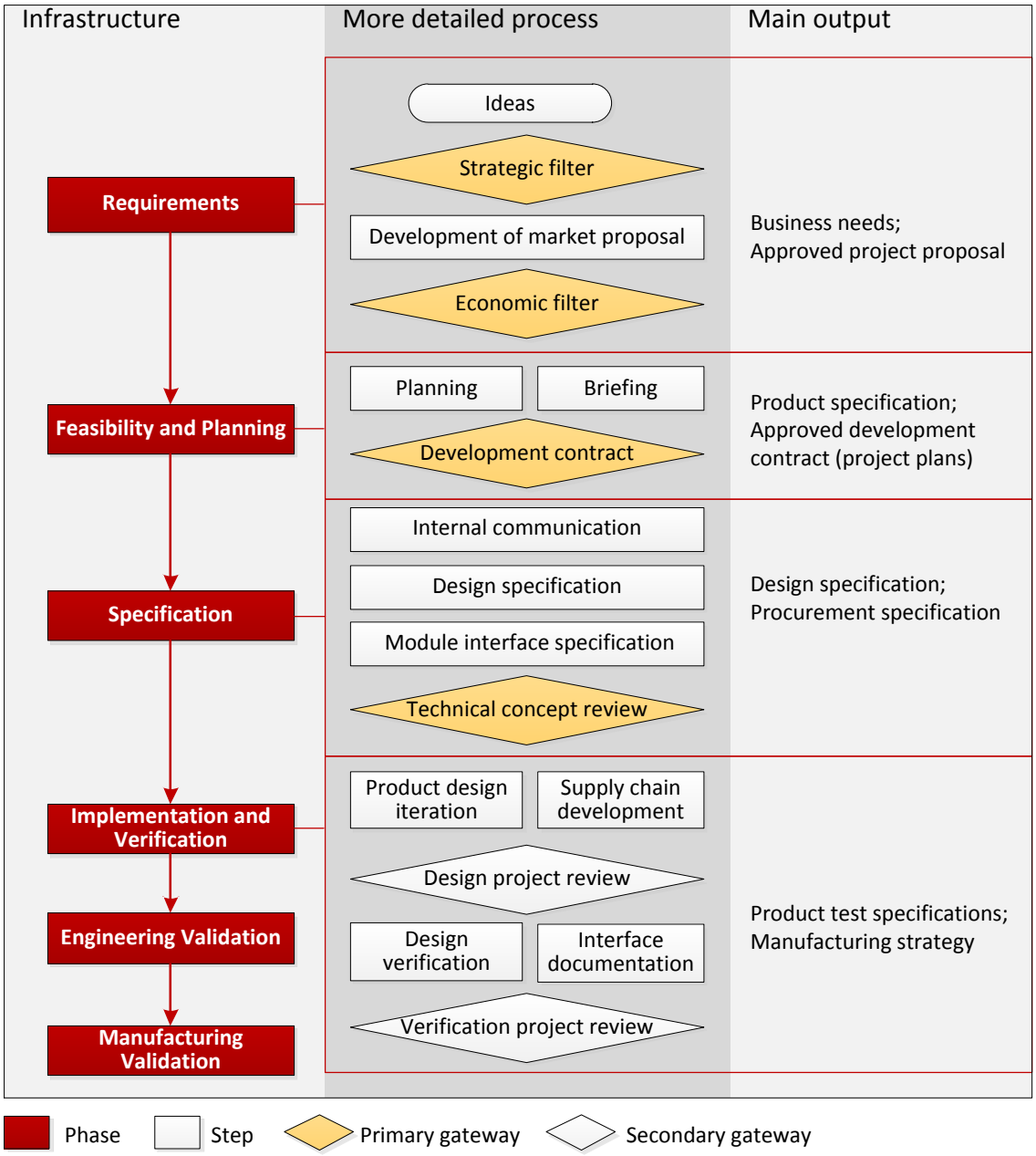


Figure 3.40 A summary of the key stages, activities, and output of the company's product delivery process.

Causes of the issues

Causes of issue 1

The NPD process was forged ten years ago. It had not been updated while the company itself and the environment have both changed. This is evident from archive research into recent projects, and interviews with product, project and quality mangers.

The company was undergoing business strategy transition. Firstly, its business focus was changing from delivering products to delivering services. Secondly, it was working on delivering

more innovative solutions for the future while it was used to being led by manufacturing. As a result, the company's recent projects varied a lot in both size and type, which produced different requirements in terms of project management. However, the NPD process was not designed to address all these requirements. For example, the process is too complicated for the re-design of a component; and it was too rigid for guiding a radical innovation project. Consequently, the company's process was poorly applied in NPD practices. This observation was exemplified by my conversation with a senior product manager and the quality manager:

"A faster process for some less complex projects is required"
– a senior product manager who has worked in the company for over 15 years

"Project teams often ignore our in-house product delivery process."
– as per my conversation with the quality manager

Causes of issue 2

Firstly, the NPD process is a linear and complicated stage-gate process. Such a process is considered by many authors and practitioners to be weak at managing innovative activities (e.g., Koen 2004, Shaeffer & Zirkle 2008) (Refer to Chapter 3.2.4.4).

"I borrowed the approach from previous projects on which I worked before moving to the company..."

"I think the agile process suits the project better than the company's stage- gate process."
– as per my conversation with a product manager

Secondly, the NPD process does not reflect strong design culture and does not even clearly describe the design process. As pointed out by the company's innovation consultant:

"Business requirements often change during the development cycle. As a result, product designs have to be revised frequently'

Two project managers also highlighted that:

"Product development teams are under-resourced to do the design revisions properly."

In the company's NPD process map (Refer to Appendix E), the only specified design stage/step is 'Product design iteration'. It is in the 'Implementation and Verification' phase, which is after design specification has been approved. Therefore, 'Product design iteration' is actually part of the design engineering function instead of generating and developing ideas and concepts. In contrast, the NPD process implies that there is a very strong influence from the operations department. The term 'operations' is not commonly used in organizational structures, but in this company it refers to planning for manufacturing, training, sub-suppliers, materials, and

testing, which are usually carried out by personnel, purchasing and engineering departments in most other companies.

"The R&D team works mainly to meet the new requirements from the operational director"

– as per my conversation with the chief engineer and two project managers

Design activities are rarely described in the process partly because the company did not have its own design team and the design process for most projects was subcontracted to outside design companies. In this scenario where subcontracting is taking place, careful consideration must be given to managing the collaborative relationship to ensure a strong design output that meets the business objectives. Unfortunately, this management requirement is not reflected in the company's NPD process map either.

Causes of issue 3

"It is difficult to add new features to a product when the design process has been completed. However, this is often required to meet the requirements from new customers and to keep the existing product competitive."

– as per my conversation with a product manager

In all fairness, unexpected design changes after the approval of design concepts can hardly be avoided in some projects, particularly in the complex HHCP sector (Refer to Chapter 2.2). However, the risks, costs and other negative influence brought about by the design changes can be diminished or better controlled in the process of determining the variables by studying potential users, customers, markets, competitors and regulations. Also addressing the variables in the establishment of project plans is crucial. Besides, forging a platform strategy to manage the determined variables and informing designers the potential influence produced by such variables must not be lost.

Keeping in mind such influences will allow for changes at a later stage such as leaving space for modifications in designing the structure and inner space of a component beforehand, and saving 3D models in an easy to edit format.

Unfortunately, there was neither strong front-end research nor platform strategies in most projects that I reviewed or observed. This observation was exemplified by my conversation with the operation director:

"… better resource and capacity plan should be made to reduce project failures."

and the marketing manager:

"The marketing department do not often undertake research on the

market and competitors. We work mainly on managing portfolio and supporting the sales team in managing the relationship with customers"

and the quality manager:

"More time should be spent on the feasibility and planning stage to avoid major changes that happen later."

Adopting a platform strategy means developing and manufacturing a family of product variants derived from a common platform and/or modular architecture. Obviously, the reuse of processes, components and design solutions creates advantages in learning curves and economies of scale. Furthermore, forging a platform strategy in advance aids in managing a product's lifecycle against the desire for product customization and competitive pressure. Additionally, platform strategies can elevate existing brands, modules, and sub-system technologies, which can further lead to revenue growth.

The absence of platform strategies may be due to lack of time or being unaware of the merits of this approach. However, the more critical cause is the lack of decent insights into markets and customers upfront, on which a platform strategy is based. As per my conversation with a product manager:

"We need a better understanding of our own products and their capacities in NPD; the marketplace that they are operating; the drivers affecting that marketplace; and who are the main players in the marketplace and their shares."

This can be attributed to the company's NPD process structure, which does not support front-end research very well. As set out in Figure 3.40, the company's NPD process incorporates six linear stages: Requirements, Feasibility and Planning, Specification, Implementation and verification, Engineering validation, and Manufacturing validation. The first stage 'Requirements' begins with 'opportunities'. 'Opportunities' comprises three major steps: Strategic filter, Development of market proposal and Economic filter. None of these activities and steps clarify how and when to discover and to evaluate opportunities, and by whom (nor in the more detailed version in Appendix E).

Moreover, there is no well-established system to collect and to manage valued information in shaping project strategies. This conclusion is supported by the findings that project and product managers complain that their sales departments, which leads market research, do not even understand their own systems, nor do they produce market and customer information as needed for supporting new product development; that some company employees who work in downstream applications such as service said they were not encouraged to contribute to

NPD, and the valuable information they provided was not fully considered by the management teams; that the briefing process which is considered to be critical in project requirement generation and management is often missed out or out of sequence in a project cycle; and that the briefing documents are sometimes lost even before the end of a project.

"Information from Service and Field engineers can hardly fit into the current process."

- as per my conversation with the Installation manager

"The sales department should understand our own systems better."

- as per my conversation with a product manager

Causes of issue 4

Some key NPD activities were poorly conducted, conducted out of sequence, or even missed out in practice, which produced serious quality issues in the execution of the procedure. One major cause is related to 'Issue 1' – the NPD process is not adaptive to projects of various types and sizes. To make matters worse, there was no adjustment to the premade process in most projects. This is because: 1) the process itself does not provide adjustment solutions for various scenarios; and 2) there is lack of early communication between project management teams and the quality department which manages the company's product delivery process.

Quality problems occur mainly in the front-end of a project cycle, to be more specific, in the 'Requirement stage' and the 'Specification stage' (Figure 3.40 & Appendix E). For example, the 'critical technical concept review' step which determines whether a design specification is approved and distributed or not is often missed out in practice. To tackle the issue, the NPD process should provide sufficient detail and pin down key activities, for example, when should the anticipated users become involved in the process; should a design concept be further evaluated with customers or users before being approved, and when and how? Besides, the team members are not experienced in carrying out some important front-end activities, such as user study and design briefing. It is essential to support the team members on selecting and applying the right methods and approaches as needed for individual projects.

"More time and resources should be spent on the front end stage to avoid major changes that happen later."

- as per my conversation with the quality manager

Conclusion

The issues above are related to various components of company operations, such as organizational structure, business positioning and company culture. Instead of looking at the

whole, this study concludes that significant improvement can be achieved by focusing on **5 key factors** that produce significant overall effects:

1. NPD process generation and management
2. Stakeholder engagement
3. Company culture
4. User engagement
5. Information discovery and management in the fuzzy front end

The combination of the above factors serves as a macro-level guideline for improvement which will be analysed in Chapter 3.4 for generating detailed strategies and approaches to implementation.

3.4 LESSONS LEARNT AND IDENTIFIED ISSUES

3.4.1 SUMMARY

This chapter clarifies the lessons learnt during the workplace research (Refer to Chapter 3.3; Appendices D – G). Issues are analysed and improvement ideas and strategies are produced focusing on the 5 key factors of improving HHCP innovation identified in Chapter 3.3, namely:

1. The generation and management of the NPD process (Chapter 3.4.2)
2. The engagement of stakeholders (Chapter 3.4.3)
3. Design influence in company culture (Chapter 3.4.4)
4. User engagement in the fuzzy front end (Chapter 3.4.5)
5. Data and information management (Chapter 3.4.6).

This leads to the theory and conclusion that the process for creating the design brief is central to improving HHCP (Chapter 3.4.7). It results in the specification of a toolkit for supporting small and medium-sized home healthcare product (HHCP) suppliers in establishing and applying applicable design briefs.

3.4.2 ADOPTING A FORMAL AND ADAPTIVE NPD PROCESS

3.4.2.1 A FORMAL NPD PROCESS

Why?

Professionals and organizations worldwide have been actively exploring ways to improve innovation success (e.g. Warren & Susman 2004; Neely et al. 2001; Rothwell & Dodgson 1991). It has been found that successful product or service innovations usually go through calculated processes from concept to launch. For example, the Product Development & Management Association (PDMA) has sponsored best practice research projects since 1990, to identify trends in NPD management practices and to discern which practices are associated with higher degrees of success. Their studies conclude that formal processes for NPD are now the norm – a total of 69% of the reporting firms indicate use of formal, cross functional process for NPD (Barczak et al. 2009).

A formalized NPD process provides a product supplier with a roadmap, which guides its teams through a series of logical steps to developing new solutions or upgrading existing products/services (InnoSupport 2010). It helps to ensure that critical, limited resources are allocated to the projects of most importance to the business and to reduce overall the time to market of new technologies and the products they enable. It also aids in ensuring that all team members understand project goals and boundaries, and are aligned to the product strategy, and that strategies are revalidated from stage to stage. Furthermore, it can improve operational efficiency, which is achieved by streamlining a company's core processes to more effectively respond to changing market forces in a cost-effective manner. In addition, it aids supports the establishment of a product platform. Thus, forging and applying a formal NPD process is critical in leading to a successful product or service (e.g., Booz, Allen & Hamilton 1982; Cooper 1988; Griffin 1997).

How?

This study defines a formal NPD process to comprise 4 key formal components:

1) a platform strategy
2) research and design processes
3) a process for communicating and presenting the research and design outputs
4) an evaluation process

Working on the above components can produce a robust NPD process.

1) A platform strategy

A product platform is basically a broad range of products based on a core technology or design. It is easy to lose control of such a platform when it is developed into an industrial platform, and when stakeholders of various functions get involved. This is why a modular architecture or a common platform is required in the process of developing a family of product variants derived from a core solution. Specifically, formulating a platform strategy upfront

- can improve time and cost efficiency in developing new product versions as demanded by customers or markets
- ensures consistent product language
- can leverage brands, modules, and sub-system technologies

2) A formal research and design process

Healthcare product innovation is complex with iterative feedback loops between Marketing, Design, Manufacturing, and R&D in the project front end. Formal tools serve two main purposes during project definition: 1) it helps design teams ensure that they have considered and captured every essential aspect of the design problem – to avoid unpleasant surprises later; 2) it also helps in the communication of the design specifications to other parts of the organisation, so they can make go/no go decisions or sensible choices about the resources required to support the development of the design. However, it should also be noted that a too rigid design process may strangle creativity. For example, the Head of Design in BT Group is emphatic that formal processes do not adequately describe or control the interaction between designers and design management necessary for delivering a good quality result (Design Council 2007).

3) A formal process for communicating and presenting research and design outputs

The workplace research of this study found out that using different platforms in documentation and presentation brings about problems and wastes project resources. For example, one innovation consultant who has been interviewed pointed out ‘50% of time was consumed by transferring the format of documents across platforms’ and ‘recording and presenting data in a format which is distributable across platforms will significantly increase working efficiency’ (Refer to Appendix D). Using standardised processes for communicating and presenting research and design outputs 1) brings the core team activities together in an easy to understand document; 2) lets everyone present in equal terms, focusing more on content than presentation; and 3) allows straightforward comparison of different projects and options.

4) A formal evaluation process

Firstly, a formal planning and review process highlights and aids in addressing business, process, and investment issues early in a project.

Secondly, regular evaluation against the business criteria and the portfolio aids in ensuring that costly investments in projects are made with firm financial and market justification, aligned with the original objectives.

Thirdly, employing a formal evaluation process helps to balance opinions from different stakeholders. On the one hand, this study encourages an active involvement of a wide range of stakeholders in NPD. On the other hand, it is imperative to ensure that their opinions are equally weighted, and one person does not overpower the decision making. If one single business function leads the progress of a project, there is a high risk that it will push the consideration of specific areas too far ahead and to neglect essential knowledge from other functions. For example, innovative technology can be 'pushed' by technical staff or 'pulled' by customers. In the former case, products may differ significantly from the firm's or its competitors' existing products (Salavou 2005). There is a risk that technical staff will push too far ahead of customers and lead to a product failure. Products with 'pushed' technology may require customers to change behaviour or perception significantly before they are accepted and used.

3.4.2.2 AN ADAPTIVE NPD PROCESS

A highly effective NPD process needs not only to be formalized but also be adaptive to specific requirements. There are two adaptive levels: organizational and project:

To adapt to individual company needs

There are lots of NPD approaches to choose from. A company must first understand its own situation to select a proper approach and to revise it as needed. This is even greater important for SMEs since most of the existing NPD approaches were developed taking a perspective that is more appropriate for large, often multi-national enterprises; and without empirical evaluation on their completeness and quality particularly within SMEs, to say nothing of addressing the distinctive characteristics of the sector (Woodcock 2000).

To forge an NPD process that is fit for a particular company, this study has concluded that business strategy fit and market fit are the primary concerns:

Business strategy fit

A company's overall business strategy usually determines what NPD approach to be deployed. For example, product suppliers often focus on the products to be developed and time to market, therefore they often adopt more rigid and disciplined stage-gate methods (Refer to Chapter 3.2.2 & 3.2.4). In contrast, service suppliers place a high priority on adding value to their customers, and as a result favour a more flexible, inclusive and relational context. Besides the NPD approaches, strategic changes can also influence other factors of project management: these can include changes in organizational structure, culture and team members.

Thus, it is important to review an NPD approach with reference to a business strategy – to determine if it needs to be amended or even replaced in the context of new requirements. If change implementation efforts are to be successful, they need to be context sensitive (Balogun 2001).

Market fit

There can be sharp distinctions across different markets in one industrial sector, in terms of the interrelation between market features and product innovation motivation and requirements. For example, this study has identified that in the telecare market in the UK, reputation, well-built relationship with buyers (which are often public sector organizations), and sales channels are the most critical factors determining business success. In the telehealth market, user satisfaction figures much higher on suppliers' list. Regional variations in terms of local legislation, culture, and healthcare systems can also change business drivers and motivations, for example, if British telecare and telehealth (Refer to Chapter 3.3.3.1 for the difference between the two) suppliers enter the U.S. or Chinese market. An appropriate NPD approach must therefore address the features of specific markets.

To adapt to individual projects

Moreover, a company's standard in-house procedures need to be adjusted based on a specific project's type, size, complexity, and context, to maximise performance. For example, the criteria to evaluate a radical design concept should differ from those applied to assess incremental innovations; a very flexible structure may decrease the operation efficiency while the use of a too linear and rigid process may restrict the creativity and flexibility required for radical innovations; and certain stages or activities of a complete NPD process can be simplified or omitted in a simple project like an amendment of an existing product or component.

3.4.2.3 IMPROVING THE COMPANY'S NPD PROCESS

Addressing the company's features (Refer to Chapter 3.3.3), the improvement strategy of forging and adopting a formal and adaptive NPD process can be translated into 6 key factors:

1. reducing the complexity of the process
2. adopting a platform stagey
3. placing great emphasis on front-end research
4. providing guidance on methods to be applied in research and design
5. improving design influence in the process
6. assessing the company's NPD process regularly to see whether it fits the current situation.

These factors are mostly relevant to the planning, execution and management of NPD activities in the front-end stage of an NPD cycle. Thus, refinements have been made focusing on the specific section of the company's present procedure (Figure 3.38 in Chapter 3.3.3), which led on to an optimised front-end process (Figure 3.41):

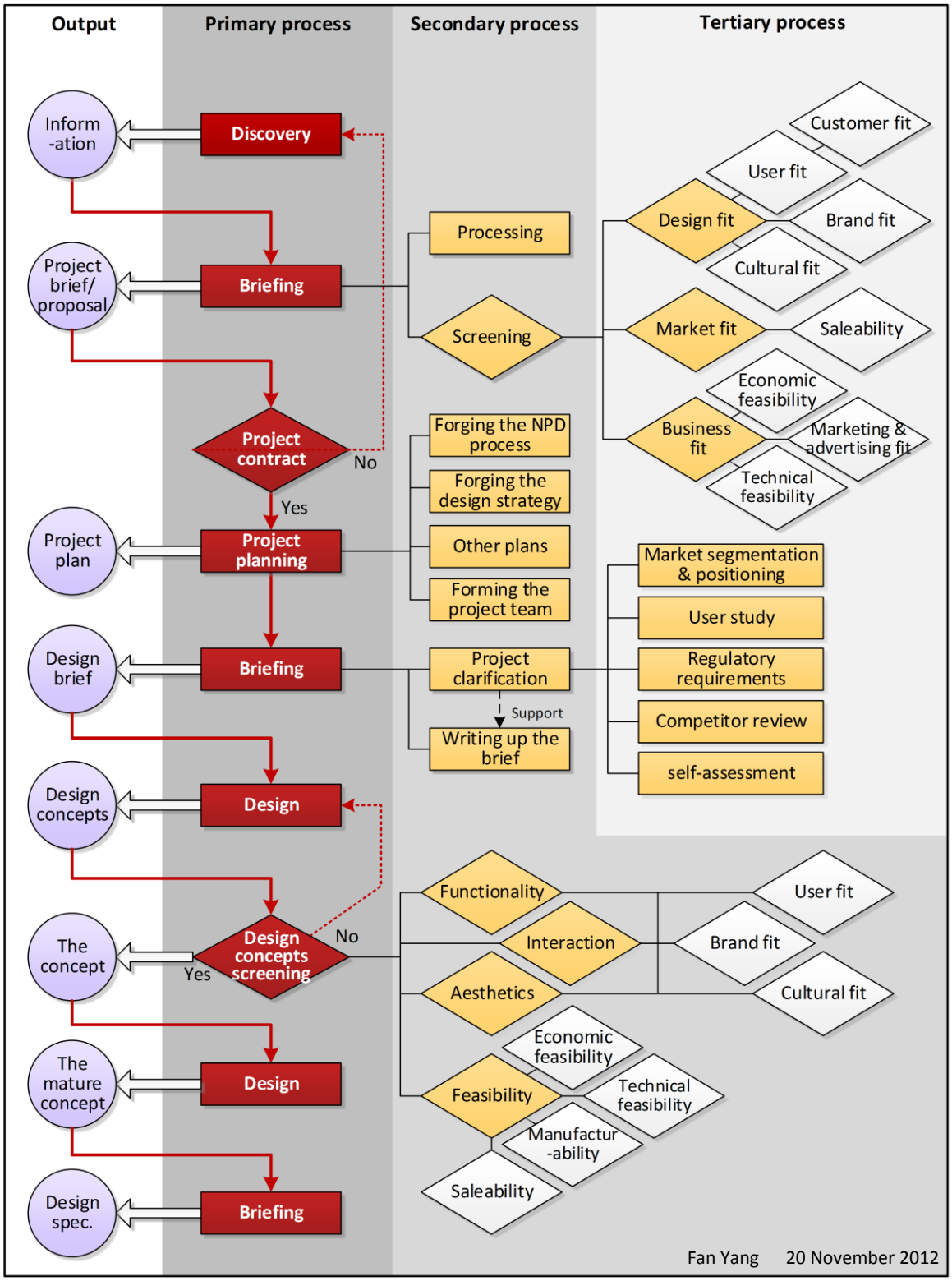


Figure 3.41 An optimised front-end process for the company

This new process

- maintains the basic structure of the existing NPD process to enable easy integration into the current system

- outlines NPD activities in 3 layers to give a greater control of the execution of the process, and to make it more prescriptive and easier to follow
- gives priority to design needs
- engages extensive stakeholders including users
- pins down the briefing processes
- defines activities and approaches (secondary process and tertiary process in Figure 3.4.1) for implementing the overall process

A checklist has been created to help the company review its in-house procedures and the methods and approaches applied in the process. This list forms a part of the toolkit for creating design briefs (See Chapter 4.1.5.2).

SECTION 1: UNDERSTANDING BUSINESS STRATEGIES

1. Business Positioning

   Which industry are we in?

   What are the industry characteristics in terms of new product/service innovation?

   What is our brand value?

2. Business Strategy

   What is our business mode and strategy? Is it fit for the current situation? For example, should our company be led by manufacturing or design; should it deliver products, services, or both?

   Is this strategy under a transformation? If yes, what influence it is likely to produce in terms of, for example, organizational structure, management framework, product development process, sales strategy, and employees' techniques and skills?

SECTION 2: DEPARTMENTAL FUNCTIONS, ROLES AND RESPONSIBILITIES

3. Overview

   What are the roles and responsibilities of different functional teams within a project?

   Which team plays a leading role in terms of the overall project management?

   Which team has the most significant influence within a project?

   Which team leads the design process?

   Is the above structure effective and appropriate to the current situation?

4. Design

Do we need our own design team? If not, shall we build long-term partnership with an independent design house or let a project leader make a decision based on the characteristics of individual projects?

In a project cycle, how to bridge the communication gap between an outside design house and our own teams, to ensure that design solutions always meet business objectives?

5. R&D, Marketing and Sales

   What are the actual functions of R&D, Marketing and Sales respectively? For example, does R&D focus on research and design support in project front-end, or supporting downstream applications such as engineering or manufacturing plan? Does Marketing forecast market trend and contribute to market strategy and project plan, or work more on sales promotion? Do Sales understand our system and products at the level wished for by our Product/Project Management?

SECTION 3: THE NPD PROCESS

6. The in-house NPD Process

   Is there a formal business-level NPD process?

   Is this process effective in projects of diverse types and sizes?

   Has this process being updated continuously?

   Is the process still effective under the current situation based on the recent feedback from various functional groups?

   Are the team members equipped with approaches and methods to carry out activities pre-planned in the process?

7. Project Strategy Formulation

   How is a project strategy formulated?

   Is it based on research or purely intuition?

   Do various functions contribute to the strategy formulation process?

8. Research On User, Customer and Market (customers and users are sometime different people)

   Is there any team which focuses on capturing information of user, customer, or market respectively?

   What approach(es) and method(s) are employed for the above tasks? Are they strong enough to ensure both the quality and the quantity of research output?

   Do we understand the market at both macro and micro level?

   Is there a formal and structured system for capturing and managing market information which includes competitor knowledge, legislation changes, cultures, and development trends?

   For what purposes were users engaged in previous NPD projects? Were there

formal user studies conducted in the front-end phases, and for design and strategy formulation? If not, shall we consider making a change?

Are the insights in the above areas addressed in writing up project and design briefs?

9. Briefing Documents (e.g. project proposals, design briefs and specifications) Generation and Application

   Does the information incorporated in briefing documents come from controlled and authentic sources?

   Were briefs properly documented, at right time, and applied as what they were meant to be in previous projects?

   How are the briefing documents stored? Are they updated continuously with project development?

   Did design solutions well meet the parameters described in briefing documents in most cases?

10. Data Management

    Is there an efficient channel which is effective in both collecting valued data and information from all employees of various functions and in delivering them to whom it may concern?

    Is there a management system which ensures that vital data and information is up to date, easy to access, live, and secure?

11. Collaboration between Functions

    Are multi-disciplinary collaborative work enabled and promoted?

    Do different groups get involved in projects at the appropriate time? Are their opinions addressed adequately throughout the planning and design processes?

    Has the potential of each department been fully exploited? For example, could the service and the installation groups contribute more in the front-end of NPD? (It has been found in this study that these two groups can provide user feedback and competitor information, as well as produce fascinating design ideas, from their daily work with users and customers.)

3.4.3 PROMOTING GREATER STAKEHOLDER ENGAGEMENT

3.4.3.1 WHY AND HOW TO ENGAGE STAKEHOLDERS

Co-working between functional teams is a necessity in delivering excellent innovation outcomes. For example, the company in which I carried out workplace research process can improve at managing highly innovative projects as well as the variables involved (See more details in Chapter 3.4.2.2). This issue can be improved by promoting greater stakeholder engagement, in the fuzzy front end of a project cycle.

What is greater stakeholder engagement? This study defines '**greater**' as **earlier** and **broader** engagement. Among all the interactions among stakeholders, communication between marketing and engineering has been identified as a key concern in new product success by many authors (Cooper and Kleinschmidt 1987, Dougherty 1989, Griffin and Hauser 1996, Dahan and Hauser 2001). This study concludes that close cooperation between design and other functions is also a key influential factor. The design process cannot be treated in isolation - designers have always needed to interact with commercial functions, with manufacturing and with product or service support. This point is also supported by the Design Council's survey of eleven of the world's top design teams (2007).

Specifically, greater stakeholder engagement can:

1) produce more valuable data and information in exploration with broader channels
2) improve the quality of design outputs by
    - having more people coming up with design ideas
    - enabling a consistent design language and user experience
    - ensuring that the design process addresses considerations from various divisions, especially those which are frequently omitted, such as the ease of production
    - and addressing user needs and wants more adequately
3) improve work efficiency by
    - reducing loopbacks in the process
    - improving communication between team members
    - enabling more advanced planning for successive phases, such as looking for sub-suppliers, preparing for testing, and training employees for manufacturing
4) reduce the risks in project development by avoiding unpleasant surprises in the later phases of projects.

Although there are obvious benefits, the case study finds that this company and many other SMEs, are reluctant or not motivated to adopt this method. One reason is the belief that greater engagement consumes more resources in the execution of individual activities. To make matters worse, this 'demerit' is immediate and manifest while any merit or profit is underlying and usually only shown in the longer term. In addition, many managers do not properly understand how to promote stakeholder engagement – the term is sometimes translated merely as organising group meetings more frequently. However, there were explorations on how to facilitate and to improve stakeholder engagement. Some approaches found in this study to be both efficient and easy to adopt follow below.

Determining the driver and the focus

Clearly defining the driver and the focus of engaging stakeholders in the NPD process lets team members be aware of why and how to achieve the goal. It also enables managers to allocate resources, and therefore aids in building confidence on adopting the strategy.

Like many other NPD approaches, stakeholder engagement should be established at both business level and project level. For example, at Microsoft and Philips Healthcare, it is a focus on users. In a particular project, the primary focus is identifying opportunities for improving an existing product, and the secondary focus is evaluating the feasibility of design concepts.

Building cross functional teams

This method has been broadly perceived by highly innovative companies as an essential element of their innovation processes. With fewer employees, many of whom have multiple roles, SMEs have advantages in forming cross functional teams, compared with larger companies.

A cross functional team can be formed for the life of a project, or for an individual activity or in a specific stage of the overall process. In the former, team composition should reflect the type of innovation and represent all functional teams that will be involved in the NPD process. In the latter, team composition should fully address the major goal and purpose of the stage or activity.

Establishing a communication platform for all team members

Firstly, employees across a company – and not just researchers or designers – can contribute with innovative ideas and reflections that are valuable to product and/or service innovation.

Secondly, engaging more team members for one task is likely to make communication and its

analysis more complex, especially if these people work in separate environments and/or get involved in collaborative working in different stages. This problem is most likely to present itself in medium-sized companies – their team members usually work on several on-going projects in parallel and are often restricted by the location and formality of departments. In this case, establishing a communication platform is most helpful.

In summary, establishing a communication platform can

- break down barriers in communication between departments and groups
- enable more frequent communication between stakeholders than holding group meetings
- reveal honest ideas by enabling anonymous communication compared to traceable tools such as emails
- support synchronized communication between various teams
- let information be managed centrally, which aids in keeping valued data alive in successive phases
- improve information delivery efficiency by diminishing layers in communication
- enhance other activities in projects, such as group meetings

A communication platform can be easily established since most companies in the sector have built up their own intranets. It can be integrated into a company's current communication systems such as web portals or email management systems.

Addressing stakeholder engagement in NPD processes

Most companies' standard in-house NPD processes do not tell who, why and how stakeholders should participate (Figure 3.42). Mapping these elements onto the project timeline demystifies the project planning and makes participation less elusive. The resulting NPD process:

- can give deeper insight into project context, opportunities and challenges in various aspects;
- aids in building a collaborative environment among divisions and team members, whether the entities are within one company or a joint venture between companies;
- assists an internal NPD team and external stakeholders like a design company in reaching a consensus on project planning and in managing project progress

The mapping method is particularly helpful in projects adopting agile processes, to give the fuzzy structure necessary governance.

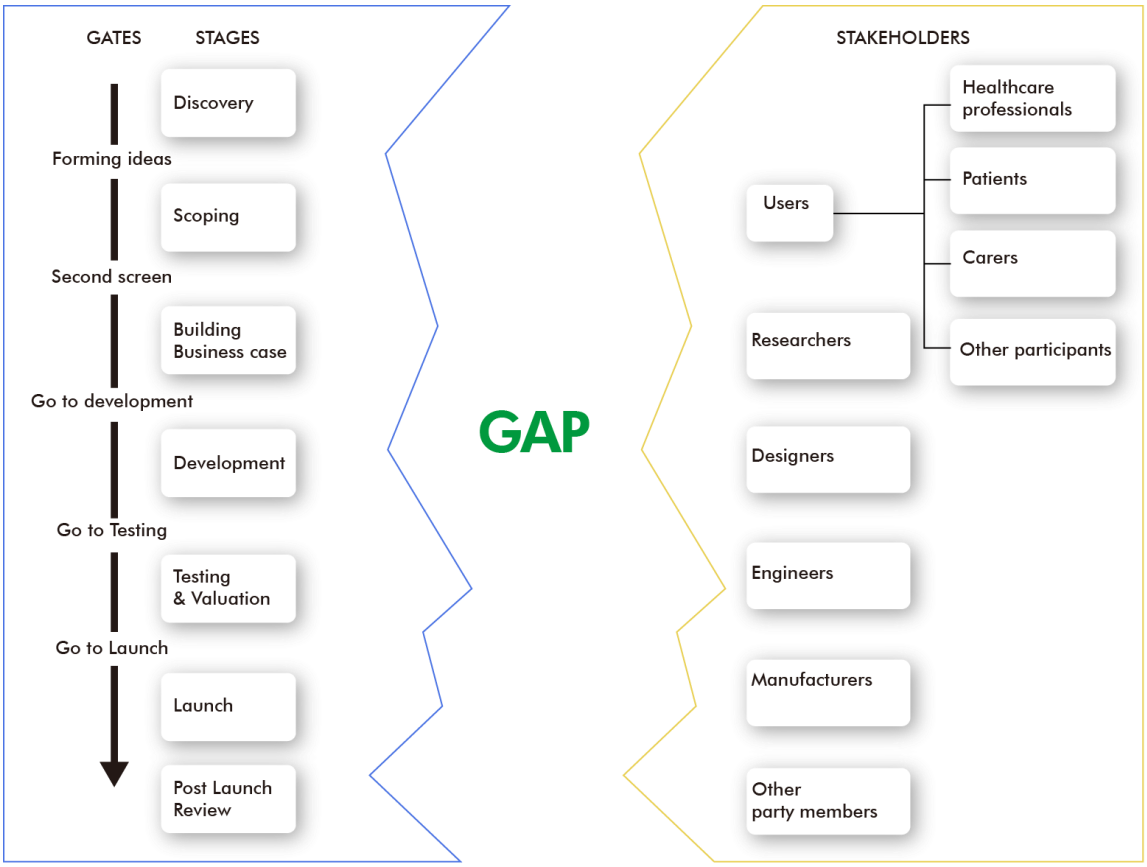
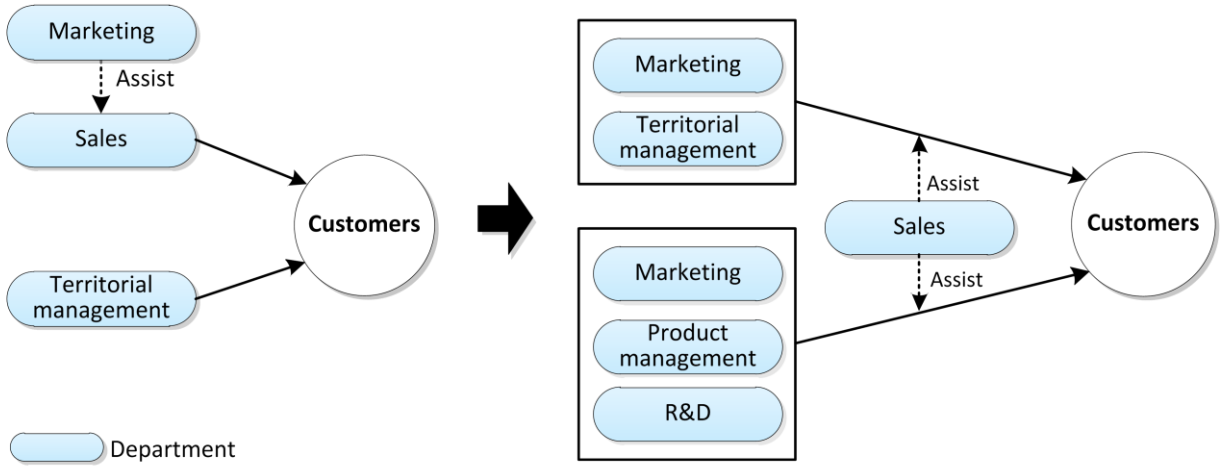


Figure 3.42 The gap between a principal NPD process and the execution of stakeholder engagement was frequently observed

3.4.3.2 IMPLEMENTING THE STRATEGY IN THE COMPANY

In the company where I conducted a workplace research, lack of multidisciplinary team working is most prominent in explorations of market, customer and user. For instance, customer information is captured mainly by the Sales and the Territorial Management teams respectively. As proposed in this study, a marketer, a product/project manager and a R&D researcher can form an efficient unit for customer research inside the UK, under the leadership of the marketing department (Figure 3.43). The participation of a product/project manager ensures that the company's product and service solutions are properly introduced to customers in terms of function and technology. Furthermore, links to the planning and the execution of a research activity should be integrated more tightly to new product innovation. An R&D researcher provides support in methodology, and consequently can provide a good planning and control of the research process, with a project/product manager collaboratively. He/she can be responsible for recording and processing valuable data and information in a customer visit/interview. For customer research outside the UK, a team should consist of at least a marketer and a territorial manager (The R&D and product development teams are only based in the UK). The teams in the headquarters should provide support as needed.



How customer research is carried out in the company The proposed customer research team

Figure 3.43 Improving customer research in the company

A brief guide on forming cross functional teams for studying market, customer and user is presented below:

Activities	Functions	Facilitators	Roles
Customer research	Research from marketing perspective	Marketer	Leading
	Addressing considerations from NPD perspectives	Product/project manager	Participating
	Building contact with local customers;	Territorial management	Supporting / Participating

Activities	Functions	Facilitators	Roles
User research	Planning research process; Determining research methods; Processing data	R&D researcher	Leading
	Capturing user knowledge from a design perspective	Designer*	Participating
	Building contact; Arranging research activities; Providing product design ideas	Service engineer/ manager	Supporting

*Include designers from inside and outside of the company

Activities	Functions	Facilitators	Roles
Market research	Carrying out consistent and in-depth market research	Marketer	Leading
	Supporting the marketing team in their work	Sales	Participating
	Addressing the features of a specific market	Territorial management	Participating

3.4.3.3 ADDITIONAL IDEAS ON DEVELOPING A NEW NPD APPROACH

Following the need of prompting greater stakeholder engagement, the new NPD approach which is to be designed in this study should aim to bridge the frequently observed gap between a company's standard NPD process and the execution of individual activities involved. To achieve this aim the format of a front-end tool/toolkit, which enables broad participations and contributions and determines roles and responsibilities of stakeholders and contributors in an NPD process (Refer to Chapter 3.4.2) started to evolve (Figure 3.44).

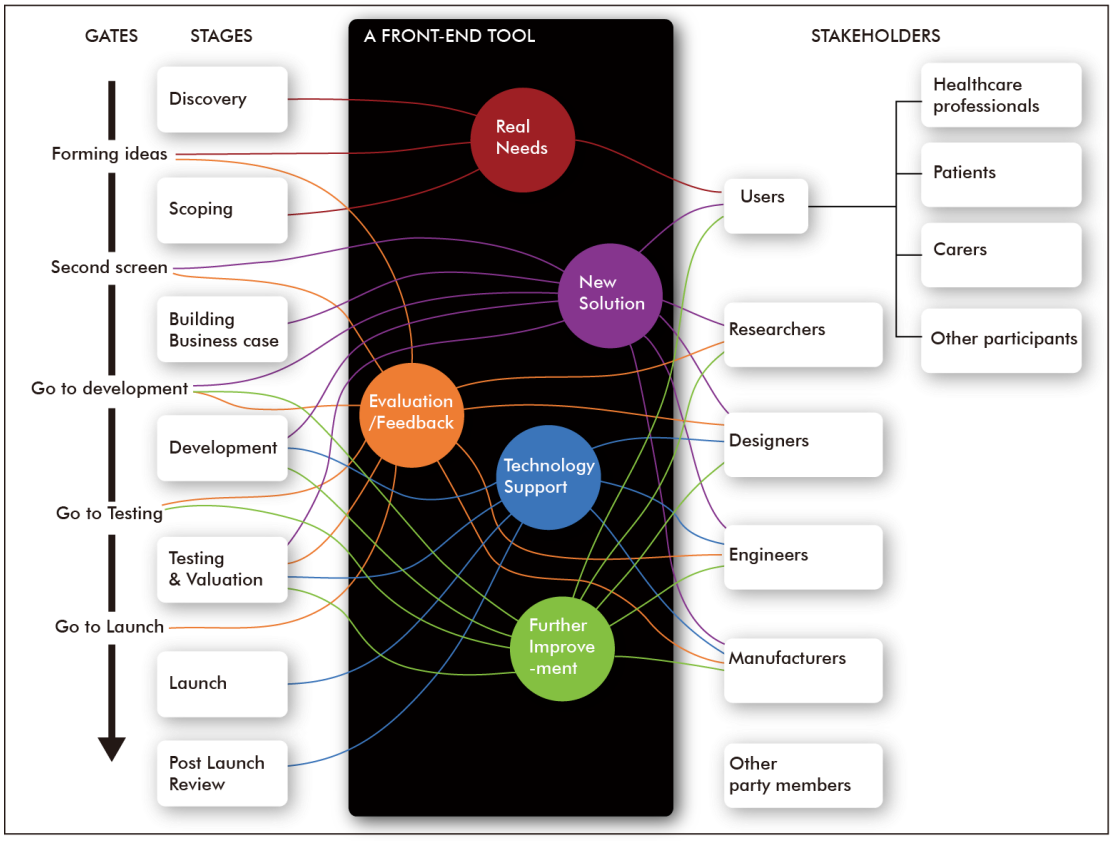


Figure 3.44 A front-end tool to bridge the gap between an NPD process and greater stakeholder engagement

3.4.4 FOSTERING COMPANY CULTURE THAT VALUES DESIGN

3.4.4.1 A BROAD-BASED STRATEGY

Culture is one of the factors that separate excellent innovative companies from the rest (Design Council 2007). Cultural barriers often exist in team work since the members of various functions usually have various knowledge backgrounds, speak different 'languages', and could be motivated by diverse concerns. This issue reduces team work efficiency and may lead to errors. It is a frequently observed obstacle in promoting stakeholder engagement (Also refer to Appendices D & H).

To overcome cultural barriers, some companies chose to educate designers in the languages of other functions. A better approach is to foster a company corporate culture that values design, as concluded in this study. In adoption, this strategy aims to extend design influence upstream and downstream in NPD processes (e.g., Rivera-Vazquez et al. 2009, Hall 2005, McDermott & O'Dell 2001).

Why?

Sufficient upstream design influence is an essential condition of establishing a strong and visible leadership of the design function. It ensures that the design needs can be properly considered in forging project plans and strategies, and reinforces design-led brand profile and values.

Downstream influence can retain design consistency through engineering and manufacturing, to transform a good design concept into a real product. It is particularly important for small and medium-sized product suppliers most of which do not have their own design teams. They frequently outsource the design process to a separate team in a different location, who usually do not monitor the execution of design outcomes in subsequent applications.

How?

Applying a well-built process for creating design briefs

A strong design brief should be created collaboratively between a design commissioner and a design team. During this process, active participation of other functional groups is also required, to ensure that a broader spectrum of ideas can be properly addressed in the output. Thus, the process of developing a strong design brief is also a valued front-end communication process between the design function and all other functions, which can be exploited to let non-designers understand the features, requirements and outputs of the design phase.

Integrating designers and design researcher into an NPD team

Integrating design researchers and/or designers directly into an NPD team, regardless of whether he/she is from inside or outside of a company, is an effective approach to enabling active interactions between design and other functions. Thus, cross functional team working, which has been pointed out in Chapter 3.4.3 as an efficient approach to achieving greater stakeholder engagement, is also a driver for fostering design influence.

Establishing a research and design method bank

Team members of many SMEs including the company in which I conducted workplace research need to be better equipped with the skills to plan and conduct formal front-end research. Consequently, there is a need for building a bank of research and design methods and best practices, enabling both designers and non-designers access to document, communicate and train in the knowledge provided.

This approach can produce a number of extra benefits:

It increases the general awareness of the goals, processes, outputs and values of research and design activities, and consequently promotes the design culture within a company. It can also promote central knowledge management, which is discussed in detail in Chapter 3.4.6. Furthermore, it reflects brand value and a supplier's professionalism - placing a summary of methods in a company's portfolio is a good advertisement.

A functional method bank should:

- incorporate both research and design methodologies and best practices.
- be open to all team members.
- be intelligible, widely relevant, current to various functions, and adapted to changing circumstances. To do so, all NPD relevant divisions within a company should contribute to its development and maintenance. For example, in Philips Healthcare, market researchers, user researchers, product designers, UI designers, and software developers alike access and contribute to the internal User Excellence Handbook.

Adjusting organizational structure and departmental functions

Organizational structure partly determines position, responsibility and influence of each function in NPD processes. It is also relevant to decision-making, which is important for management and leadership. SMEs often need to adjust organizational structure and departmental functions to better support design, especially those which do not have their own design teams.

3.4.4.2 IMPLEMENTING THE STRATEGY IN THE COMPANY

In addition to the broad-based solutions above, it is necessary for the company to **adjust decision-making** throughout NPD processes.

In the company, major influence on decision-making comes from the Product Development and the Operations, within an NPD cycle. The two departments often approach issues from different even contrary perspectives (Refer to Chapter 3.3.3.2). Figure 3.45 sets out how in the current system the CTO and CFO resolve their disagreements, which happens most often during the project plan and the design evaluation and confirmation stages – issues frequently reaches the group board for decision making as the current system does not specify the correlation between the two powerful departments.

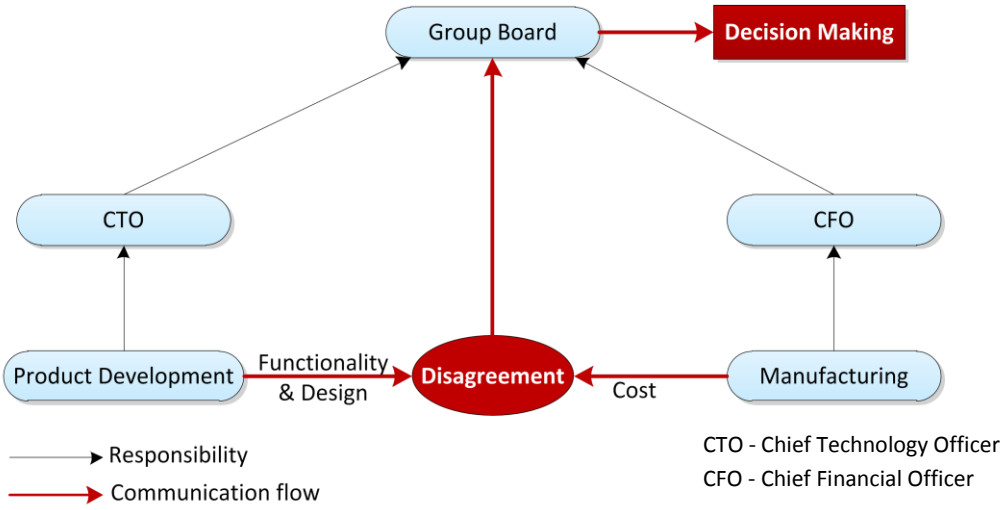


Figure 3.45 Decision making in the company which I studied

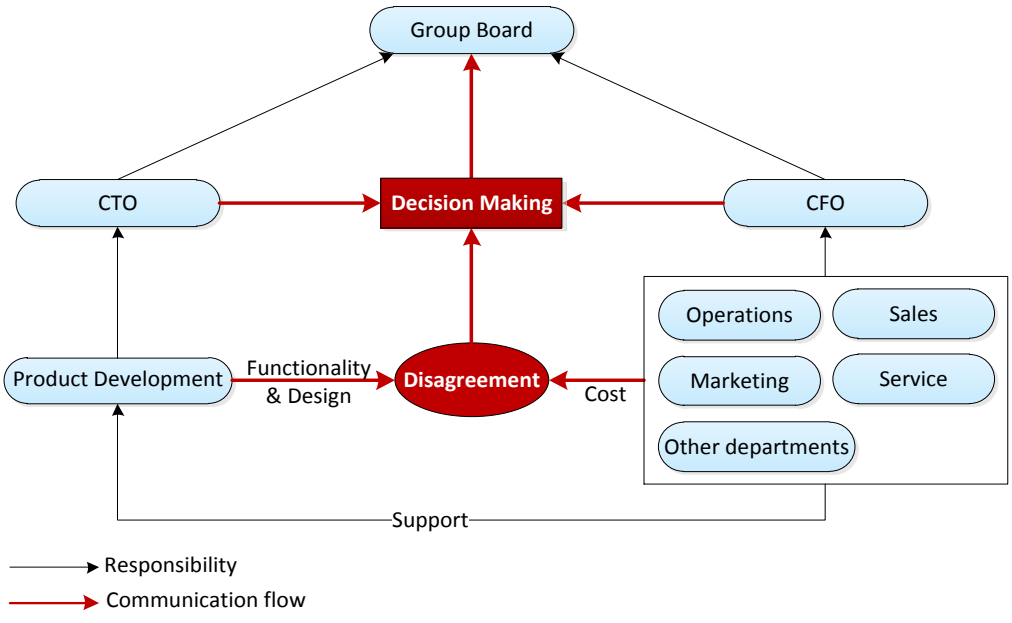


Figure 3.46 An idea on adjusting the current system to support innovation

Figure 3.46 outlines an idea for improving the current system. It determines the leading role of product development function throughout NPD processes. All other functional groups report to the project/product manager, though functional directors are at a higher position in the business hierarchy. In this new system, most decisions should be made at project level, which both promotes innovation and helps to control excessive influence from the manufacturing function. It also improves the efficiency in decision making.

3.4.5 FOCUSING ON USERS IN THE FUZZY FRONT END (FFE)

An overview of User-Centred Design (UCD)

The term 'User-Centred Design' was used by Donald Norman (1986) to describe a design based on the needs of the user, leaving aside what he considers to be secondary issues like aesthetics. UCD, which is also known as Human-Centred Design, is a multi-disciplinary activity and design philosophy that pays particular attention to the human factors and ergonomics - what they will do with a product; where they will use it; and what features they consider essential (Rodriguez et al. 2007).

In its early stages, UCD can be translated as design for users, which means that user considerations should play a part in the design process – users' social, sensorial, and emotional factors of product experience must be attended to by designers (Stappers & Szita 2009). A more recent principle 'design with users' suggests bringing users into a design process. Similar terms 'design for users' and 'design by users' take a small step further – they highlight that user insight should be positioned as the basis for forming design solutions. The evolvement of UCD principles can reveal the changing role of users in a development cycle: users are increasingly seen as design collaborators who bring valuable input, and work together with team members, beyond their traditional passive role in new product/service development.

Definition in this thesis

This study adopts a broad definition of UCD. The traditional translation 'design for users', in association with more recent concepts such as 'design from users', 'design with users', and 'design by users' are all termed as 'user centred'.

The term 'user' refers to all involved in product use – including those who share the environment and interact with the product but do not necessarily use the product themselves, for example: families of patients living in an environment with HHCPs; carers who support patients in post operation recovery; and health authorities providing and/or maintaining

products. These secondary/indirect users have similar influence on product performance in usage to the immediate users.

Why focus on users in the FFE?

On the one hand, reflecting to users' needs and wishes is a fundamental requirement for delivering safe, functional and friendly home healthcare products (Martin et al. 2006). An NPD team must perform primary and formal user research at the outsets of projects, for discovery, planning and reviewing, to deliver satisfactory user experience of innovative HHCPs and associated services. Confusing, complex and unwieldy designs are, at best, less effective than they could be, at worst, potentially dangerous to users of products (Clarkson et al. 2004). However, HHCP suppliers often rely on 'second-hand' user insights, which can lead to false information being used, whilst valuable information is missed out during the process of translation and transfer (Refer to Chapter 3.1.2.1). This leads to the fact that HHCPs are often reported to have poor user performances (Refer to Section 2). On the other hand, engaging users upfront assists in minimising risks in development; in revealing new business opportunities; and in gathering rich user information, which is valued by designers as inspiration for generating better solutions. Product users generally do not know as much about technologies as the product/service developers do, nor do they have equally sharp eyes to identify product possibilities. Nevertheless, observing people use products in life, and hearing and seeing their fantasies and frustrations can open the eyes of product developers and give them inspiration to innovate (Moore 2008).

Consequently, centralizing on users in the FFE stage benefits both the result and the overall process of an NPD project, though this strategy may requires extra investment of time and money on a particular stage of the project.

Application

UCD projects ground design solutions on how users can, want, or need to use a product, rather than forcing users to change their behaviour to accommodate existing products. In product innovation process, UCD requires team members to map potential users' needs and wants in a scientific and systematic fashion, and to apply non-recognised user needs and wants as a source of innovation (Rosted 2010).

The application of UCD is expected to enhance both effectiveness and efficiency, to improve human working conditions, and to counteract possible adverse effects of use on human health, safety and performance (ISO 13407, 1999E). This can produce further business benefits, including: increased revenues, greater customer loyalty, reduced customer service costs, and

reduced project costs and timescales.

There are four essential activities in a UCD project as outlined by ISO 13407:

- understand and specify the context of use
- specify user and organisational requirements
- produce more than one design solution
- evaluate designs against requirements

Yet, this standard specifies neither what methods and approaches to undertake during UCD activities, nor when and how to engage users in a project cycle.

Challenges

A serious dilemma in promoting UCD is that SMEs in the sector are often not motivated to satisfy the real needs and wants of end-users in NPD, which has been elaborated in Chapter 3.2.1.

Another challenge is that obtaining valid and effective user insights for spurring HHCP innovation sometimes requires extra skills and/or resources which SMEs typically lack. Product users often have tacit and latent needs and/or future expectations they themselves are not aware of, due to a lack of knowledge about new technologies that can be used in product design, or being locked in the mind-set of using existing products.

The two factors above lead to the fact that HHCPs are often reported to have poor user performances (Refer to Chapter 2.2.3). There is an emergent need for creating an effective and affordable solution for assisting SMEs in the sector in utilizing UCD.

An evaluation of UCD research techniques

As concluded in Chapter 2.2.4, most of the existing UCD methods and standards are not specific to complex HHCP development and do not provide appropriate details to guide specific NPD activities in projects of differing types. To find effective UCD research techniques which are also economical for SMEs, methods and approaches including experimental interview, inclusion of lead users, storytelling, contextual inquiry, empathic design, contextual design, persona, affinity diagram, scenario, conjoint analysis, experience prototyping and process mapping were all tested during the case study (Refer to Section 3.3.3.2). The results are summarized in Figure 3.47. It sets out the application, interactivity, control level, sample size, flexibility, time cost, and the required expertise of UCD methods available, as well as the type, depth and validity of output. The left column shows which methods can be applied together for a specific task to achieve a better result, as concluded in the workplace research.

COMBINATION OF METHODS		UCD APPROACHES	APPLICATION					TYPE OF OUTPUT INFO		TIME COST		EXPERTISE	SAMPLE SIZE	CONTROL LEVEL	INFO DEPTH	INFO REALITY	INFO QUANTITY	BONUS INFO	FLEXIBILITY	INTERACTIVITY
			INFO COLLECTION	INFO EVALUATION	INFO TRANSF-ORMATION	IDEA/CONCEPT GENERATION	IDEA/CONCEPT EVALUATION	Statistical	Non-statistical	RESEARCH PREPARATION	INFO COLLECTION									
2/14		1 Questionnaire	√	√			√	√	√	○○○	○○○○	○○	●●●●	●	●●	●	●●●●●	●	●	●
1		2 Web Forum	√	√			√	√	√	○	○○○○	○	●●	●●	●●●	●●	●●	●●	●●●	●●
16/17/18/20		3 Face-to-Face Interview	√	√			√		√	○○○	○	○○○○	●	●●●●●	●●●●●	●●●●	●●●	●●	●●●●●	●●●●●
16/17/18/20		4 Expert Interview	√	√			√		√	○○○	○	○○○○	●	●●●●●	●●●●●	●●●●	●●●	●●●	●●●●●	●●●●●
16/17/18/20		5 Group Interview	√	√			√	√	√	○○○○○	○	○○○○	●●●	●●●●	●●●●●	●●●	●●●●	●	●●●●●	●●●●●
16/17/18/20		6 Contextual Inquiry	√						√	○○○○	○	○○○○	/	●●●●	●●●●●	●●●●●	/	●●●●	●●●●	●●●●
16/17/18/20		7 Observation	√						√	○○○	○○	○○○○	●	●●●	●●●	●●●●	●	●●●	●●	●●
12/13/	GO WELL WITH	8 Role-Playing	√	√		√			√	○○○○○	○○	/								
		9 Empathic Design	√	√	√	√	√		√			○○○○○								
8/17/18/19/20/21		10 Inclusion of a Lead User	√	√	√	√	√		√			/								
		11 Contextual Design	√	√	√	√			√			/								
3/4/5/7/8/14		12 Senerio		√	√				√			○○○								
3/4/5/7/8/13		13 Persona		√	√				√			○○○○○								
1		14 Affinity Diagram		√	√	√			√			○○○○○								
		15 Participatory Design		√	√	√	√	√	√			/								
3/4/5/7//1013/14		16 Conjoint Analysis					√	√	√	○○○	○○○	○○○								
3/4/5/7//10/13/14		17 Focus Group					√	√	√	○○○	○○○	○○○								
3/4/5/7/10/13/14		18 Experiential Interview					√	√	√	○○○○	○○○	○○○○								
3/4/5/7/10/13/14		19 Experience Prototyping					√	√	√	○○○○○	○○○	○○○○								
3/4/5/7/10/13/14		20 Usability Testing					√	√	√	○○○○○	○○○	○○○○○								

●●●●● Highest Positive Impact
● Lowest Positive Impact
○○○○○ Highest Demand
○ Lowest Demand

Figure 3.47 An evaluation of UCD research techniques

The workplace study has shown that none of the tested UCD approaches addresses all of the key factors in developing functional, safe and user friendly HHCP solutions. For example, Contextual Inquiry highlights monitoring user-product interaction in the product application environment and has an open-ended nature. Compared with Questionnaire, Interview and Web Forum, this approach is effective in capturing valued details that stimulate design idea generation and in revealing tacit knowledge of which interviewees may not be consciously aware; while being much slower and more expensive. The method also requires expertise that team members may not have. Thus, companies in the sector, including the 'company partner' of this study, need to select right research technique(s) based on the nature of individual projects or tasks, rather than depending on one or two techniques in all situations.

To achieve this goal, the 'company partner' needed to educate its team members about the features of different techniques. In support of this requirement a cheap but effective solution was thought to be an on-line educational platform or a method bank integrated in their current management system. This feature (method bank) became a key element of the online toolkit developed as a part of this thesis (Refer to Chapter 4.2).

3.4.6 IMPROVING DATA AND INFORMATION MANAGEMENT

3.4.6.1 OVERVIEW

The quality of business data and information directly influences business decisions made in day-to-day affairs as well as operational efficiency. The motivations for management efforts are typically organizational objectives such as improved performance, competitive advantage, innovation, the sharing of lessons learned, integration and continuous improvement of the organization. A well-established data and information exploration and management system spurs the progress of all NPD elements and consequently is the linchpin of the whole. By adequately managing information over its lifetime, companies can be better equipped to deliver competitive offerings to the market faster and to support business goals with less risk.

My exploration for improvement focused on enabling best exploration and adoption of raw data, insights and experience gained in the NPD processes. It incorporates a range of strategies and practices for 1) discovering, 2) translating, 3) delivering and 4) storing data and information, and for 5) elevating business culture within the process. Challenges in these 6 aspects with improvement strategies are discussed in Chapters 3.4.6.2-3.4.6.6. The elements of these sections are interact with each other.

3.4.6.2 DISCOVERY

Current situation in the company

There is seldom any systematic research in the front end of the company's NPD projects, which leads to an unstructured manner of discovering data and information. This study finds out that the obtaining of **customer insights**, **end-user insights** and **market insights** are the 3 critical areas that need to be improved.

1) Customer insights

Customer research had, for some years, been conducted by the sales department. The marketing department who only joined in for more recent Interviews, questionnaires, and face-to-face discussions are used to gauge customer needs.

The sales department is made up of the internal and the external sales teams. The external sales team, as described by the sales manager, plays the role of 'hunters'. It focuses on searching for new business opportunities and building up relationships with potential customers. The internal sales team plays the role of 'farmers'. It is responsible for managing and further developing the established relationships with customers (Figure 3.48).

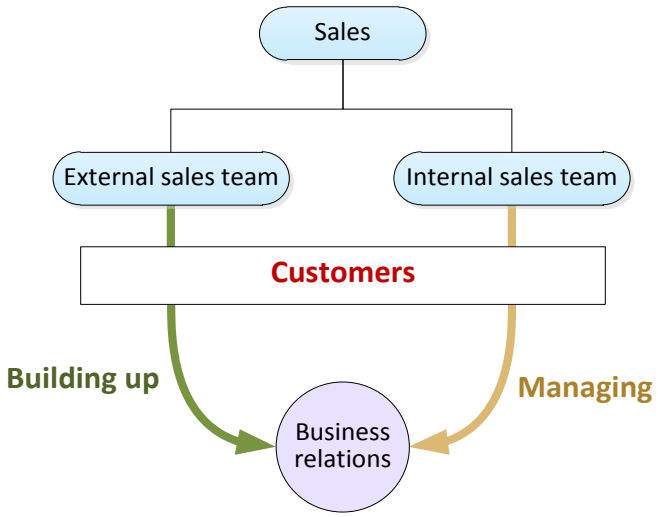


Figure 3.48 The structure and functions of the sales department

2) User insights

There is no formal user research in the front-end phase of NPD in most of the company's projects. General user insights are obtained mainly from information gathered by the service department. There are a large number of services engineers who work daily with product users. They visit users' homes to solve technical problems, to install new products, or to replace components. During this process, they often communicate with users on product performance, and in the product application environment. This is indeed an efficient information source, while weak at maintaining reliability. This drawback presents in two aspects: 1) valuable data such as user behaviour is frequently ignored; and 2) the collected data is sometimes recorded and/or translated in poor quality. This is because user research is not the duty of service engineers, neither are they equipped to carry it out.

3) Market insights

It has been frequently pointed out by interviewed product managers that there is a lack of macro-level market knowledge to be applied in forgoing product/project strategies. The issue's root cause, as concluded in this study, is that there is no consistent and systematic market research in the company.

As a matter of fact, there is no department or team which works exclusively on market research. Market information is collected by territorial management and sales, and then transferred to product management and a group board (Figure 3.49). Product management and a group boards may also contribute to utilizing their own information channels.

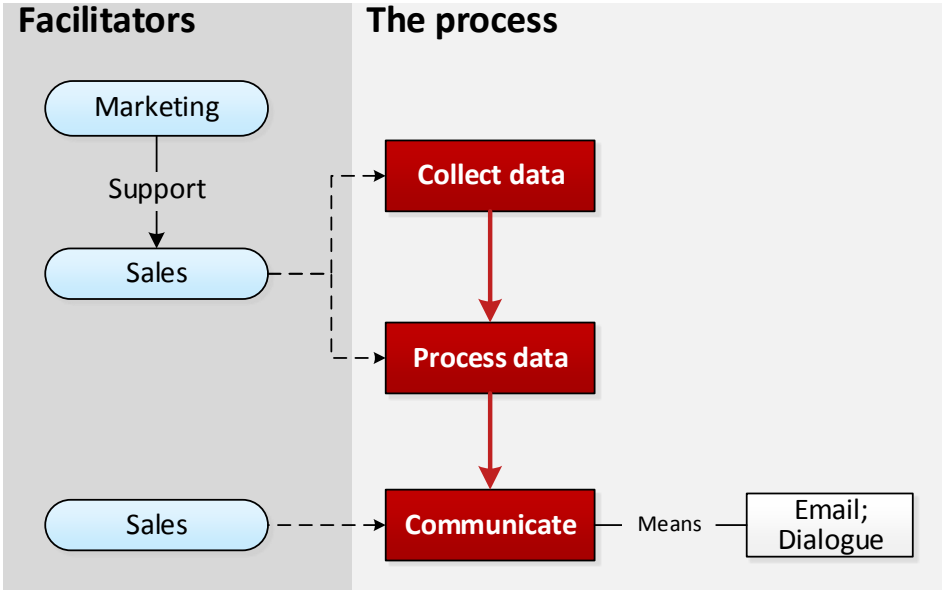


Figure 3.49 The company's process of market research

Improvement strategies for the company

Of all departments/groups, marketing and R&D are the two which most need to be repositioned and redefined to improve data and information discovery to help in the design brief.

Repositioning the R&D department:

There is a conflict in how to use the R&D department (Figure 3.50).

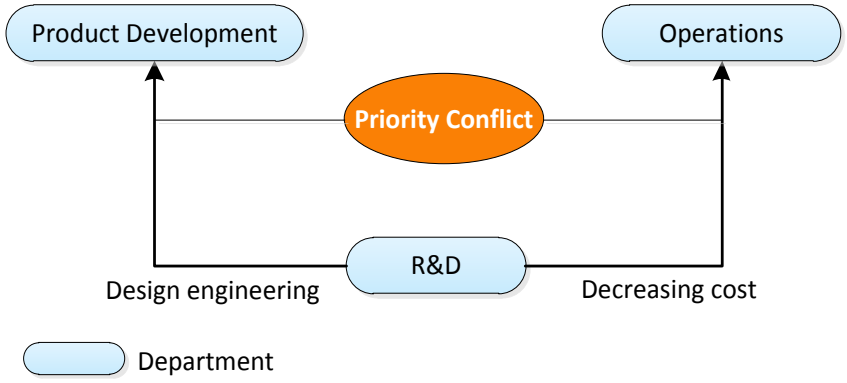


Figure 3.50 The actual function of R&D in the company's NPD process

The R&D's actual function is mainly manufacturing support – it does little 'research' or 'design', but works mainly on supporting the operations department in reducing manufacturing costs, and the management department in documenting briefing documents. Its team leader reports to both the product managers and the operations director (Refer to 'Issue three' in Chapter 3.3.4). The R&D set about organizing activities involving users in a few recent projects. It's

disappointing that the majority of these activities occur after the product design process, with the purpose of testing design prototypes or new products.

In order to better support innovation, the workload of R&D should be shifted from supporting manufacturing and documenting to design-related research activities. To support creativity and to ensure the validity of research outcomes, R&D must also work independently instead of playing a supporting role in projects.

Figure 3.51 sets out how to better position R&D in the company's NPD process.

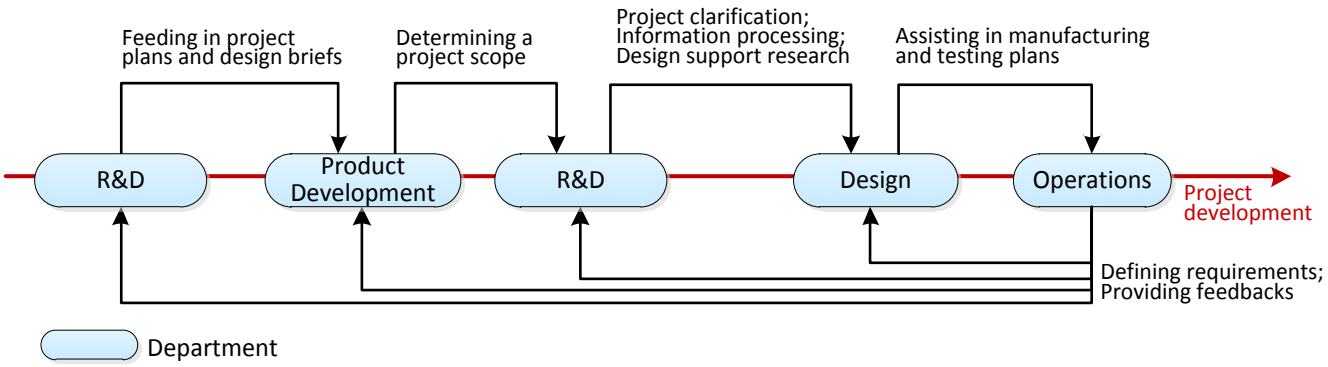


Figure 3.51 A suggested format of using R&D in the NPD process

Repositioning the marketing department

The marketing department should replace the sales department's leading role in the market research process and focus on this function in its routine activities. This study defines the marketing department's proper functions as:

- to identify market requirements and translate the data into product requirements
- to be the voice of the market in the development phase
- to communicate back to the development team when a product has been brought onto the market, to facilitate downstream marketing and sale activities

3.4.6.3 TRANSLATION

Data produced in research is only valuable if they can be applied in downstream applications. The translation process plays a critical role in realising this aim. It links exploration and idea generation in NPD - it starts with a broad perspective and then reaches specific implications for solutions in an iterative way.

Both the company and most other SMEs can improve their data translation processes by: 1) translating data as needed for different applications, and 2) maintaining data traceability:

1) Translating data as needed for different applications

An NPD activity can produce valuable data relevant to the work of different departments. However, the data must be translatable in different perspectives, at various levels, and in diverse departmental terminologies, to produce effective knowledge for them all. In a user experience testing, for example, marketers tend to prefer structured and actionable input; whereas designers often want to know who the users are, how they interact with the product, and what their comments are in detail.

2) Maintaining data traceability

In SMEs, the translation process is of particular importance as front-end data and information, such as business opportunities, usually goes through multiple translations before reaching data consumers (Refer to Chapter 3.4.4). In delivery processes, richness, validity and accuracy of data can be easily corrupted, and valuable data fragments are frequently lost. Such a situation highlights the significance of maintaining traceability of data in translation and delivery, to enable new consumers of data to trace back to its original source even if its owner has changed multiple times, to repeat the translation process based on new purposes. Managing data and information centrally (Refer to Section Chapter 3.4.5) contributes to putting this strategy into practice.

3.4.6.4 DELIVERY

Current situation in the company

Original data is often processed when being handed over from one functional team/member to another. Between the original data and their consumers, there are often multiple communication layers. This is unsurprising as SMEs tend to be organised in a traditional hierarchical 'family tree' structure (Refer to Chapter 3.4.4.2), and rarely have a separate research, design, or data management team. As a result, a large percentage of design and research related data and information is produced and processed by other functional teams as extra output, and is sometimes delivered without adequate caution. The lack of systematic front-end research (Refer to Chapter 3.4.6.2) also leads to a relatively unstructured manner of data transfer.

Figures 3.52 – 3.54 outline how user, customer, and market data and information is typically explored and delivered in the company partner's NPD projects. The linear delivery processes, as set out in the diagrams, comprise many layers and lack adequate communication among stakeholders. Such a manner of data delivery can hardly ensure consistency and richness; and

is weak at keeping data 'alive', even before the completion of a project cycle. It therefore could reduce work efficiency, hinder creativity, and lead to errors in downstream applications.

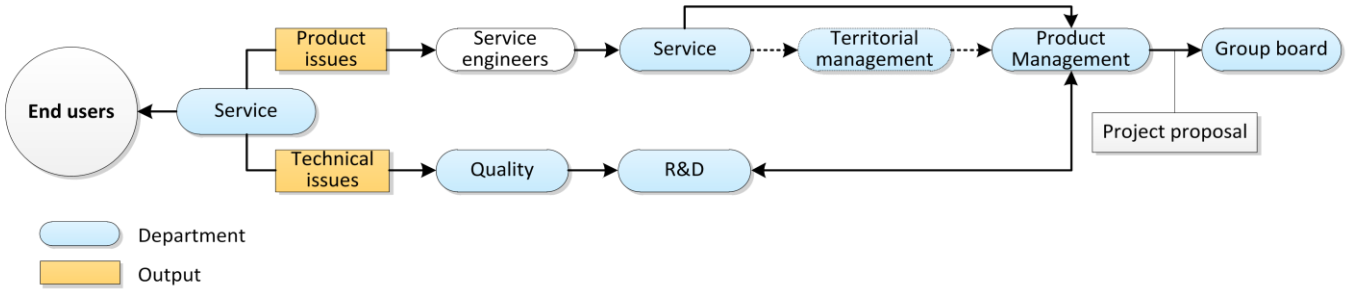


Figure 3.52 The process of collecting and communicating user information

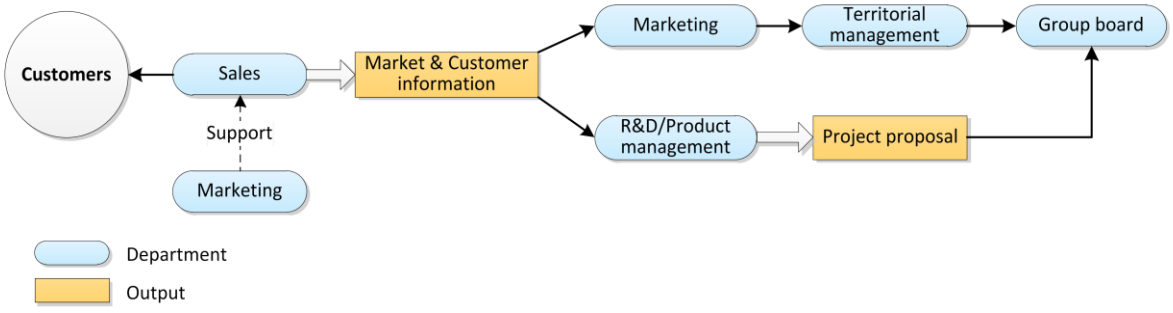


Figure 3.53 The process of exploring and delivering market and customer

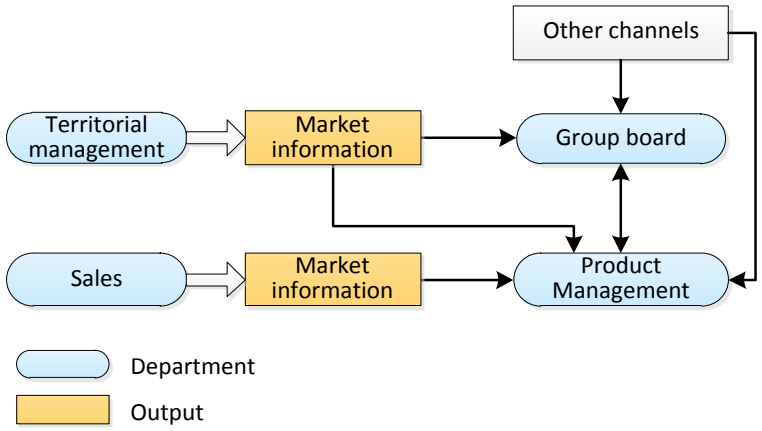


Figure 3.54 The process of collecting and communicating market information outside of the UK

Improvement ideas

To make a change, the company should manage data and information produced in NPD processes centrally (See Chapter 3.4.6.5 in more detail), and enable more direct communication between data and information generators and receivers/users. These two improvement ideas can be also applied by many SMEs in the sector.

Taking the improvement ideas (including the other ideas discussed in this chapter) on board, an optimised data and information delivery process has been generated for the company

partner (Figure 3.55). It suggests an easier access to raw data that is managed centrally; and outlines the roles of various functions involved.

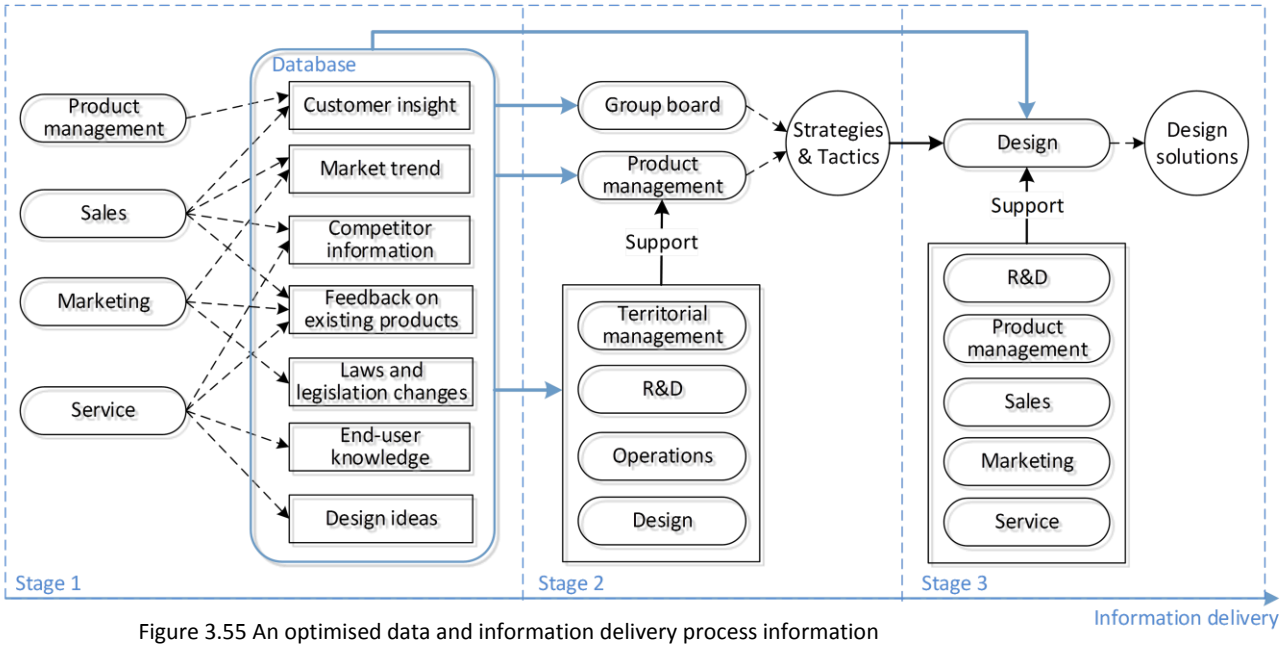


Figure 3.55 An optimised data and information delivery process information

To implement the improvement strategies, this study also suggests to communicate and to transfer data via a company communication platform.

The most common way of collecting findings in work and 'blue-sky thinking' ideas from all employees is like this: an employee gets an idea; he/she then reports it to the manager/director of his/her department/group; the manager/director collects all valuable information received in a couple of weeks/months; and then passes them through the business hierarchy via group meetings.

Compared with the above procedure, transferring data and information via a company-wide communication platform, which has been introduced in Chapter 3.4.4.1, would also be very beneficial as follows:

- significantly improve traceability, with data and information readily available online; functions, positions and contact of data and information creators easily available
- preserve quality by avoiding middle men in the transfer of information. This is to avoid the original data and information being mistranslated because of the recipient's lack of knowledge and experience
- may lead to more detailed input since an information creator may want to spend more time on editing it than his/her boss
- enable greater engagement by giving everybody opportunities to comment

- remove time constrains for readers – people who take charge can read through data and information at their convenience, and choose how much time to spend on it
- enable easy and frequent check-ups for new updates – there could be a long time span between two group meetings with the right people present
- build up a feeling of contribution

Such a platform can be integrated into companies' existing management systems which have been widely supported by intranets. For a small company with dozens of people, it can be as simple as a blog.

The above thinking as well as the conclusion of adopting a centralized management manner (See Chapter 3.4.6.5) lead to the decision of developing an online toolkit for improving NPD (See Chapter 4.2.3).

3.4.6.5 STORAGE

Issues inside the company partner

"Information should be accessible by whoever needs it in the company and be presented in a common format."

– as per my conversation with a project manager

In the 'company partner', valuable data and information are sometimes missing, incomplete, duplicated, or inaccurate, and are kept in heterogeneous application silos with insufficient consistency among them. The root cause is that the independent instances in project folders are created by different team members, while there is no well-defined and recognized discipline that provides a consistent understanding of data entities and their relationships. Meanwhile, the stored data and information is poorly maintained - there is a lack of formal data-governance to provide accurate and consistent information to the downstream applications that need it. These gaps erode data and information quality, and hinder team members from accessing and deploying data and information as needed. With the day-to-day growth of data volumes, the problems are likely to be exacerbated.

Furthermore, master data for NPD related applications is poorly established and deployed, for instance, there is no standard format of recording, presenting and communicating data and information. As indicated by one of the company' business directors, around 50% of time is consumed through transferring the format of documents across platforms within the company. It is important that all team members apply a format which is distributable across platforms. There is also a need for well-defined disciplines which provides a consistent understanding of master data entities and their relationships. To drive adoption, the company should refine its

business-wide standards for collecting, managing, and applying master data, and then enforce compliance in all practices.

In terms of master data, this study shows that the most critical issue is about the briefing documents created in the planning and design stages (See more details in Chpter 3.4.6). There is no business-level definition on why and how to do it, nor is there an action plan for operation, management and quality control.

Strategies for improvement

The company needs a significantly improved management approach to elevate the value of data and information that are produced in daily work. Following this change, the company should also refine its current organizational-level data standards for storing and maintaining information, and then to enforce consistent compliance with them. Specifically, it needs to:

1) Centralize data and information management

Instead of being housed in multiple systems and with no governance, project data and information should be saved on the central drive, and be managed by a separate team which accommodates new data and information, and edits, clarifies and revises them as required to support project operations. Centralized management can drive adoption by keeping data and information 'alive' and enabling fewer manual processes for downstream applications that consume data and information. It can also significantly increase the overall operating efficiency through fostering communication synchronization across teams, lightening administrative burdens, reducing errors caused by redundant work efforts, and enabling optimized business processes.

2) Produce master data of higher quality

To drive the adoption of central management of data and information, a company should create its own master data. It refers to both internal standards adopted by a company and external standards which are often referred to, which may accommodate data and information across multiple domains, such as quality samples, products, NPD process frameworks, information of customers and suppliers, board-level strategies, and financial constraints.

Master data is basic but critical to company operations across multiple systems, applications, and processes. It supports transactional processes and operations, though it is non-transactional in essence. Hence master data has been widely recognised as part of a company's assets (e.g., IBM Softeware 2010; Wolter & Haselden 2006) and is shown as the linchpin of centralized data and information management.

Master data needs to be managed by a single source with formal governance is to enable consistency and global recognition within a company

Functions and applications:

- Master data defines protocols and global benchmarking in business operations, which enables fundamental alignment, synchronization and integration across a company — with every party sharing a single global version of the truth and speaking the same 'business languages'. (Taylor and Laylin 2010).
- It also facilitates product performance management. To assess the current performance of an existing product, companies need to know what the raw data was when the project was first initiated. This would include for instance marketing data from customers. If a product suddenly starts to 'fail' a few years after it was first produced, comparing the current master data with the original can reveal the root causes of the failure – whether it is because the design process in the first place was flawed; there are fundamental changes in customer expectations; or service engineers do not do their job properly. This can also indicate whether products and services within a company have remained consistent.
- Furthermore, business master data can accommodate valuable knowledge and insights gained from previous projects, and as a result, can serve as reference data that is supportive to project initiation. Specifically, building and managing master data not only takes best practice forward into future projects, but also reduces the chance of repeating the same mistakes. Thus, it can save time and resources that could be consumed in reinventing the whole, as well as improving NPD outcomes substantially.

3) Classify direct and indirect data

Focusing on improving adoption further, this study suggests clarifying data and information produced during a project lifecycle into two groups: direct and indirect.

The direct group incorporates day-to-day transaction data which is all about a project progress. It is mainly about finance, work and logistics. Indirect data and information may overlap those from the direct group, but differs from the latter by its value beyond the current project. It comprises reference data which may be adopted or be referenced in future work, such as shelved design concepts and prototypes, discoveries of new materials and techniques, and failure reports; and strategy-level information, for instance a business opportunity which may lead to a new project. Indirect data and information therefore should be managed as an asset of a company. It is a substantial resource for assessing, updating and expanding business

master data.

4) Store data and information at different abstraction levels

To facilitate dynamic communication and cooperation across functions and teams, data and information needs to be presented in an easy to understand fashion. However, different applications often require the same data/information in various degrees of details and depth. For example, in initialling the development of a new version blood glucose meter, market researchers tap in all of the raw sales records in the UK of last ten years to forecast the future sales trend, while after reading through the forecasting report the project manager may want to have a quick scan of some of the sales data elements at higher abstraction levels. This is why saving data and information at different abstraction levels facilitates the adoption. This strategy reacts to the idea of translation based on applications (Refer to Chapter 3.4.6.3).

3.4.6.6 CULTURAL FACTORS

Key factors

1) Openness

An open approach by all stakeholders is a fundamental requirement for a successful NPD process. Unfortunately this cannot be promised in most of the cases that I studied. This is either because there are many stakeholder layers to pass, often dilute the 'openness' of communication processes, or there is excessive protection of 'business secrets'.

Inside the company, there was an obvious lack of openness and alignment in data management, although it should be noted that project documents containing data and information as used by projects should only be accessed by those with security clearance and/or permission. For each individual project, there is a project folder established in the on-line data safe where valued data and information produced in the development process should be kept. Meanwhile, managers of different functions who participate in the project also establish their own archives to organise the project related documents. This issue leads to misunderstanding among project groups and team members. One example is that most project/product managers referred to hard copy archives they organised themselves as supporting material during discussions about individual projects, though the on-line database is more secure and also easy to access. As a matter of fact, project folders saved on the company central drive are much less frequently visited during a project cycle than expected, and are rarely used after a project has been completed. Team members also pointed out that it was difficult to find data and information they want in the database. It should be noted that

these problems exist not only in this specific company but also in some other companies surveyed in this study.

2) Sense of contribution

> *'… Even when I have fed back to the company design ideas or suggestions from the customer, I often do not know what has happened to them. It is like a black hole…'*
> – *as per my conversation with an installation engineer from the company.*

The sense of contribution is another critical cultural factor in data and information management. It is an important factor in motivation. It is supportive to a feeling of being responsible, in charge, proud, and involved with work output, and is therefore a driver of active stakeholder engagement (Mongiat & Snook 2007).

Authorship and ownership are two factors in building up the sense of contribution. Enhancing the two factors can transfer power to both team members within a company and outside stakeholders, like clients and users who are interviewed in front-end research. More specifically, it let team members feel that they own their work, such as a design idea or a written document, and also enable outsider stakeholders to become co-designers.

Implementation

Communicating data and information via a **centrally-managed database** (Refer to Chapter 3.4.6.5) and **company-wide communication platform** (Also refer to Chapter 3.4.4.1 & 3.4.6.4) that is focused data and information processing, transfer and utilisation can establish a balance between the needs for openness and security. This does not imply that all day-to-day communication must be processed through the two systems. They can coexist with traditional emails and meetings, but bring about benefits including:

- letting data and information be readily available for potential requesters
- enabling collaborative working on live data
- breaking departmental barriers in communication
- assisting in achieving data synchronization
- promoting greater contribution across a company
- enabling continuous management of a large volume of data by a separate team or person, which is vital to maintaining consistency and unifying format

All the above influences help to address the management requirement of openness, as well as

flexible access control which is necessary for upholding data confidentiality.

3.4.6.7 AN OPTIMISED DATA AND INFORMATION MANAGEMENT FRAMEWORK

Figure 3.56 briefly summarizes the framework proposals brought forward in Chapter 3.4.6, with regard to the company's present status. This framework divides the usually fuzzy data lifespan within an innovation process into 7 stages: 1. collect data; 2. process & brief; 3. present & communicate; 4. Screen; 5. forge strategy; 6. Brief; and 7. downstream applications. It highlights the design needs, for example, there are specific stages for project briefing and design briefing. The framework also pins down the facilitators in each individual stage. It also specifies how data should be stored throughout the process.

The framework for data and information management can be embedded into an optimized front-end process (Figure 3.41 in Chapter 3.4.2.3) generated for improving NPD in the company.

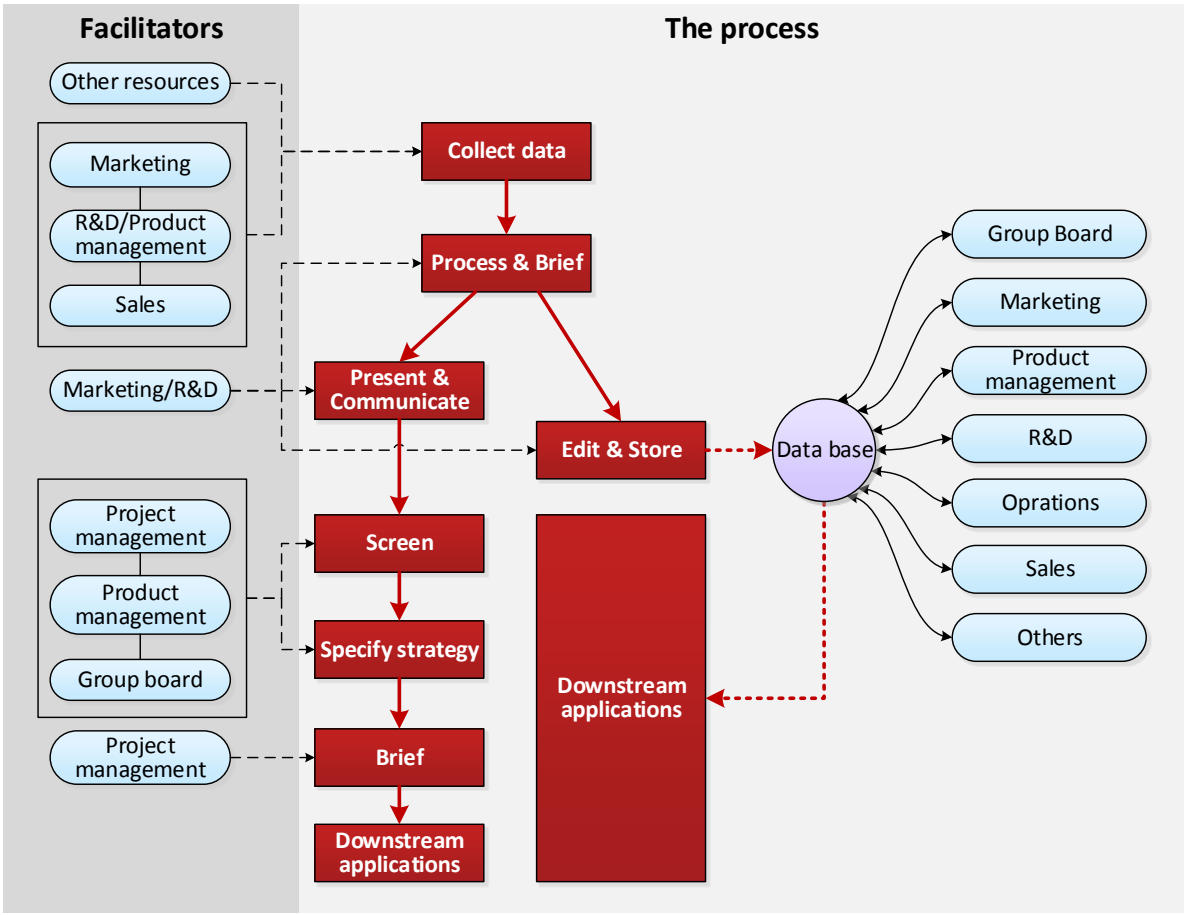


Figure 3.56 The framework for data and information management in the company

3.4.7 IMPORTANCE OF THE DESIGN BRIEFING PROCESS

3.4.7.1 WHAT IS THE DESIGN BRIEF?

Although there is no meaningful standard to a design brief, it can be viewed as a design oriented written agreement which outlines the business objectives and the design strategy to meet these objectives. It focuses primarily on the business objectives and the desired results of design – not the aesthetics. It is usually drawn up after the project brief/proposal has been signed off by the board and initiates the start- up of the design work.

A design brief is central to company innovation as it serves as the guiding document for the design process of a whole new product development (NPD) cycle. If we see the design process as a sub-project within company innovation, the design brief can be viewed as the project plan.

A design brief is a living document. It usually incorporates both flexible and inflexible elements. For example, product functions, user interaction and visual effects are usually flexible, while deadlines, financial resources, and production and retail merchandising requirements are at times less flexible. The flexible requirements evolve with the project progress to being more transparent and rigid as the project matures. It should be noted that whether an individual element is flexible or inflexible is based on the specific situations of individual projects.

3.4.7.2 THE NEED FOR AN EXCELLENT DESIGN BRIEF

In general

Product design has become an increasingly competitive world and design differentiation is making and breaking a lot of products and companies. In the home health care sector, design is a powerful tool to translate people's needs into meaningful solutions with appropriate technologies. However, the challenge remains how to achieve a successful design. For example, how to develop a solution that addresses the diversity, unpredictability and fluctuation in users' profiles and abilities; how to effectively translate research findings into design; how to manage multidisciplinary teams with different background languages, and different professional perspectives; and how to keep such a team on track in the overall development process? Creating a strong design brief provides a solution to these issues, at least to some extent.

The design briefing process is a powerful tool to improve outcomes for any type of company which carries out product and service innovations.

Specifically, a design brief can be a design roadmap, a project-tracking document, a

presentation outline for approval of the design project, an operational plan, a benchmark for measuring design outcomes, and an archival document that will be useful for similar projects in the future. Its establishment is a critical element of an innovation process, and can be a major tool to improve innovation outputs, either when design is executed in house or externally by independent designers and design consultancies. This approach saves double the time and money in the long run that is spent on doing it (e.g., Bush 2013, Fuston Creative 2013, and Design Council 2007).

Above all, drawing up a strong design brief clarifies the scope of an NPD project, sets the plan and boundary of a design task, and contributes to the progress of the entire NPD process and following areas.

The process of creating a design brief helps the design team to understand fully the business problems that they are required to solve. A design brief is most necessary when the design process is outsourced to independent designers or design consultancies. In this scenario, the quality of a design brief can have significant influence on the performance of the design outputs.

Engaging in design briefing reduces the risks and uncertainties in new product and service development. It requires all key team members to reach a consensus on the fundamental questions of the design task upfront, for example, what the user experience should be; and do the design translations match the initial requirement? Therefore, it helps to ensure that all are aligned to the product strategy. It serves as an essential reference point, which ensures that critical design issues are addressed and opinions of different stakeholders are taken on board before the design work rolls out.

The design briefing process also promotes the collaboration and co-creation across groups and teams. A strong briefing process brings all key members of a project's teams together, and provides them with an essential opportunity to communicate face to face in the front-end of a project. For a design subcontract, the briefing process also serves as an essential approach to develop trust and understanding between the design commissioner and the design executor.

In addition, it spurs the generation of standout design solutions. Designers often need specific information to fully understand a design task, and to generate innovative design ideas. The briefing process let a design team to communicate with other departments and/or collaborative partners, and to ask specific questions as required.

The relation between the design briefing process and the five key factors

A design brief sets the course of an entire design process and contributes to the establishment of the overall NPD procedures. The process of creating and applying design briefs focuses on the front-end of a project cycle and provides a valuable opportunity to bridge the gaps between functional groups and to address the considerations from various NPD aspects. As discussed above, the design briefing process has significant influence on all of the five key factors determining NPD performance (Refer to Chapter 3.4.2 -3.4.6) (Figure 3.57). Forging an effective design brief and applying it properly in NPD practices can promote the improvement of the whole. Consequently, a company can prioritise their workload on this point to achieve great improvement at lowest cost.

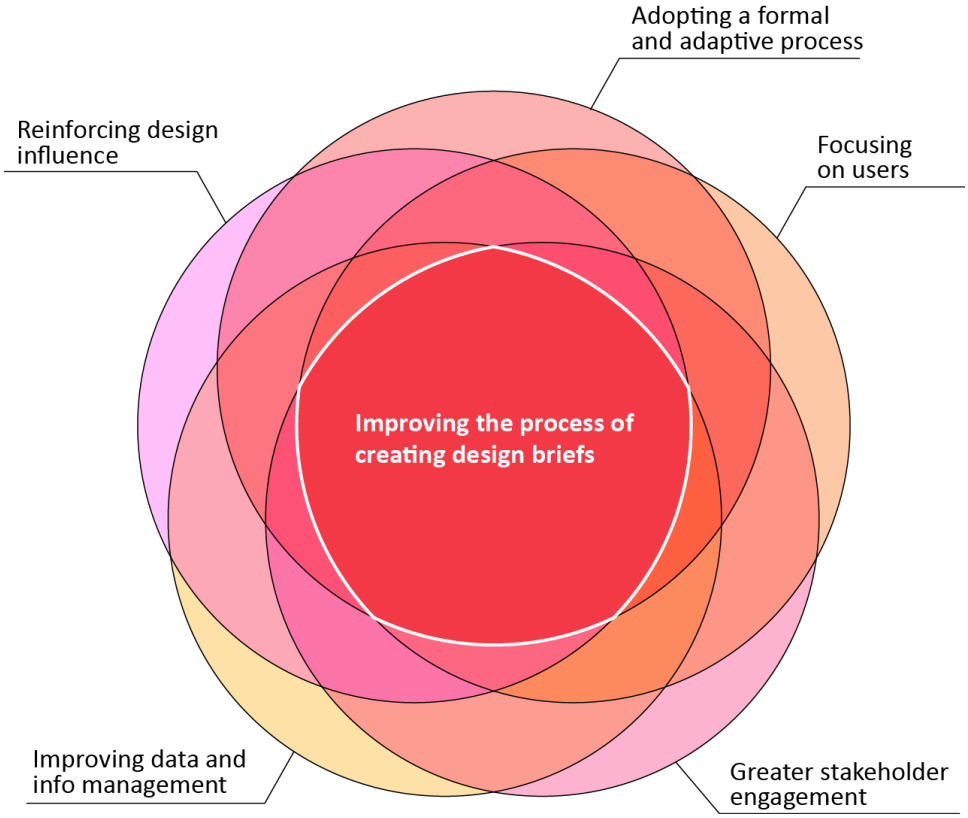


Figure 3.57 Improving the process of creating design briefs has significant influence on the five key factors

3.4.7.3 CURRENT STATUS

It is known that a strong design brief is vital to successful product design while relatively few companies engage in any structured approaches to the development of the design brief (e.g., AHMAD et al. 2011, RYAN 2012). Researches undertaken during the placement show that in general, the functions and significance of the design briefing process has not been broadly recognised. Even when being planned in a company's principal NPD process, it was frequently missed out in practice. This inevitably leads to a multitude of (often very costly) design modifications as the product life develops. SMEs often have poor briefing processes since they

may not have separate divisions to represent the many functions such as design, marketing, sales and services, which may be involved in the development of briefing documents. However, even in larger companies this study has found that communication (or rather lack of it) and other issues like departmental barriers between the various divisions adversely affects the generation of adequate design briefs.

SMEs [1] vs. Large companies

My previous working experiences have shown that large companies like General Electric (GE) and Philips Healthcare tend to carry out briefings as part of formal product and service development processes. In contrast, a small and medium sized supplier rarely does the same.

For many SMEs in the sector, creating a design brief is not what they are used to doing. They often do not want to spend extra resources on applying the design briefing process, especially when they are already stressed by limitations of time and money. Their management groups tend to believe that drawing up a design brief is more to do with larger projects carried out by large companies (Refer to Appendix L2). Thus, although the project brief is usually written, a design brief rarely is. Even when a document which incorporates some of the information that are usually contained in the design brief is present, it is often drawn up and referred to at inappropriate times, for example, after the design concept has been generated. Such documents often fail to fulfil the desired functions of the design briefing process, and as a result are often used as part of a project summary or a progress report instead. Without a proper design briefing process, design tasks are usually initiated, explained and transferred in an informal manner, such as via email or a verbal agreement. This explains why it is often challenging for many of the interviewed design commissioners and design groups themselves to recall the exact details of the initial requirements or to recover the documents, which accommodate the information, if they exist, even before the end of a project.

1. This study focuses on product and/or service suppliers which innovate. As defined in Chapter 3, SMEs in this thesis refers only to small and medium-sized product and/or service suppliers. Design consultancies, most of which can be categorised as SMEs, are discussed as a separate group here.

3.4.7.4 THE DESIGN BRIEFING PROCESS IS MOST IMPORTANT FOR SMES

In large companies

Many SMEs, including those in this study, say a design brief is more to do with large companies (Elmansy 2014), whilst some managers and directors of the latter think quite the opposite. For example, a senior project manager of a leading automotive manufacturer who I interviewed pointed out that the design brief tends to be more necessary in SMEs than in large companies:

> *'… In the matrix organization, information tends to be easier, better in quality and faster than traditional hierarchies … It has been said larger companies with larger and more sophisticated projects tend to attract the most able, and by being professional in their field, they tend to know their job in satisfying their boss, the company, the customers, legislation, geographical and customer requirements…'*

He explained that large companies tend to follow a matrix organization, which breaks down the barriers between groups. And as a result, employees tend to know their own jobs and be kept updated on a project's progress without a brief. His point is supported by my case studies.

In large companies, communication in projects tend to be smoother, easier, faster and better in quality, and unexpected problems are less likely to occur. With larger teams and more sophisticated projects, large companies tend to have a projectized matrix organisation with both project and product line managers (Figure 3.58). Their project teams are formed for the life of a project, and tend to work together in the same office space, whether they work as strategists, marketers, buyers, designers, researchers or engineers. In a projectized matrix organizational structure the project manager is responsible for the entire project and reports to a higher level of management than with other matrix examples. This allows him or her to request functional resources as needed, and have a better control of the overall project progress, including the execution of design. A team member can more easily communicate with both the one who has overall authority on the project and other team members, without the restriction of location and formality of departments (Figure 3.59). Although in theory each team member needs to report to two bosses under this structure, the 'dual-boss syndrome' is unlikely to occur as the authority on the project is determined upfront. A team member keeps in regular contact with a functional director [1] mainly on matters such as providing feedback and requesting technical support (Figure 3.60).

1. A functional manager is a person who has management authority over an organizational unit, such as a department.

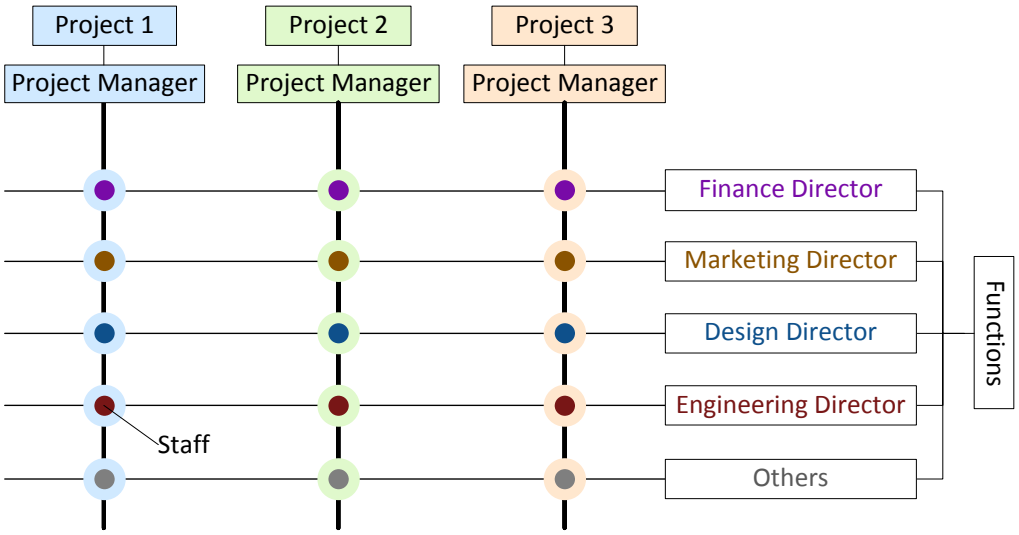


Figure 3.58 Schematic project matrix organizational model common to large companies

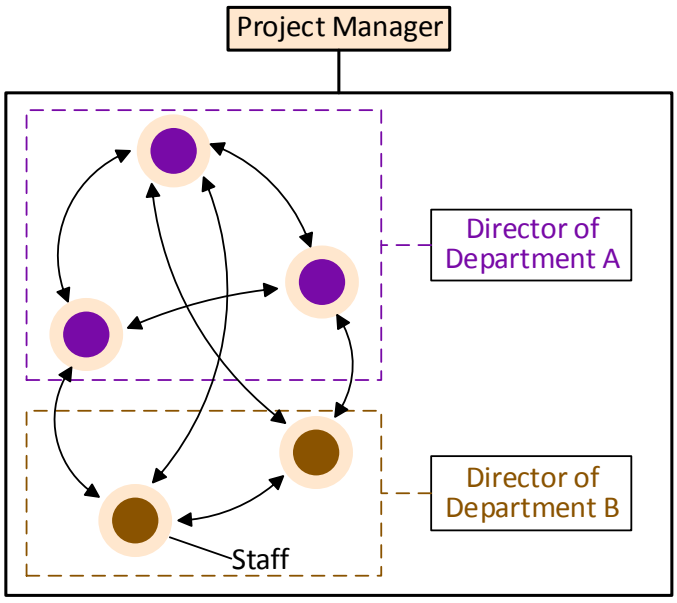


Figure 3.59 In a projectized matrix organizational structure, the authority on a project is more centralized and communication tends to be smoother, easier and faster.

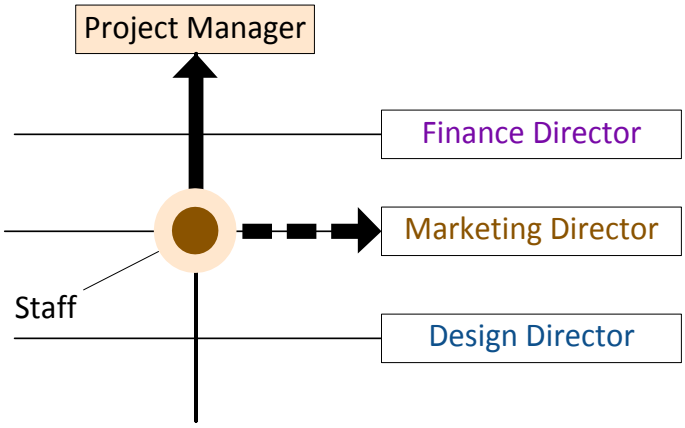


Figure 3.60 In a projectized matrix, although a team member need to report to more than one manager /director, the authority on the project is clear.

In SMEs

In contrast, SMEs tend to be organised in a traditional hierarchical 'family tree' (Figure 3.61). This structure is simpler - each member of staff has only one boss, making the chain of command simple and easy to understand; cheaper- having both a project manager and a functional director can be more expensive than simply having a functional director who may play the role of a project manager from time to time; and effective on keeping each departmental member current with the latest information on the specific department's function. However, under this structure projects with their ownerships tend to be handed over from one department to another which does not only create more layers in communication but could also lead to 'blame' between departments and groups (Figure 3.62). It is also weak in integrating the development and controlling the progress of a project and the quality of the output, as no one has overall responsibility on a given project. Each functional director may know a specific aspect of the product's development but none have a full knowledge of the whole. Sharing authority can also slow a project or take it off course if the project manager and functional directors do not agree on certain project facets.

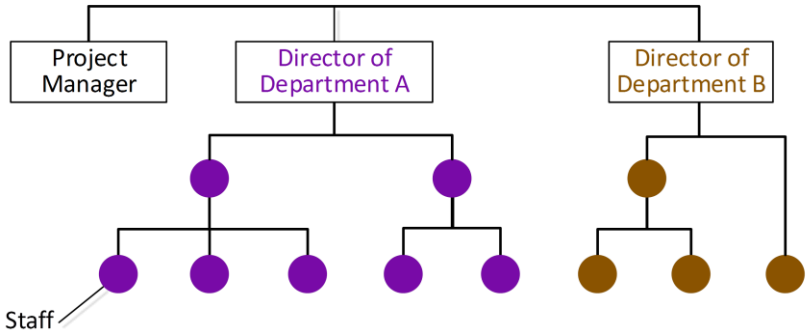


Figure 3.61 The traditional hierarchical 'family tree' organization

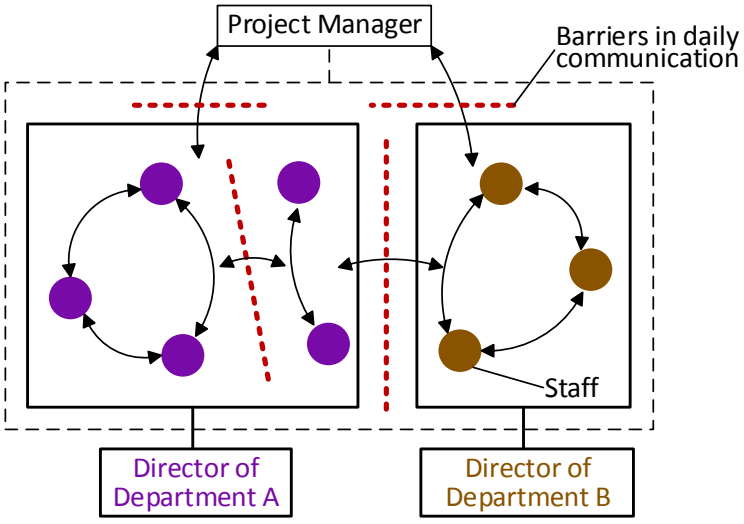


Figure 3.62 The traditional hierarchical 'family tree' structure may hinder effective daily communication between departments.

As a result, while in large companies adopting a strong design briefing process strengthens collaborative working within a project team by encouraging communication and idea sharing (Figure 3.63); it is an essential stage for ensuring necessary contribution from stakeholders in planning, to avoid costly mistakes in later stages of a project (Figure 3.64).

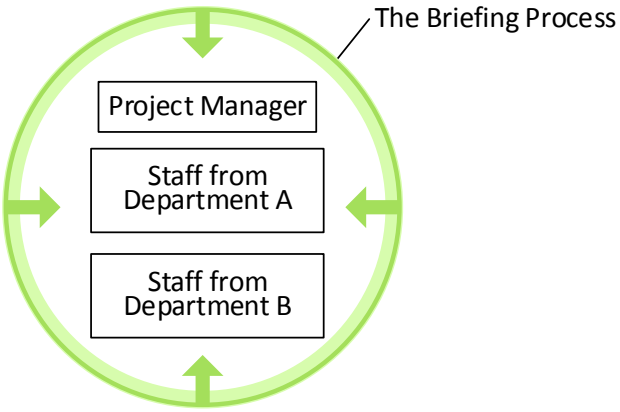


Figure 3.63 A strong briefing process enhance interdisciplinary team working, when design is carried out by a product supplier's own design team.

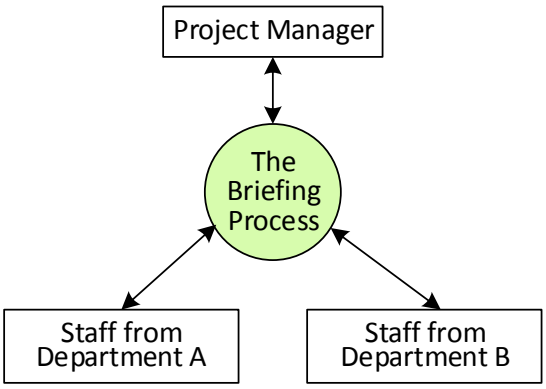


Figure 3.64 The briefing process is an essential stage to build a necessary connection between NPD stakeholders from various departments.

Furthermore, few SMEs in the HHCP sector have their own design departments, and therefore frequently outsourced product and/or service designs to external design consultancies. This format, compared with an in-house design process, is likely to raise uncertainties and risks in terms of process and output. On one hand, external designers may not be aware of the history, culture, business strategies, product lines, and technical ability of their design commissioners as needed for producing a good design solution. On the other hand, some SMEs as observed in the study, may lack experience at selecting suitable design companies for specific tasks and at managing a collaborative working style. These challenges can be exacerbated by SMEs' lack of thorough consideration from a design perspective and insufficient ability to predict potential barriers and problems upfront.

In contrast, large companies are generally more experienced in playing both the roles of designer and design commissioner, and thus are more skilful at assigning and supervising the design process. This explains why in field study issues are more frequently observed in SMEs, though large companies also subcontract some of their designs to external designers or design companies.

3.4.8 CONCLUSION

Forging and adopting a strong design briefing process is the crux of addressing the 5 key factors in improving NPD processes in a cost-effective manner. Compared with large companies, small and medium-sized product suppliers tend to benefit more from both a strong briefing process and form referring to the brief during the project, especially in consulting engagement (Figure 3.65).

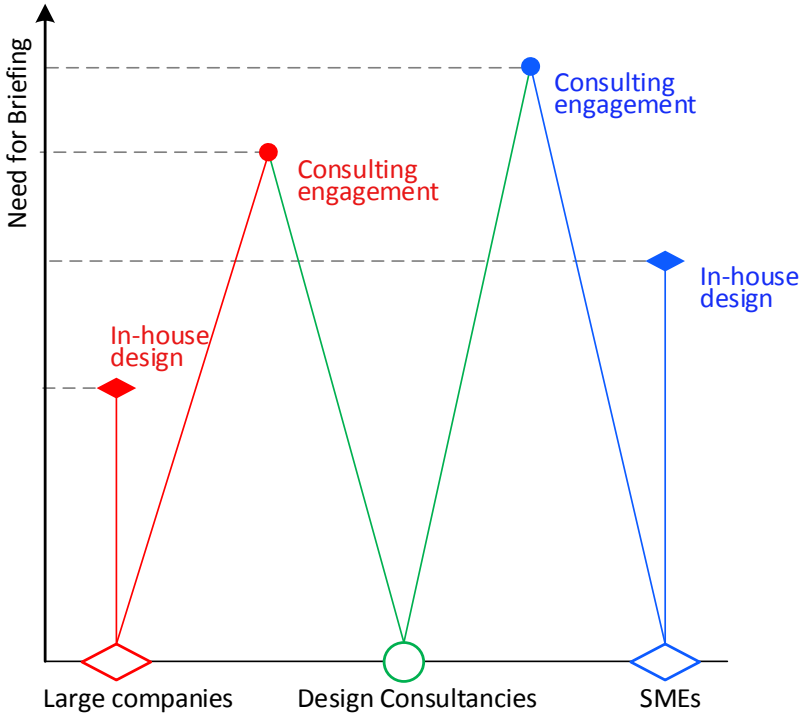


Figure 3.65 A comparison of levels of need for design briefing in different scenarios

To do so there is an urgent need for developing a design briefing approach that ensures a proper understanding between designers and design commissioners and that aids in managing a design project's progress. Addressing this conclusion, the model of a new design briefing approach was designed, and is outlined in Section 4.

4 HOW TO DEAL WITH THE PROBLEM

4.1 THEORETICAL MODELS AND OPPORTUNITIES

4.1.1 SUMMARY

Chapter 3 concludes that engaging a well-established design briefing process should provide a highly cost effective approach to NPD success, particularly for SMEs. The creation of a design is in the front-end of a project cycle, and is therefore a 'fuzzy' process which involves iterative feedback loops between marketing, design, manufacturing, and other divisions. Although these iterations may not be amenable to project management techniques, a level of structure and control is necessary to ensure success and to avoid unexpected risks.

This chapter explores how to establish a formalized but adaptable brief creation approach which can address the characteristics of individual projects, companies and industries, to ensure the consistent high quality of design briefs.

4.1.2 PRINCIPLES BEHIND A STRONG BRIEFING PROCESS

Brief creation happens in the fuzzy front-end of a project cycle, and is therefore full of uncertainties. Brief creation activities often involve iterative feedback loops between marketing, design, manufacturing, and other functions. To ensure the consistent high quality of design briefs, it is essential to build up a formalized but flexible brief creation process which fully addresses the characteristics of individual projects, companies, and industries. Addressing the 5 factors in improving NPD processes identified in Chapter 3.4, a combination of the following 5 approaches benefits the brief writing process:

1. Research-based: resolving questions, uncertainties, and disagreement in the process of writing up a brief based on research instead of all intuition.

2. Consensus and understanding: giving thorough consideration to diverse factors, for example, the economic feasibility of an idea, and reaching a consensus between all involved.

3. Transparency (within security limits): centralising information management with open access to all involved in the project development, within security limits.

4. Presentation and access: following a formalized format and providing rich information

instead of, or that supports, 'abstract' written briefs. Using a variety of techniques, e.g., image, video and collage.

5. Centralized management: managing briefing documents centrally and as company assets.

These approaches form the framework for a new design briefing approach which are written with common data, built upon a consensus, and are presented in ways that are engaging and informative. These are discussed in more detail in sections 4.1.2.1 – 4.1.2.5.

4.1.2.1 RESEARCH-BASED

A design brief is only useful when it incorporates all the information required, and the information is valid. It needs to be based on genuine research rather than just claiming it is 'research based'. An effective design brief should comprise not only the commissioner's wishes but also how to realise these, as well as any constraints. The establishment of all information needs to be based on both valid data, and experience and intuition.

There is practical value in carrying out extensive research at the front-end of a project to evaluate early hypothesis and other output from the project planning stage, such as a sales strategy decisions. However, research should not be limited to evaluation functions (Design Council 2005). Systematic research is vital for many of the key activities in the fuzzy front-end stage - market segmentation and positioning, and identifying and understanding potential customers from both strategic and design levels. It contributes to defining a proper project road map and to setting the parameters for project development. Research can also expose constraints which is a valuable practical measure of commercialization at the front end.

This study recommends using both quantitative and qualitative techniques. Design briefing is usually initiated through questionnaires, which are cheap and efficient at collecting data and suitable for SMEs. This suits the planning of a project since there are often time and budget constraints. However, such quantitative methods are likely to omit rich and latent information that may reveal new opportunities. Applying qualitative research approaches, such as interviews, workshops, and affinity diagrams allows two-way communication between the management and other parties in the early stages.

4.1.2.2 CONSENSUS AND UNDERSTANDING

A strong design brief must be drawn up collaboratively between the design group and the design commissioner [1], rather than being handed over from one person or group to another

as a task. Both parties should be equally accountable for the results of the design project.

As well as the designers and the design commissioner, writing up an effective design brief needs the active engagement of others involved: marketers, strategists, product engineers, design researchers, business consultants, operational directors, and service engineers. This ensures that considerations from different perspectives and throughout a project cycle can be addressed at the fuzzy-front end.

Direct and indirect users of a home health care products are also viewed as stakeholders of product development in this study. Their engagement is not necessary for every project, but it does strengthen the validity of a brief in many cases. Whether to involve them in the brief creation process must be considered seriously by project managers.

Giving thorough consideration to diverse factors and achieving a consensus between all involved brings the benefits below:

1) Diminishing underlying risks and mitigating design changes

Specifically, showing the document to different parties ensures

- that every essential aspect of the design problem has been captured and considered - to avoid unpleasant surprises later;
- that differences in the way people see the project aims and objectives are revealed and can be resolved upfront saving considerable time and expense further down the line;
- that the design direction is not led by a single business, design, or manufacturing objective. If one voice overpowers the decision making, there is a risk that it will push the consideration of a specific area too far ahead, and neglect other functions.

2) Generating new opportunities and ideas

The briefing process itself can produce valuable ideas. Fostering greater stakeholder engagement in the brief creation process gives functions like service, installation, and operations, which traditionally do not participate in front end activities, opportunities to contribute with their insight. Research in this study has shown that their engagement can produce brilliant ideas that strategists, designers or marketers are not aware of.

1. When the design process is carried out externally, the supplier with the need for a design is the commissioner.

4.1.2.3 TRANSPARENCY (WITHIN SECURITY LIMITS)

Product design is closely related to other components, such as sales, maintenance, engineering, marketing, testing, and recruitment. As a result, design related decisions often have direct or indirect influence on other functions.

Enabling transparency in design management promotes consistency both between individual project phases and between different parties, which is often a challenge. This is particularly true when external parties are involved.

Transparency allows downstream applications to respond to design changes promptly. Even when all the work in the planning stage has been well conducted, unexpected design changes may still occur because of, for example, legislation changes or new customer requirements.

Here I take one of my own experiences as an example: In a Dutch Design Company, I worked on a project designing a new drill to replace an existing product. Because of issues with suppliers, the commissioning company had to replace the motor after the design concept had been brought into engineering. As a result, although the designers had set aside space for a potential upgrade, the new 3D model's dimensions had to be revised, which at great cost led to the disposal of the original mould. The earlier the changes at strategic level are absorbed into designs, the smaller the impact they will have on the whole project.

Transparency also promotes stronger interactions between the design function and other parts of a company, which the Design Council survey revealed to be a key concern (2007). Such interactions foster multidisciplinary working and promote the design culture in a company.

A design brief serves as a design strategy and a road map. With transparency in design management, a design brief is open and accessible to all engaged in a project rather than being shared only between a project manager and a design team, within security limits. It means that all parties are aware of the core principles, values, requirements, limits and risks of a design concept as well as any critical decisions made during or related to the design process. However, unfortunately, my experience is that the issue of transparency is frequently overlooked by product developers.

4.1.2.4 PRESENTATION AND ACCESS

It has been observed in this study that there is often a lack of consistency in the format of presenting design briefs. A long written design brief can be 50 pages, while a short one is only half an A4 page. Various formats are often employed in a single company, for example, an interactive presentation, a template, or an email. In many cases, briefs are presented just as

an email or even a verbal agreement, which are too 'loose' to be adequate throughout an entire project cycle. Some briefing documents are even lost before a project is completed.

There is no single correct format for a design brief. However, it is essential that there is a physical briefing document rather than it being only a verbal agreement. Furthermore, within a company a brief should be written following a standardized format, and in an easy-to-understand fashion. In addition, briefs should be managed centrally to facilitate application and to enable easy comparison between projects.

A real functional design brief should incorporate both strategic and researched information in order to generate a stand-out solution. For example, when describing the target audience, basic information such as age, sex and income although vital, is insufficient to clarify the real business requirements. A comprehensive user profile including life style, living environment, health conditions, and cultural background is usually required. In addition, the design commissioner needs to avoid withholding relevant information from the design executor.

A thorough and articulate design brief should incorporate the following factors:

- Project aims
- The specific requirements and expectations of the design outcome
- The development process of the project
- Budget and time-scale
- Target group profile - a precise, complete description of the target user group.
- Details of the key stakeholders of a project
- The marketing strategy. For example, who are the competitors, and how will the products be sold?
- The measurement of success. How will the design outputs be measured and by whom?
- Company profile. This information may only be required when external design teams are involved in a project.
- Design examples. These are mostly required when external design teams are involved in a project.
- Platform strategy; cost of product; service and consumables requirements

4.1.2.5 CENTRALIZED MANAGEMENT

The application of a design brief is just as important as its writing. To make full use of briefing documents, they need to be managed centrally, for example via the intranet of a company.

Any change in functions may lead to an amendment to design wishes, requirements, and

parameters. A design brief must evolve with the project progress and centralized management can ensure that it is revised promptly and continuously, in order to reflect changing environments, and also that any changes are communicated to all those relevant.

The briefing documents created for one project can be used as valuable referencing materials for future projects, and therefore should be managed as company assets. This places a requirement on management for better traceability, which can be achieved if the NPD process complies with a quality standard such as ISO9001.

4.1.3 A NEW BRIEFING PROCESS (V.1)

Addressing the proposals in Chapter 4.1.2, a process model for drawing up project briefs and design briefs was created in this study. It focuses on addressing end-users' real needs, adapting to changing environments, fostering greater stakeholder engagement, and managing information processing in a formal and structured manner. This model suggests intimate collaboration across functions from the outset of the brief creation. The players should represent all business functions to address considerations of diverse aspects. It is essential to adjust the team structure after the type and the drive of a project has been defined to reflect and adapt to the feature of specific projects. Efficient cross functional team work is a requirement of sorting out complex data to find a practicable development direction.

The process model has four main development phases and two main freezing phases. The four development phases are 1) Data Organization, 2) Data Screen and 3) Development, Definition and Clarification, and 4) Process Planning. The two freezing phase are Strategic Review and Design Brief review (Figure 4.1).

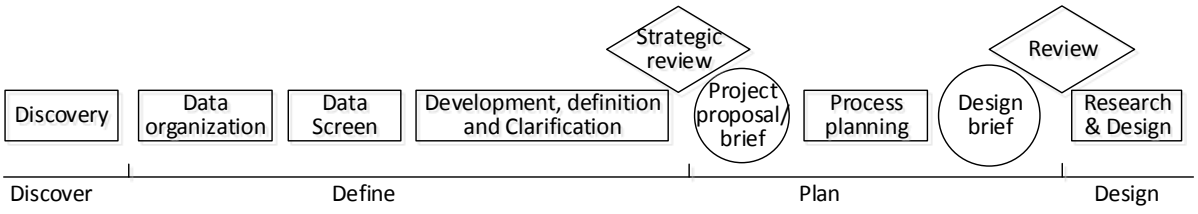


Figure 4.1 The structure of the proposed briefing process

Data Organization, the first phase, is to analyse, translate and group the data collected in the discovery stage. Earlier sections have highlighted the importance of developing an adaptive management technique. This is why the team must consider the nature of innovations that

potential opportunities will lead to in the front end. This will lead to the adjustment of the overall development process, as well as the plan of detailed methods and activities to apply throughout a project. This model suggests defining data based on the source of opportunities. This should be 1) User Knowledge, 2) New Technology, 3) Customer Requests and 4) Strategic Demand. A large volume of qualitative data from field interviews, open-ended survey responses, support call logs, or other channels may be received from the discovery stage, particularly from user research. To review these data efficiently, the use of an affinity Diagram is an easy but efficient technique. This technique helps to sort numerous ideas into groups, based on the given criteria. It also creates an opportunity for active interactions between players, thus fostering greater engagement.

The values of the information are reviewed based on considerations from facets of 1) technical feasibility, 2) saleability, 3) economic feasibility, 4) market fit and 5) user fit. This identifies the most promising opportunities to work, from all those uncovered in the previous stage. Different criteria should be applied to assess data of different groups. For example, needs and wishes from product end users, technical feasibility, saleability and economic feasibility will considered (Figure 4.2).

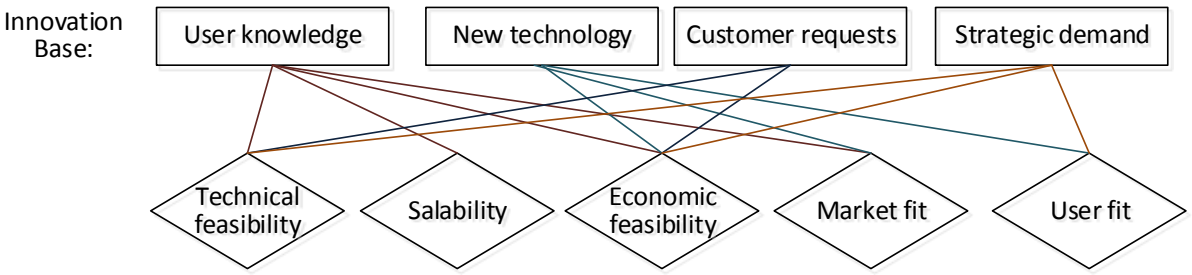


Figure 4.2 Screen data of different groups based on different criteria

The third phase is development, definition and clarification. The screened data will be further analysed and developed in this phase to become richer information to feed the project brief. The team needs to investigate the potential of opportunities from 1) market segmentation & positioning, 2) potential customer exploration, 3) regulatory requirements, 4) competitor review and 5) capacity in innovation. They should also refine the type of the project, to see if it will lead to a highly innovative project or a variation to existing products and services. In addition, they must review all the work carried out, and clarify the core value, business opportunities, and challenges and risks from diverse perspectives. Ideas from all functions must be addressed in this step (Figure 4.3).

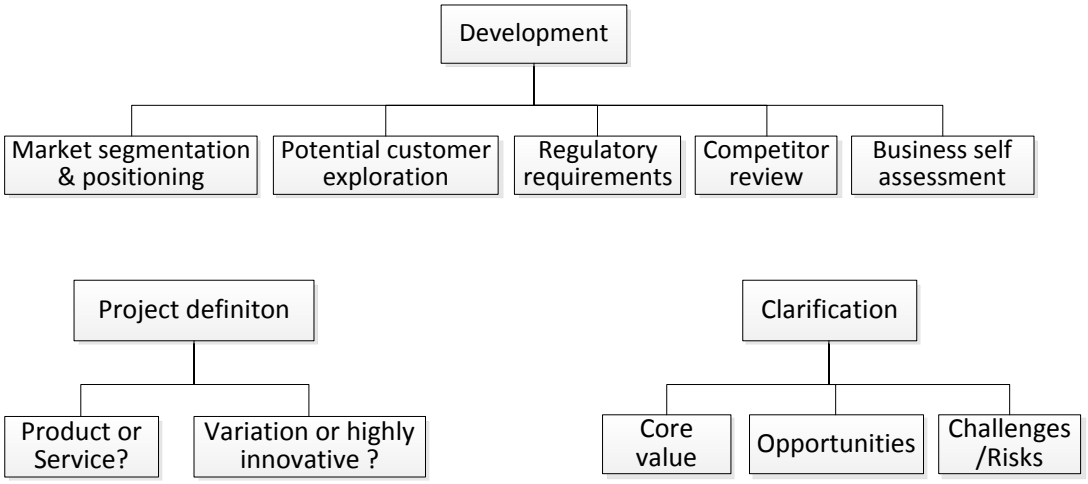


Figure 4.3 Development, Definition and Clarification

The conclusion and results of previous work will be summarized into project briefs to go through business hierarchy for review. If they pass, the pro-posed opportunities will be taken into formal development.

The formal development starts with process planning. This is the time for the development team to consider whether the in-house development processes will suit specific projects. They must forge a project- focused process which addresses all considerations in the project brief. Four activities – 1) exploring constraints & business considerations, 2) determining design functions (abstract level), 3) forging design strategy, and 4) mapping the players onto a project timeline - move forward in parallel.

This model suggests that the development team determines the functions of the outcome in terms of both practical and aesthetics at this stage, which is earlier than in most of the existing development processes. The purpose is to promote an early consideration of the design needs. It also helps to ensure that a design agency understands the companies' requirements properly when the design will be carried out by a third party, which happens frequently in the sector.

The design functions are evaluated from the facets of 1) Design fit, 2) Business fit and 3) the consistency with the requirements and features defined in the previous work (Figure 4.4).

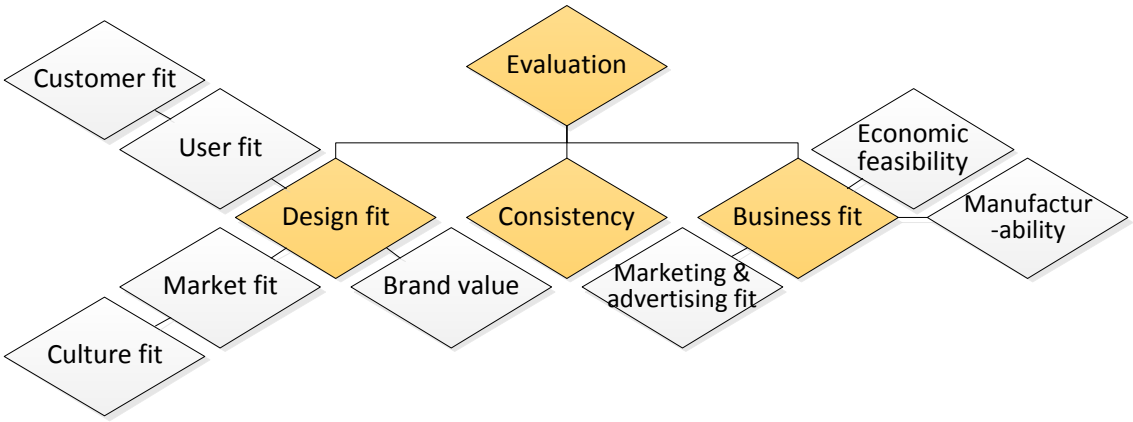


Figure 4.4 Process steps necessary to elaborate the design requirements

The complete process model is illustrated as Figure 4.5.

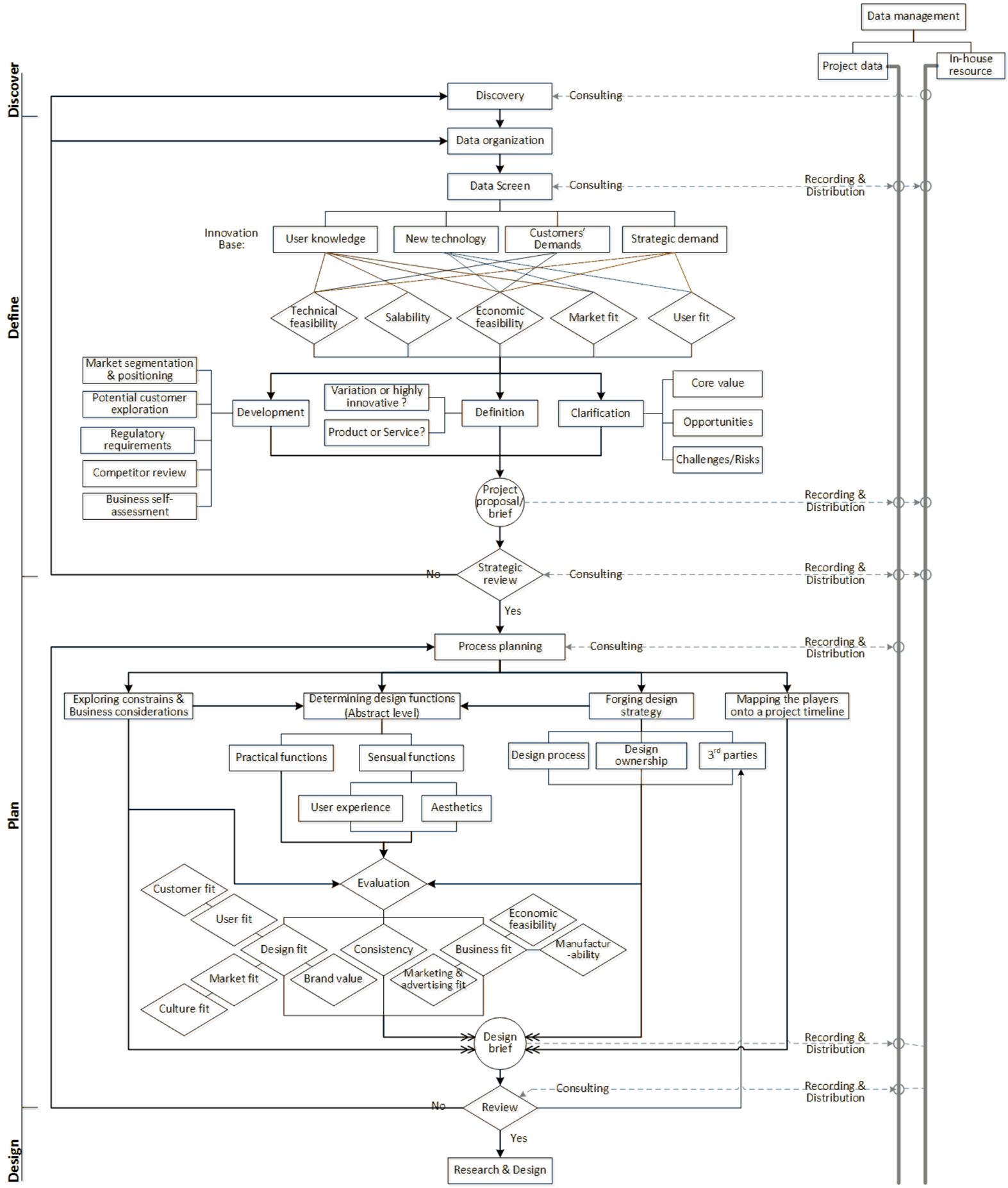


Figure 4.5 A new process for creating briefs (V. 1)

4.1.4 EVALUATION OF THE PROCESS (V. 1)

This briefing process was evaluated via expert interviews, and by the 2nd International Workshop on Modelling and Management Engineering Processes at Cambridge University (See Appendix I). Comments were taken from more than 10 experts from innovation management related backgrounds, for determining improvement directions.

Critical points emerging from this feedback for the next stage of research:

- Narrowing down a smaller focus area of the briefing process/approach and defining what the most attractive part is. A briefing tool developed based on this approach could be too complex to be adopted by SMEs.
- The format of a software tool may present difficulties in use.
- Do not underestimate the time that could be consumed in developing a working tool. Considering this is a doctoral research project completed by a single person, do not try to solve all the problems.

4.1.5 AN IMPROVED DESIGN BRIEFING PROCESS (V.2)

To prioritize design briefing within the front-end of the NPD process, the improvement approach was to concentrate on establishing a more effective design briefing approach which is easier to implement.

To resolve the conflict between easy acceptance and easy implementation in practice, the new approach splits the design briefing process into two parts: **a skeleton** and **implementation strategies**.

The process skeleton comprises four phases (Figure 4.6):

4.1.5.1 SKELETON OF THE PROCESS

Figure 4.6 The skeleton of the design briefing process

Stage 0. Preparation

Insufficient preparation at the very start can easily lead to the failure of a whole product innovation project. To establish an effective design plan, a strategist first needs to understand their own company's situation in terms of an individual project characteristic. This is particularly important when he/she is working on an unfamiliar or a highly innovative project. Preparation is defined as stage 0, which implies: it is the first stage in the process, and that it is a stage which does not relate directly to writing up a brief and is not always necessary depending on a project's complexity and the brief author(s) and other contributors' experience.

Stage 1. Identification

Identification comprises two sub-stages. In stage one, a project manager initiates a draft of the briefing document, which incorporates the design objectives and parameters in terms of business strategies and plan. This document provides the initial identification of the design task. In stage two, the manager should communicate the draft in a group meeting with the design team and representatives of other functions within the project. New ideas, problems and disagreements are expected to be exposed and generated in the meeting.

Stage 1.5 Research & Development

This is an intermediate stage between Identification and Refinement.

In Research & Development, the ideas, problems and disagreements generated from Identification should be explored and analysed collaboratively, possibly including the engagement of the R&D, the Marketing or the Sales teams. From this comes an amended draft design brief. Compared with the first version, this revised draft includes insights from various aspects, such as user interaction, design ideology, technical feasibility, manufacturing, installation, and maintenance, apart from business strategy. This stage may take from one week to two months based on project size, type and complexity.

Stage 2. Refinement

In Refinement, the new draft is shared with all functions in a group meeting, and is hopefully approved by all. If there is a critical issue(s), the briefing process should loop back to Research & Development. The approved draft goes through final refinement by the project manager and the design team together.

4.1.5.2 IMPLEMENTATION STRATEGIES

For Stage 0

A design commissioner should check if they fully understand their company's current situation before they start writing a design brief. To do so, they may ask themselves questions such as: is using our own design team the best option for this particular design task; does the design team understand our brand ideology; is the whole team familiar with the type of innovation; are our engineering and manufacturing teams capable of delivering the solution expected; and what is the long-term strategy of the company. Failing to answer these 'basic' questions can cause unexpected issues in later stages, and may even lead to the failure of a whole project.

Therefore, a checklist (Figure 4.7) is generated based on the question bank in Chapter 3.4.2.3, to aid design commissioners in reviewing their own understanding of the key factors in defining a design task that is fit for purpose, and achieving a greater control over the whole design process. Compared with the latter which was created with a focus on the characteristics of the 'company partner', this checklist addresses the needs of different types of companies.

The checklist comprises two sections: 1) understanding business strategies, and 2) preparing for writing a brief. The questions in the first section aid users in understanding of the board-level business strategies, and the second section is more closely related to the parameters of individual projects.

Figure 4.7 The self-assessment checklist:

SECTION 1: UNDERSTANDING BUSINESS STRATEGIES

1.1 Business positioning

Which industry are we in?

What are the industry characteristics in terms of new product/service innovation?

What is our brand value?

1.2 Overall business strategy

What is our business mode and strategy?

Is this strategy under a transformation? If yes, what influence it is likely to bear on this project in terms of, for example, team members, management framework, and sales

strategy?

1.3 The business-level new product development (NPD) process

Is there a formal business-level NPD process?

Is this NPD process effective in projects of diverse types and sizes?

Has this process being updated continuously?

Is this process still effective under the current situation based on the recent feedback from various functional groups?

Are the team members equipped with approaches and methods to carry out activities pre-planned in the process?

1.4 Data management

Is there an efficient channel which ensures that valued data and information from all employees of various departments and teams can be delivered to whom it may concern?

Is there a management system which ensures that vital data and information is up to date, easy to access, live, and secure?

SECTION 2: PREPARING FOR WRITING A BRIEF

2.1 DEPARTMENTAL FUNCTIONS, ROLES AND RESPONSIBILITIES

2.1.1 Overview

What are the roles and responsibilities of different functional teams within a project?

Which team plays a leading role in terms of the overall project management?

Which team has the most significant influence within a project?

Which team leads the design process?

Is the above structure effective and appropriate to the current situation?

2.1.2 Design

Do we need our own design team? If not, shall we build long-term partnership with an independent design house or let a project leader make a decision based on the

characteristics of individual projects?

In a project cycle, how to bridge the communication gap between an outside design house and our own teams, to ensure that design solutions always meet business objectives?

2.1.3 R&D, Marketing and Sales

What are the actual functions of R&D, Marketing and Sales respectively? For example, does R&D focus on research and design support in project front-end, or supporting downstream applications such as engineering or manufacturing plan? Does Marketing forecast market trend and contribute to market strategy and project plan, or work more on sales promotion? Does Sales understand our system and products at the level as wished by Product/Project Management?

2.2 THE NEW PRODUCT DEVELOPMENT (NPD) PROCESS

2.2.1 The NPD process

Does the project comply with the business-level NPD process?

Does the design strategy comply with the NPD process implemented in the project?

2.2.2 Project strategy formulation

How is a project strategy formulated?

Is it based on research or purely intuition?

Do various functions contribute to the strategy formulation process?

2.2.3 Research on user, customer, and market (customers and users are sometime different people)

Are there teams which focus on capturing information of user, customer, and market respectively?

What approach(es) and method(s) are employed for the above tasks? Are they strong enough to ensure both the quality and the quantity of research output?

Do we understand the market at both macro and micro level?

Is there a formal and structured system for capturing and managing market information which includes competitor knowledge, legislation changes, cultures, and

development trends?

For what purposes were users engaged in previous NPD projects? Were there formal user studies conducted in the front-end phases, and for design and strategy formulation? If not, shall we consider making a change?

Are the insights in the above areas addressed in writing up project and design briefs?

2.2.4 Briefing documents (e.g. project proposals, design briefs and specifications) generation and application

Does the information incorporated in briefing documents come from controlled and authentic sources?

Were briefs documented in an appropriate format, at right time, and were applied as what they were meant to be in previous projects?

How are the briefing documents stored? Are they updated continuously with project progress?

Did design solutions well meet the parameters described in briefing documents in most cases?

2.2.5 Data management

Does this project comply with the data management system?

2.2.6 Collaboration between functions

Are multi-disciplinary collaborative work enabled and promoted?

Are different groups get involved in projects at appropriate time? Are their opinions addressed adequately throughout the planning and design processes?

Has the potential of each department been fully exploited? For example, could the service and the installation groups contribute more in the front-end of NPD? (It has been found in this study that these two groups can provide user feedback and competitor information, as well as produce fascinating design ideas, from their daily work with users and customers.)

Figure 4.7 The self-assessment checklist

For Stages 1, 1.5 and 2

3 key factors

A design brief is initiated, developed and confirmed throughout Stages 1, 1.5 and 2. During this course, there are three key factors for consideration: Market, Business, and Design (Figure 4.8). They can be viewed as a summary of secondary factors, such as brand language, culture, and technical feasibility, and subsequent factors, such as market trends and personnel (Figure 4.9). These three key factors form a stable triangle which sets the base of the activities in each stage of the briefing process. Focusing on the three key factors ensures that the wishes and parameters from various functions can be properly addressed in the process output.

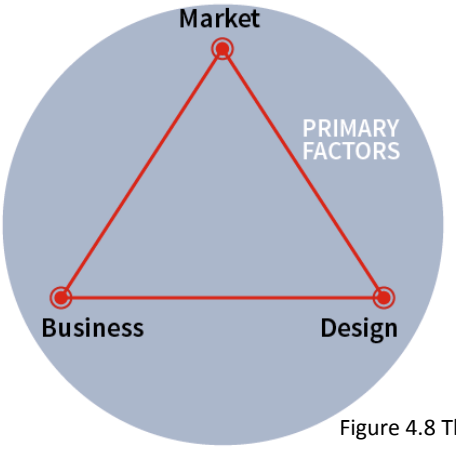


Figure 4.8 The three key factors in consideration

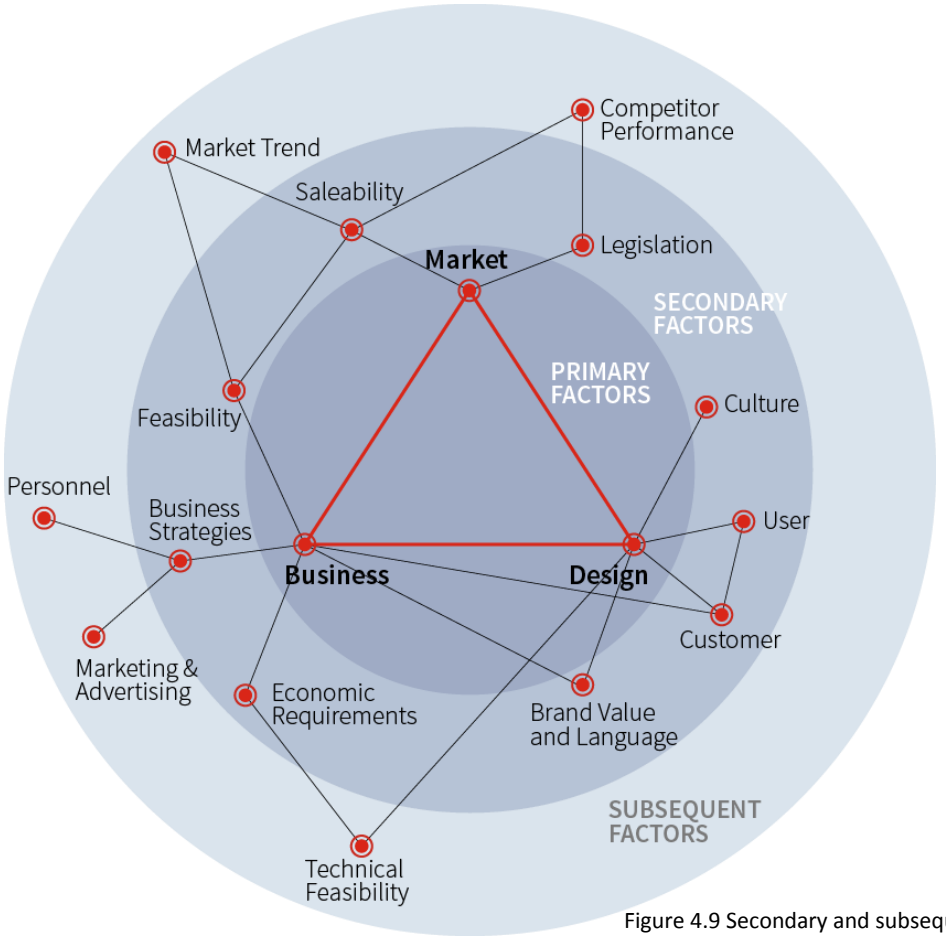


Figure 4.9 Secondary and subsequent factors

The two-triangle framework

To address the key factors throughout the design briefing course, a two-triangle framework is provided to reinforce the skeleton briefing process, which guides the planning and execution of the activities involved (Figure 4.10).

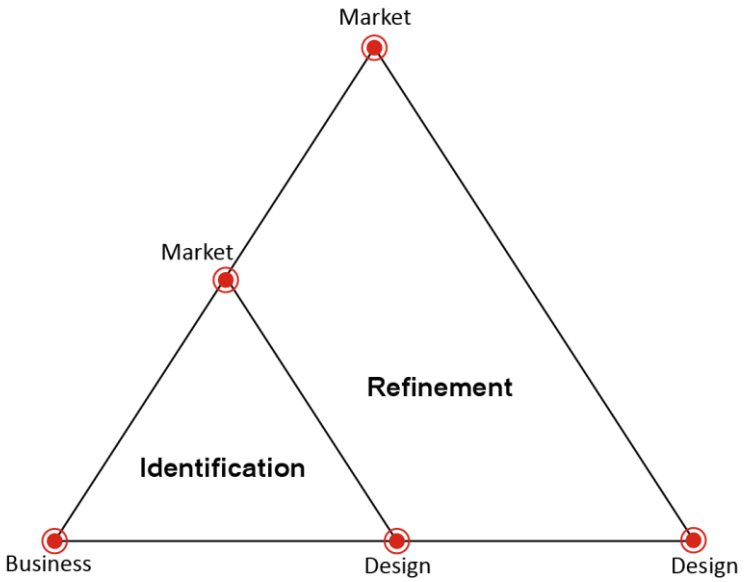


Figure 4.10 The two-triangle framework

In the identification stage, brief authors translate the strategies and objectives of an NPD project into the detailed description of a design task, in terms of wishes and parameters from marketing, business, and design perspectives (the first triangle) (Figure 4.11). This draft needs to be communicated and evaluated with all key stakeholders from various divisions, and will further be amended and developed in the Research & Development stage (expanding the first triangle) (Figure 4.12).

In the refinement stage, the amended draft with new input is reviewed by all in a group meeting, to confirm if it fits market, business and design requirements (the third triangle) (Figure 4.13). If the draft can pass the gateway, it will become the official design brief after final amendment and being added with confidential information such as budget, sales region, legislation, and supplier details. If not, the briefing process shall loop back to stage 2.

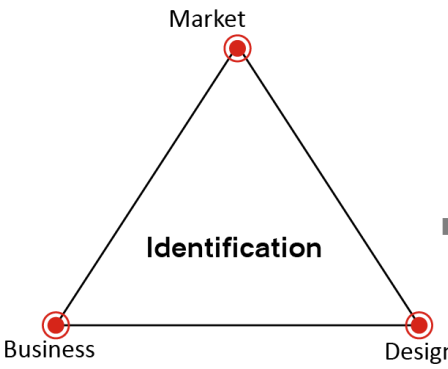


Figure 4.11 Identification

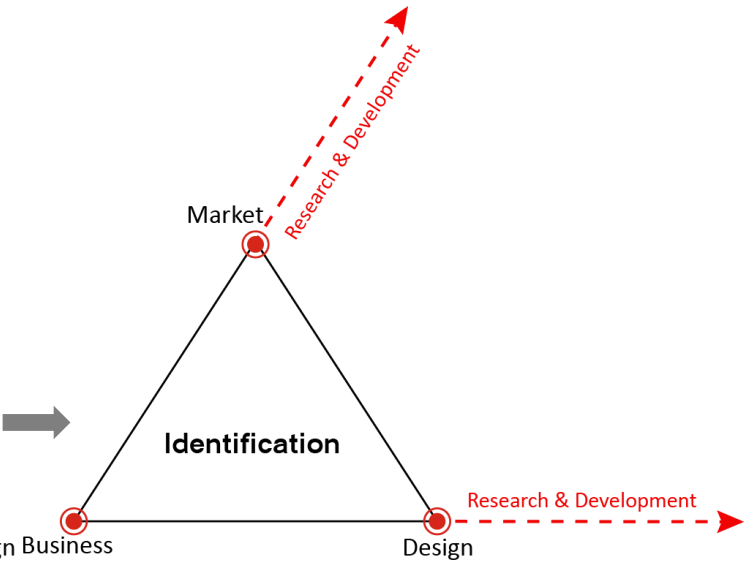


Figure 4.12 Development

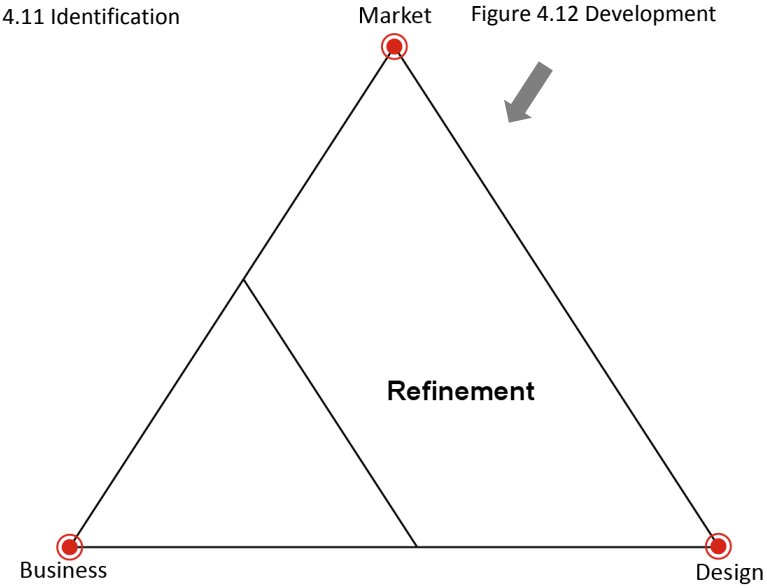


Figure 4.13 Refinement

4.1.6 DESIGN SPECIFICATION OF A DESIGN BRIEFING TOOLKIT

The decision was made to develop the proposed design briefing process into a working toolkit. By making the abstract approach visible and more insightful, it can be easier for potential users to understand what they need to do and what they will receive in return.

Based on the principles set out in this chapter, a list of design requirements has been generated:

1. Background

As part of the doctoral research output, the design briefing toolkit aims to improve the

creation and application of design briefs in NPD projects, with the features of home healthcare field in mind.

2. Target audience

The primary users would be design commissioners and design team leaders, who can be a project manager, a product manager, or a chief designer, depending on the organizational structure of individual companies and the format of the design project.

3. Expected functions

There are two primary functions of the toolkit:

Coaching & Inquisitiveness

This function includes: introducing the worth of spending time and money on writing up an excellent design brief; and coaching users how to do it following the proposed briefing approach.

Writing a brief

The toolkit should assist users through the briefing process step by step, and should produce a robust design brief which is ready for use in the end.

4. Design requirements

In terms of functions:

1. Translating input from various disciplines into design insights as needed for the design process.
2. Maintaining data richness and tractability.
3. Supporting and guiding greater stakeholder engagement.
4. Creating a common vision and design language shared by different disciplines and enable a collaborative integration to find solutions.
5. Encouraging the generation of design attributes such as new ideas, new materials.
6. Saving time and financial resources in the long run by reducing the need for design changes, avoiding unexpected problems in downstream applications, and ensuring that resources can be applied at the right place and right time.
7. Asking the user questions rather than being a passive platform.
8. Providing a data management solution.
9. Can be used independently, without being integrated into a company's management system.
10. Recording and presenting data in a format which is distributable across platforms.

In terms of UI and interaction design:

1. Easy and simple to follow for users from various disciplines.
2. Promoting co-working.
3. Visualizing abstract principles and steps clearly.
4. Easy access across different parts/pages.
5. People friendly fonts and colour.
6. Limited usage of colour and images to avoid distractions from the core value;

1. Format

An online application. This is required to enable centralized data and information management and to facilitate collaborative working across functions and teams.

This list pins down the direction and boundary of the toolkit development work in the next stage of the research.

4.2 THE TOOLKIT FOR CREATING A STRONG DESIGN BRIEF

4.2.1 SUMMARY

Based on the proposed approaches for creating a strong design brief (See Chapter 4.1), an online toolkit was developed in this research. Although many online toolkits such as Smartsheet (http://www.smartsheet.com/coordinate-anything-3) and Red Booth (http://redbooth.com) aid in managing projects, they do not support writing a design brief, nor do they mention addressing the characteristics of the home healthcare field. The toolkit developed in this research fills this void. It is both a coaching tool for communicating and promoting the proposals and a working tool that produces ready-for-use design briefs. This chapter specifies the structure, interface, and page contents of the toolkit.

Towards the end of development, the toolkit was tested with a number of individuals from universities, research institutes and companies covering a spectrum from large multi-national to very small, based in the UK and overseas (Refer to Appendix M). The results are also introduced in this chapter.

4.2.2 DESIGN JOURNEY

This practice based research study can be divided into two stages:

Stage 1 Generation of the knowledge

The toolkit represents a summary of knowledge gained (Refer to Chapter 3.4 & 4.1) generated from primary (Refer to Chapter 3.3 & 3.4) and secondary research (Refer to Section 2, Chapter 3.1 & 3.2).

Stage 2 Development of the toolkit

There were four sub-stages in building the toolkit:

1) Developing the first prototype
2) First round evaluation
3) Further improvement
4) Second round evaluation

4.2.3 PRACTICE BASED OUTPUT

The main practice based design output is an online design toolkit which aims to improve the process of creating and applying design briefs in product innovation (Figure 4.14). It has been developed with the HHCP field in mind, but can also be applied in other industries.

There is a CD with the toolkit on it for the reader of the thesis to reference. For a limited period of 18 months (Oct 2014 - March 2016), the reader can also choose to review the toolkit online: http://designbriefingtoolkitv2.businescatalyst.com/

Figure 4.14 The logo of the toolkit for creating a brief

4.2.3.1 FORMAT

Why an online toolkit? The format both facilitates communication among stakeholders and work groups, and improves their data sharing capability. It also enables remote and/or collaborative work on one single document. Furthermore, intranets are widely used by target companies and a web tool can be easily embedded into an existing management system (Refer to Chapter 3.4.6.4).

Despite the above benefits, some interviewed brief authors still prefer the traditional paper format. The doubts are mainly on the working efficiency and the lack of experience with a digital tool. This highlights the requirement for a simple and easy to follow interface and integration design.

4.2.3.2 PRIMARY NAVIGATION OF WEBSITE

There are two major divisions in the toolkit: **Foundation** and **The Brief** (Figure 4.15).

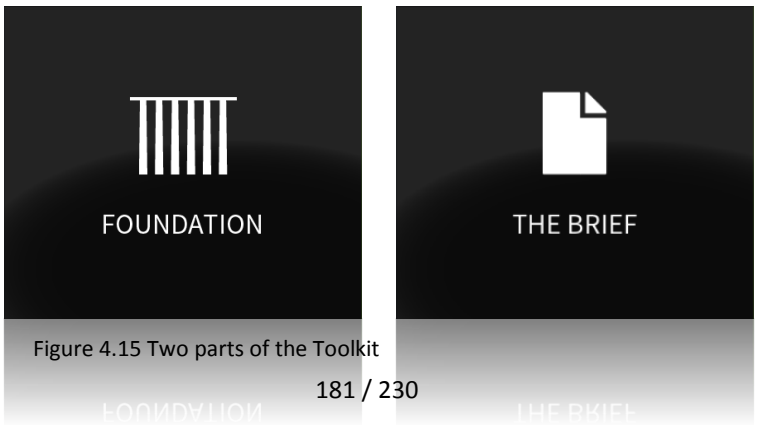


Figure 4.15 Two parts of the Toolkit

1. Foundation

This division outlines the research background and the principles behind creating and applying strong design briefs. It realises the tutorial function written in the design specification (Refer to Chapter 3.4.7.4). It incorporates three sections: **Background**, **Principles** and **Methods Bank** (Figure 4.16).

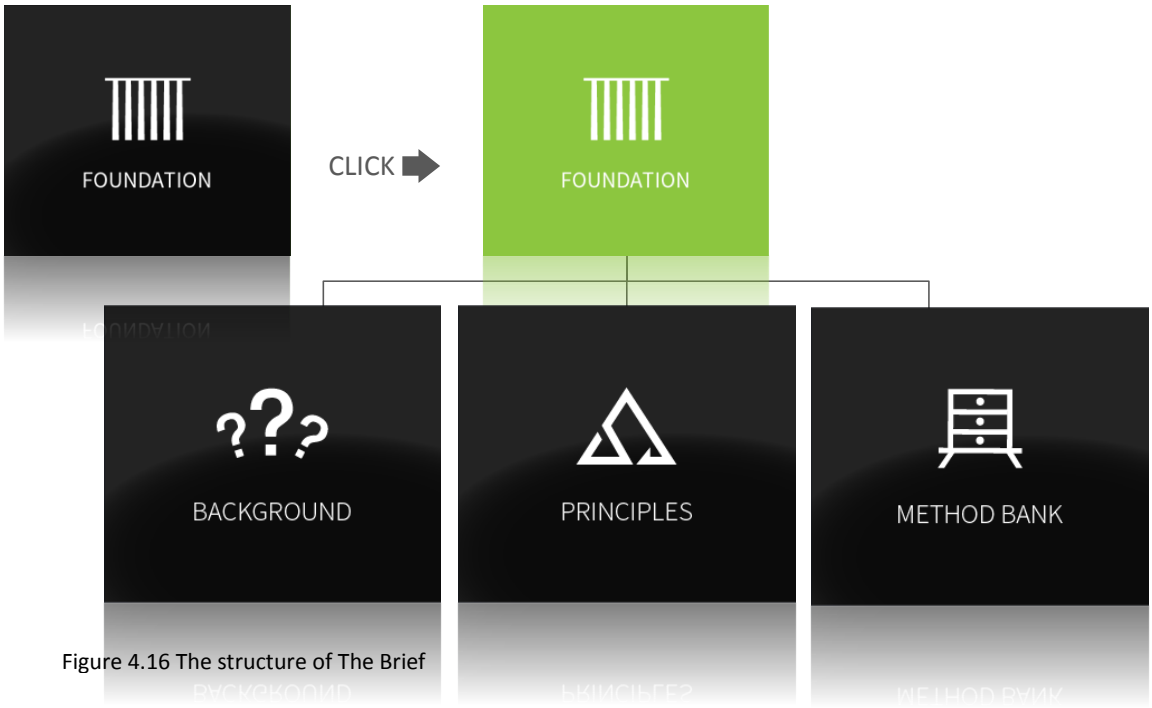


Figure 4.16 The structure of The Brief

2. The Brief

The Brief guides users through the proposed process of preparing and writing a strong brief. This division ensures that the principles introduced in the Foundation are fully adopted. It consists two sections: **Preparation** and **Write a Brief** (Figure 4.17).

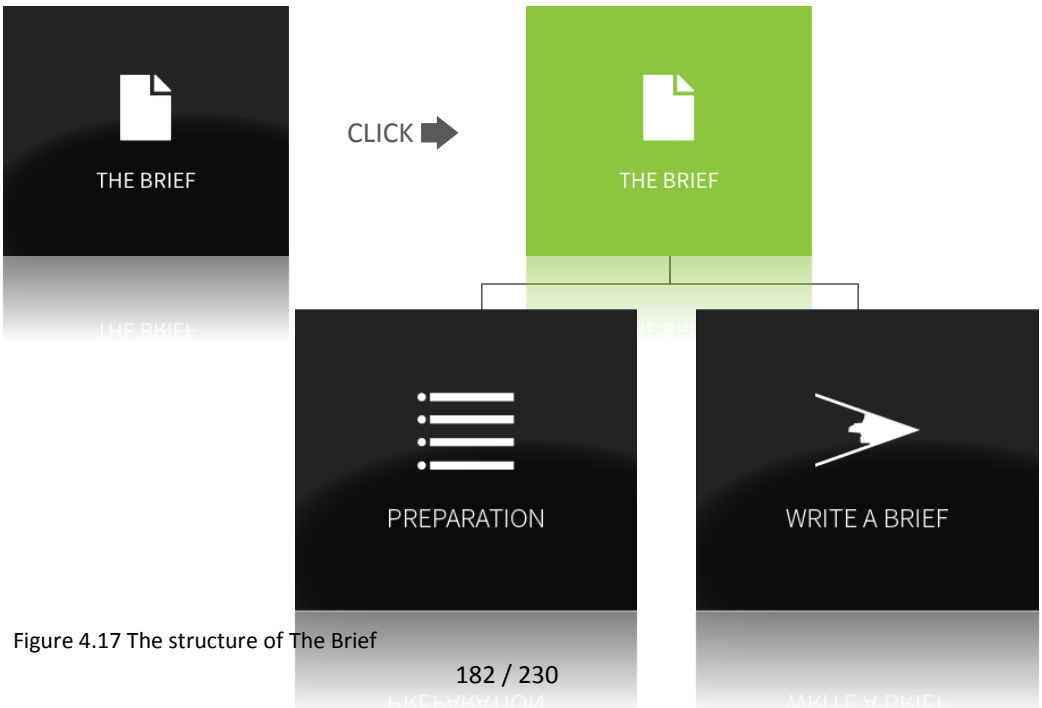


Figure 4.17 The structure of The Brief

4.2.3.3 INTERFACE

The design of the interface focuses on usability and user experience, to efficiently communicate the proposed research and design principles; and to make the toolkit easier to follow. This is achieved by using graphic and interactive elements (e.g. the thinking diagram), to visualize the more abstract briefing process, on the condition of keeping the simplicity of the interface, to avoid drawing unnecessary attention.

The knowledge background, and work habits and approaches of the target users, e.g., project/product managers and design team leaders, are considered in the design of user interaction. For example, the toolkit provides a self-assessment list in PDF format for users who prefer traditional paper format. As illustrated in Figure 4.18, the interface of the toolkit is divided into left menu, header menu, section name, and content.

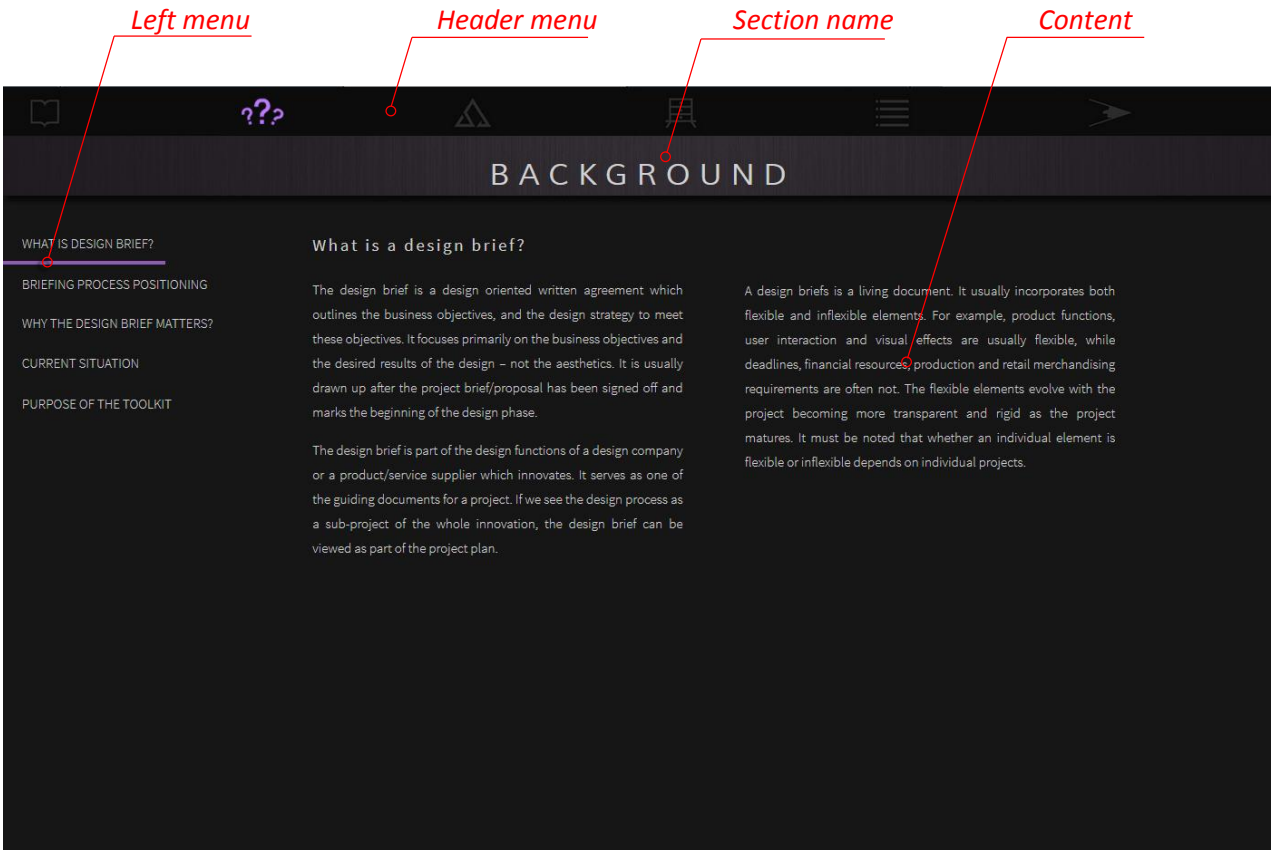


Figure 4.18 Introduction of the interface (See Appendix L. Figure 4.18 for lager version image)

Header menu

The header menu enables easy access across sections. It has six buttons for:

Section 1. Introduction (Home page)
Section 2. Background
Section 3. Principles
Section 4. Method Bank

Section 5. Preparation

Section 6. Writing a Brief

Each button was designed with a unique icon, which contributes to the simplicity and vividness of the interface design (Figure 4.19).

Figure 4.19 Design of the top menu

Left Menu

This menu is on each web page enables quick access to the different sections. A button in the menu will be underlined in the page's theme colour once the section which it links to appears on the screen (Figure 4.20).

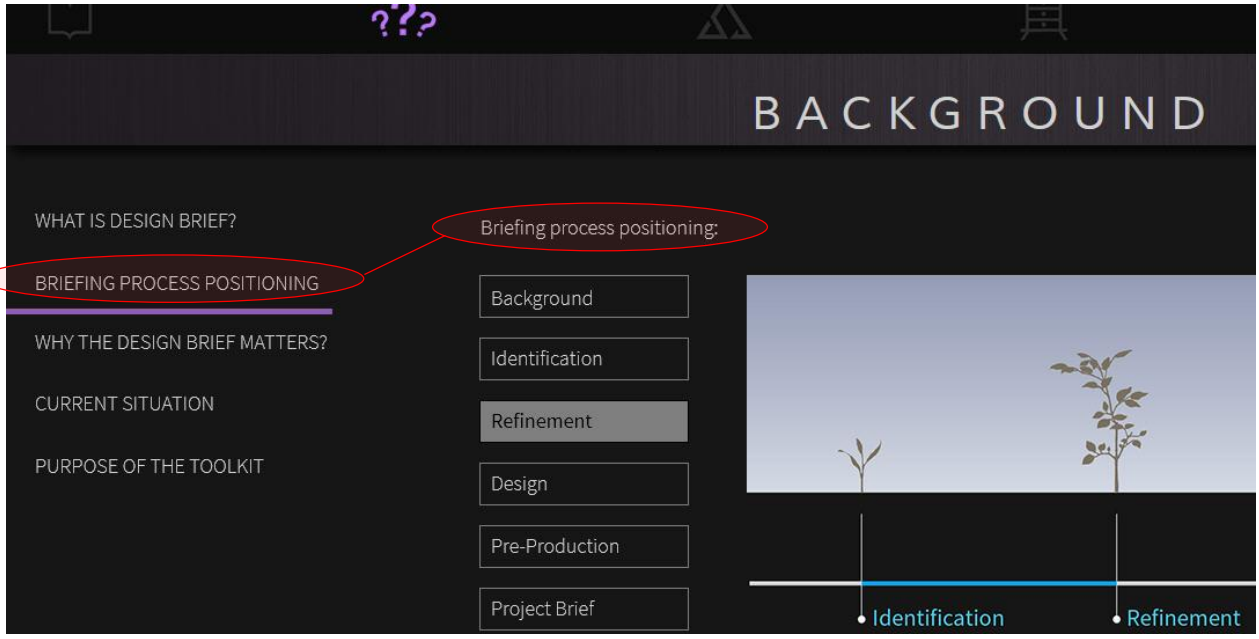


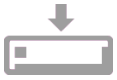
Figure 4.20 Instruction of the left menu

Other buttons

See more details/ Related-subjects/ Open brief

Help

Insert documents



Download

The brief

4.2.4 PAGE CONTENTS

The reader is advised to refer to Appendix M for clearer screenshots in larger format.

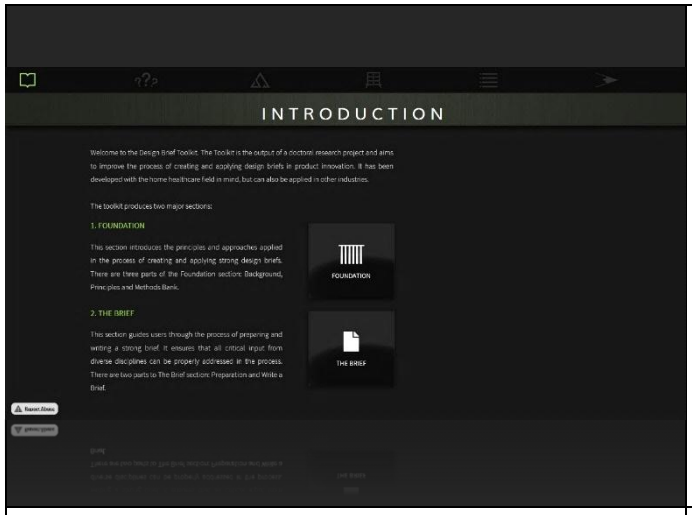
Front page

This Icon of the toolkit is in the centre of the front page (Figure 4.21). The page scrolls down automatically when users click anywhere on it.

Figure 4.21 Front page

See Appendix M. Figure 4.21

SECTION 1



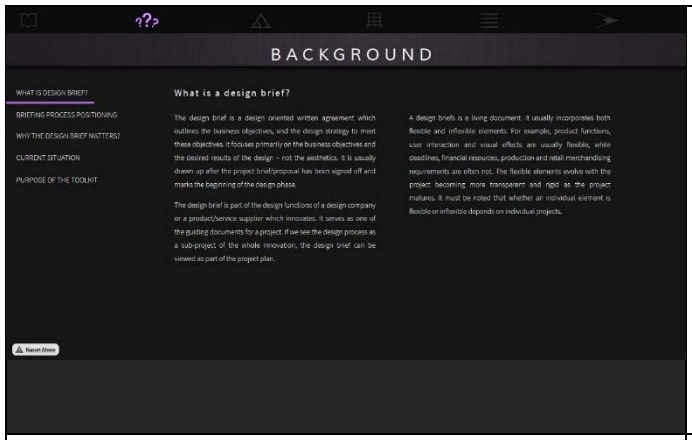
Home page

Scrolling down from the front page, users see Introduction which outlines the purpose, structure and functions of the toolkit, and also acts as the home page. It is designed mainly for first time users, and explains how to use the toolkit. The design enables easy access across pages/parts, so users do not have to return to this page during their work (Figure 4.22).

Figure 4.22 Home page / Introduction

See Appendix M. Figure 4.22

SECTION 2



Background

This section introduces:

- What is a design brief
- Briefing process positioning
- Why the design brief matters
- Current situation
- Purpose of the toolkit

Figure 4.23 Introduction

See Appendix M. Figure 4.23

Figure 4.24 Principles

Principles

This section outlines the principles and knowledge behind my briefing process. It is a critical part of the tutorial function which is to promote a new way to create and to apply design briefs (Figure 4.24) (Refer to Section 4.2.3.2).

See Appendix M. Figure 4.24

On the Principles page, clicking on each title in the left hand column takes you to the respective explanation (Figure 4.25):

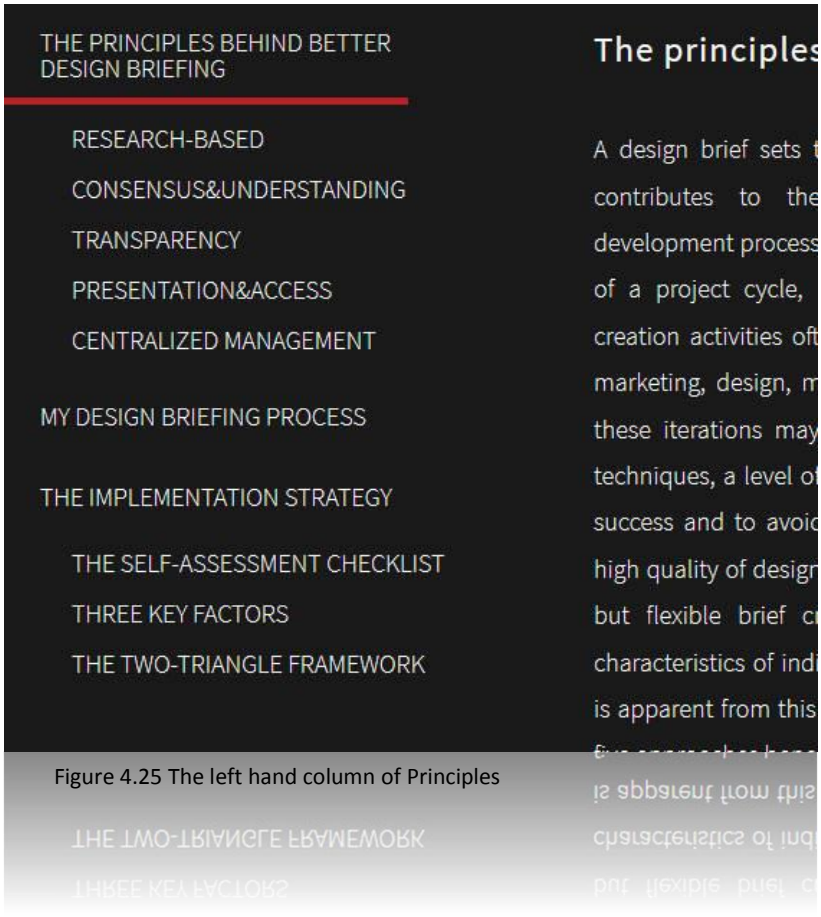
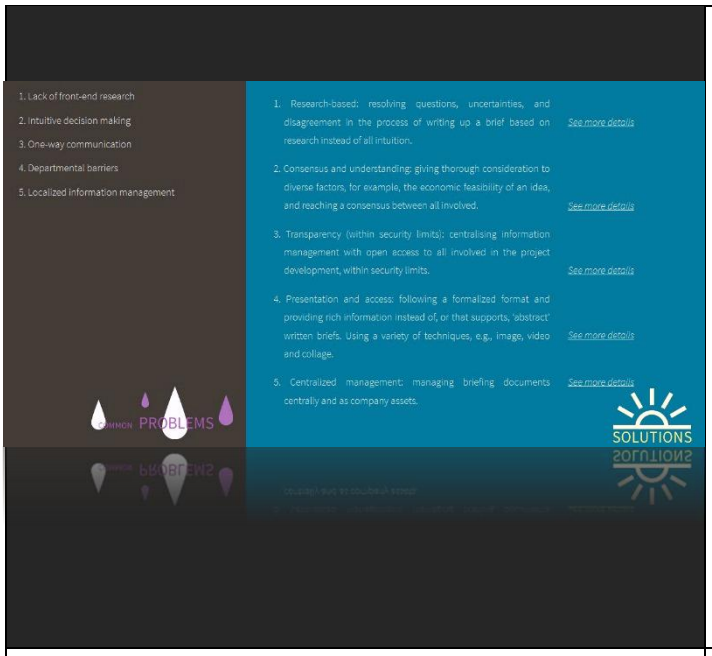


Figure 4.25 The left hand column of Principles



This page outlines five critical causes of poor briefing process (Figure 4.26) (See Chapter 4.1.2):

1) Lack of front-end research
2) Intuitive decision making
3) One-way communication
4) Departmental barriers
5) Localized information management

and proposes solutions:

1) Research-based
2) Consensus and understanding
3) Transparency
4) Presentation and access
5) Centralized management

Figure 4.26 Critical issues in design briefing as well as resolutions

See Appendix M. Figure 4.26

To strengthen the connection between principles and brief creation, related-subject icons are placed to enable easy access across sections (Figure 4.27) (Refer to Section 4.2.3.3)

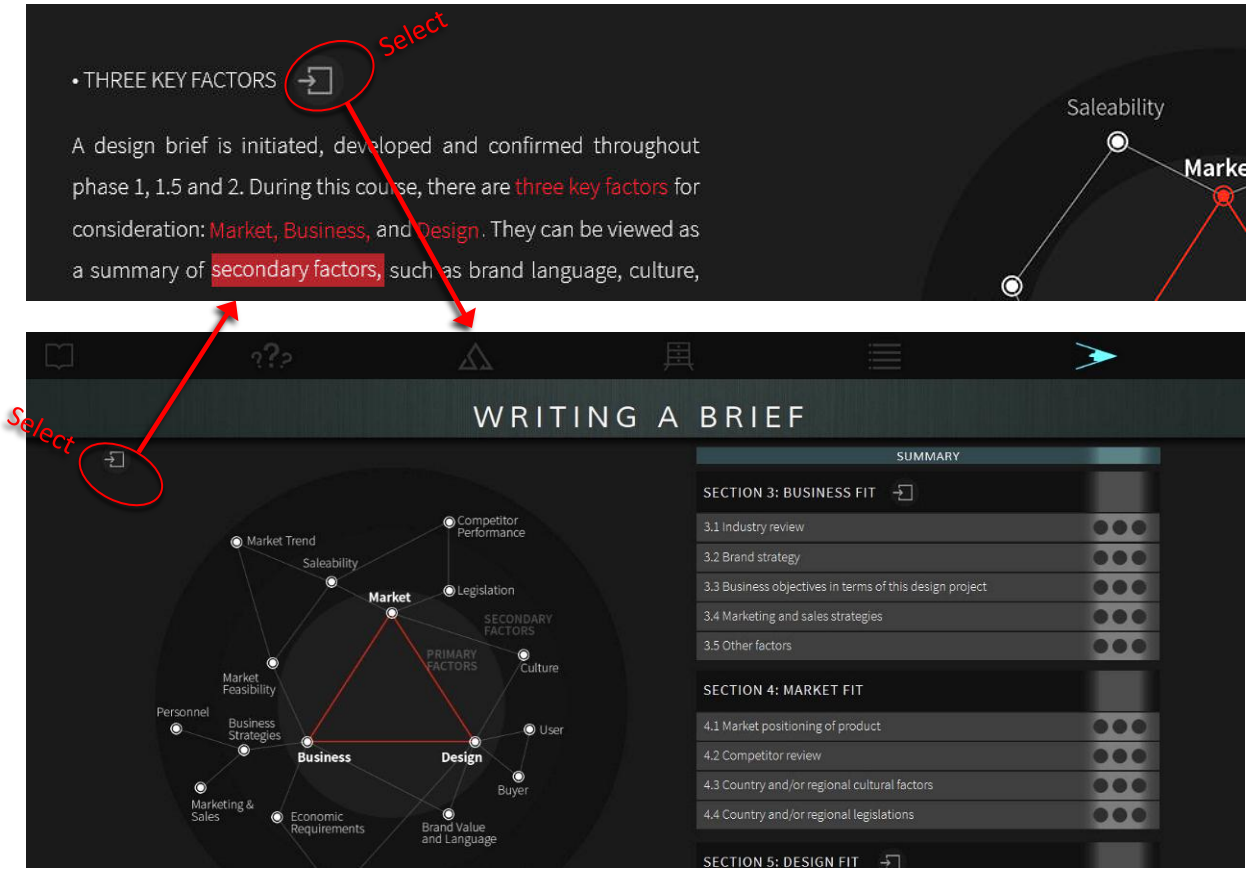
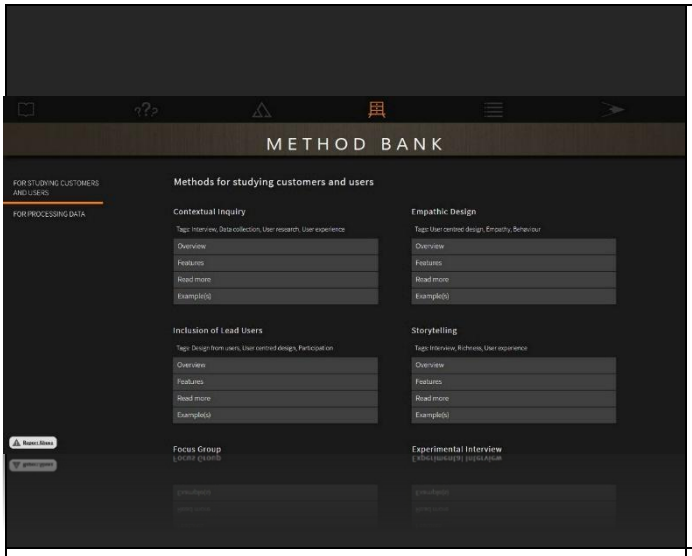


Figure 4.27 Clicking the related-subject icon by the side of Three Key Factors section leads users to the Key Factors page within the Writing a Brief section (See Appendix L for larger version images)



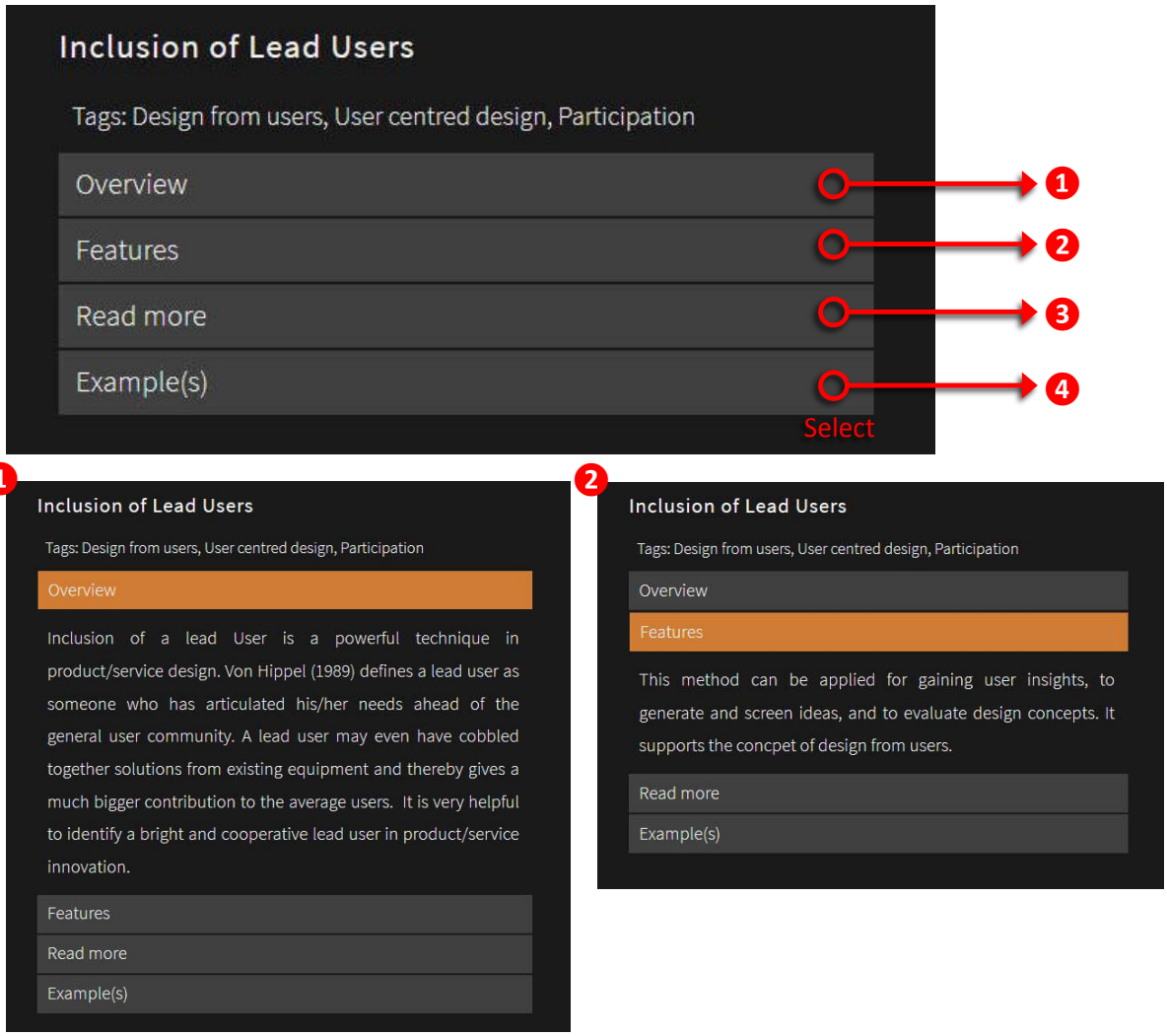
Method Bank

Methodologies and approaches which can be used in design brief creation, such as customers/user studies and data processing, are collated in the Method Bank (Figure 4.28). With a few frequently employed methods being listed in the toolkit. Users are encouraged to add/modify/delete items, to adapt the method bank to individual companies, projects, or users.

Figure 4.28 Method bank

See Appendix M. Figure 4.28

Each method divides into: Overview, Features, Read more, and Example(s) and available via the four grey drop-down blocks (Figure 4.29).



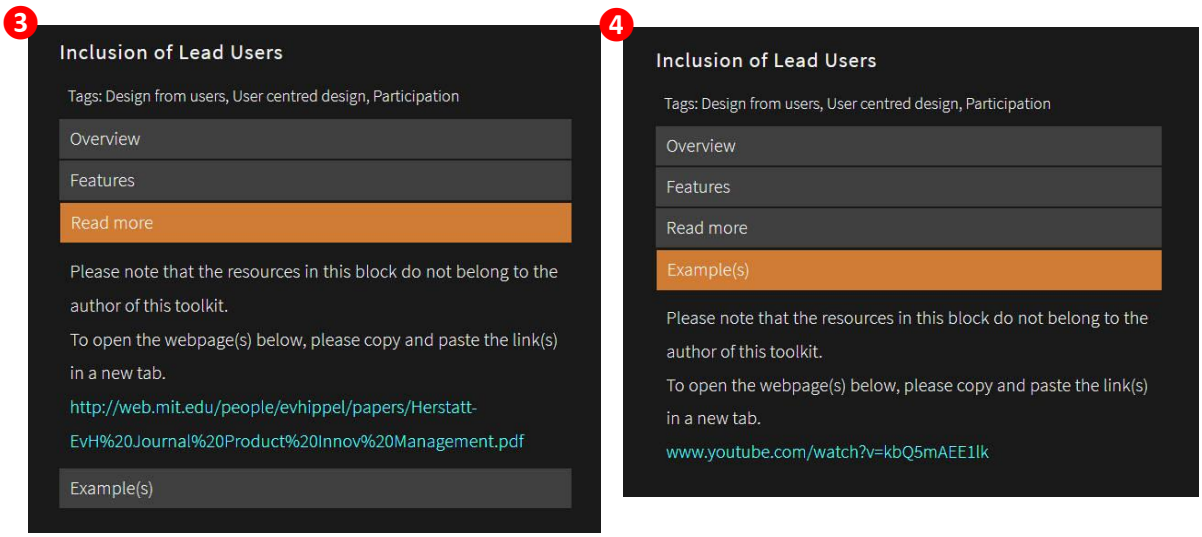


Figure 4.29 An example method in the bank

SECTION 5

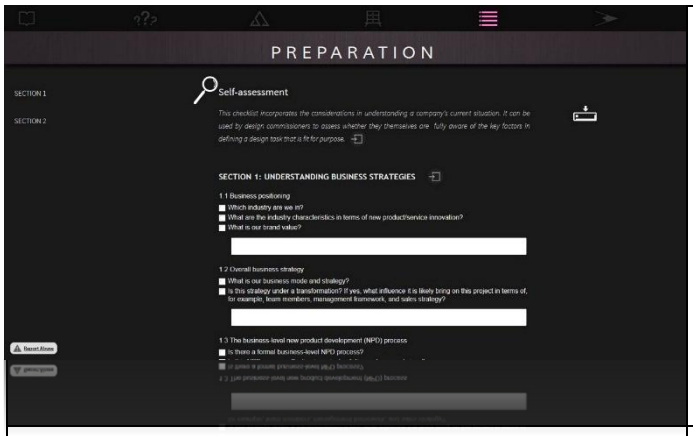


Figure 4.30 Preparation

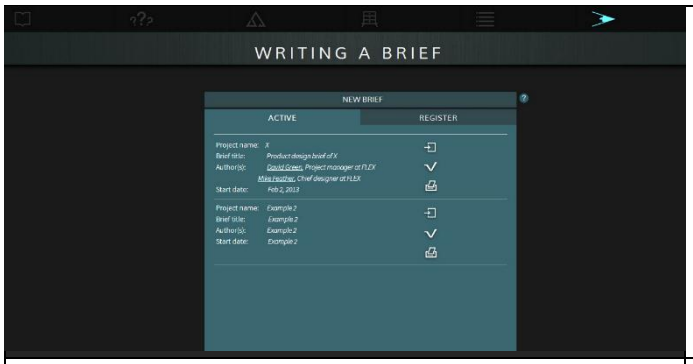
Preparation

The checklist aids design commissioners in reviewing their own understanding of the key factors in defining a design task that is fit for purpose, and achieving a greater control over the whole design process (Figures 4.30 & 4.31) (Refer to Section 4.1.5.2).

See Appendix M. Figure 4.30

To make any notes there is a text box after each question. The questions are linked to the Writing a Brief section by the related-subject button.

Figure 4.31 The items on the page



Writing a Brief

This section divides into two main parts:

1. Brief creation & management
2. Data entry

Figure 4.32 Preparation

See Appendix M. Figure 4.33

Part 1. Brief Creation & Management

Figure 4.33 illustrates the two panels for managing briefs and for creating a new brief.

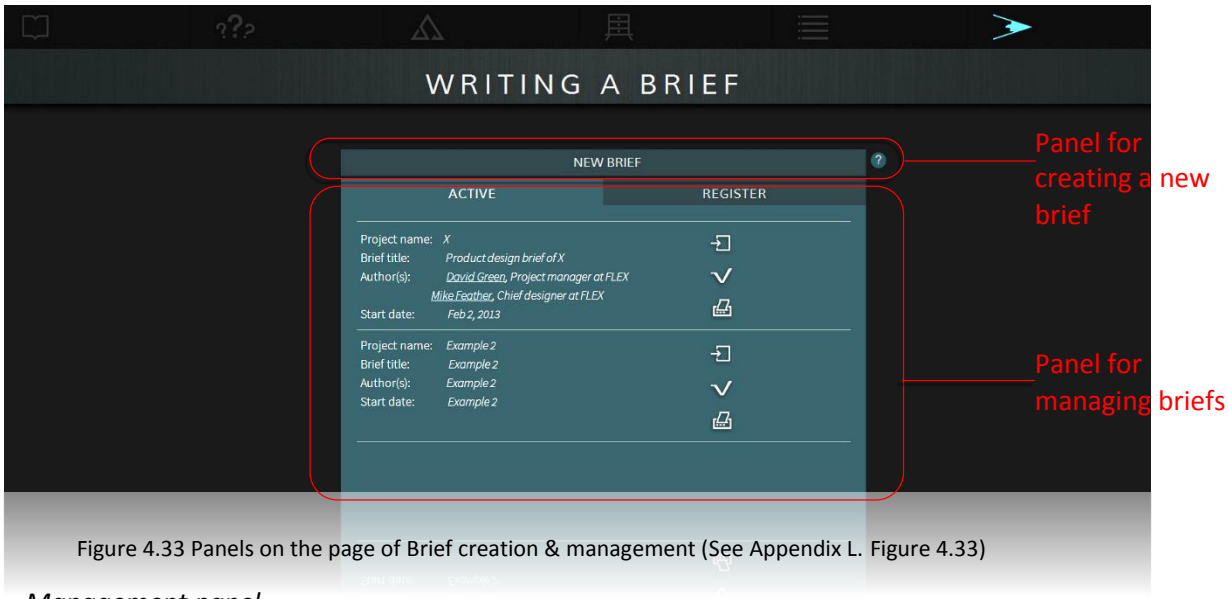


Figure 4.33 Panels on the page of Brief creation & management (See Appendix L. Figure 4.33)

Management panel

This toolkit automatically stores briefs new and old in the users account. This improves the efficiency in management and to prevent historical documents being lost (Refer to Chapter 3.4.6.2 for examples of poor brief management). The feature enables centralized information management which facilitates the interrogation and review of the briefs and encourages stakeholder engagement and cross-team fertilization. Furthermore, it reinforces accountability throughout the briefing process, and thus leads to stronger briefs. The knowledge that the briefs are properly recorded will encourage the authors to provide more robust information.

Stored briefs can be accessed by all within security limits using the Register menu (Figure 4.34). Briefs in the Register are shown with key information: project name, title, author(s), and start and due dates. This design enables the whole brief creation process, and thus makes the understanding of project success or failure easier.

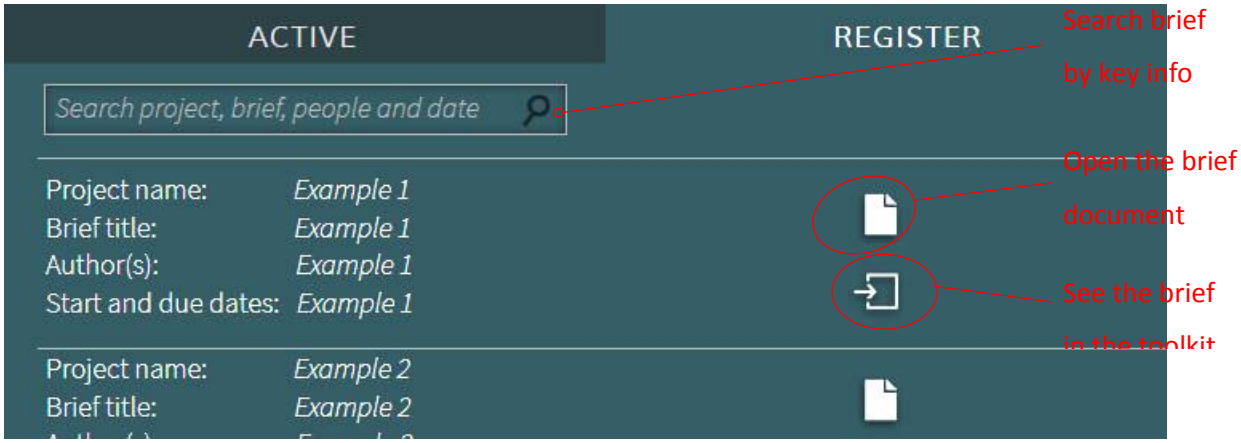


Figure 4.34 Register menu

To continue working on an incomplete brief, select Active menu on the panel, then select which brief to open (Figure 4.35).

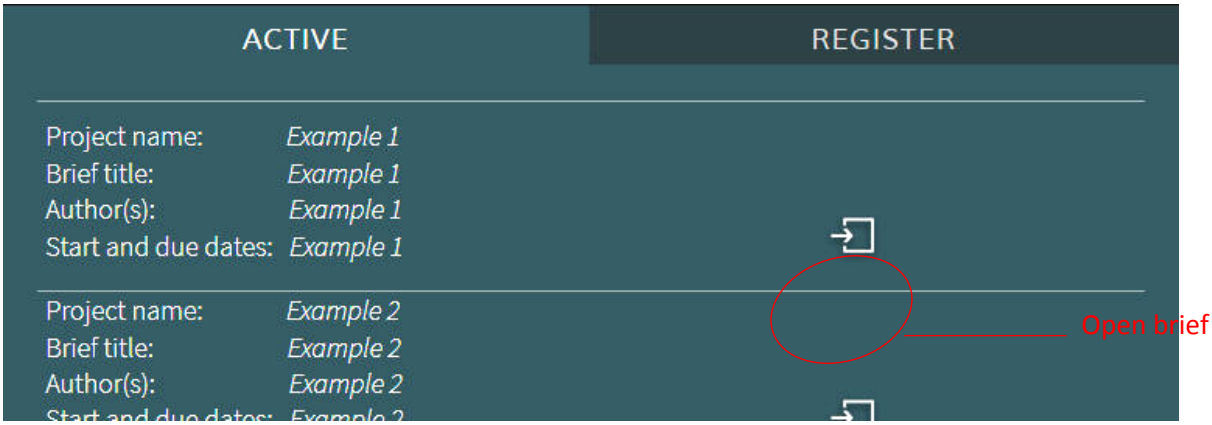


Figure4.35 To continue working on an incomplete brief

Panel for new brief

To initiate a new brief, select the New Brief menu and enter the project title, author and start date (Figure 4.36). Then click Confirm to open the first page of the brief – Context.

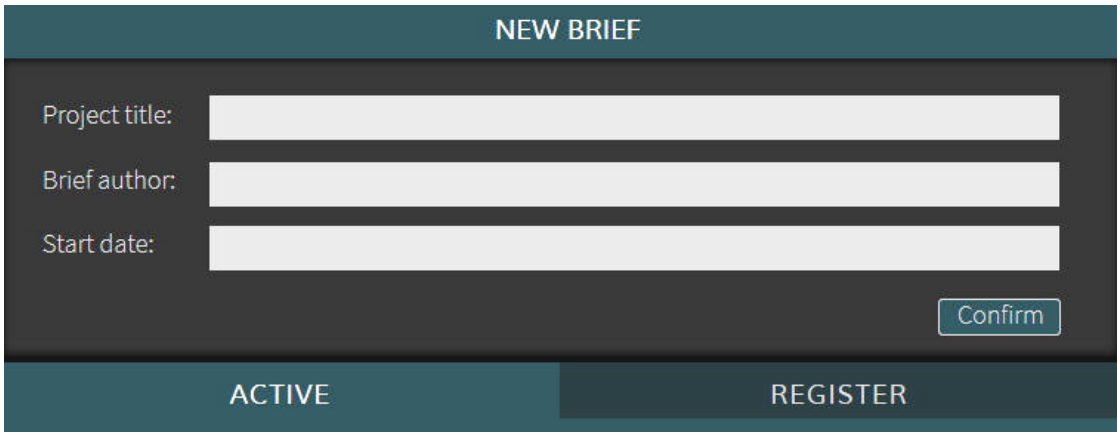


Figure 4.36 To initiate a new brief

Part 2. Data entry

The user goes through three pages/steps, namely: 1) context, 2) key factors and 3) plan, to complete a new brief. The directional arrows at the bottom left and/or the bottom right enable the authors to scroll between pages.

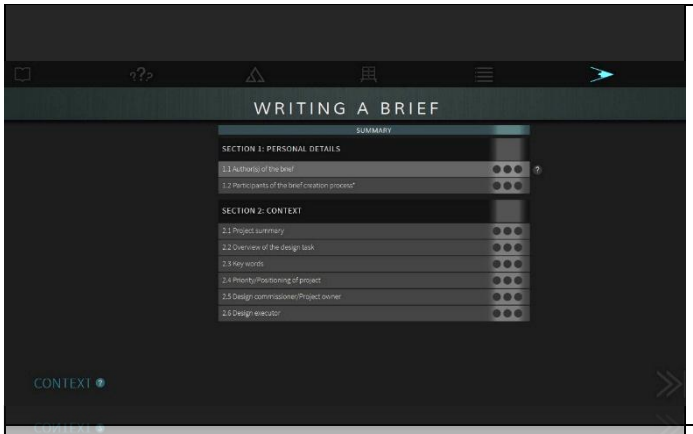


Figure 4.37 The Context page

Context

Basic information such as project name, brief author, summary and positioning of the whole product development project, and the overview of the design tasks are required on the Context page. This content should be completed by the design commissioner (Figure 4.37).

See Appendix M. Figure 4.37

Figure 4.38 The Key Factors page

Key Factors

This is the most important page in the Writing A Brief section (Figure 4.38). It requires the entry of the information specifying the design task and its parameters. This information is classified as for business fit, for market fit, and for design fit, based on the implementation strategy of the proposed design briefing process (Refer to Chapter 4.1.5). This page should be completed by the design commissioner and the design team leader in collaboration. The rest of the team members should also contribute as required.

See Appendix M. Figure 4.38

Figure 4.39 shows the interactive chart on the left hand side of the Key Factors page was created based on the theory introduced in Chapter 4.1. It illustrates the relation between the factors for consideration in initiating a design brief. There is a white dot by the side of each factor. Clicking on a dot leads the user to the relative data entry box(es) on the right hand side.

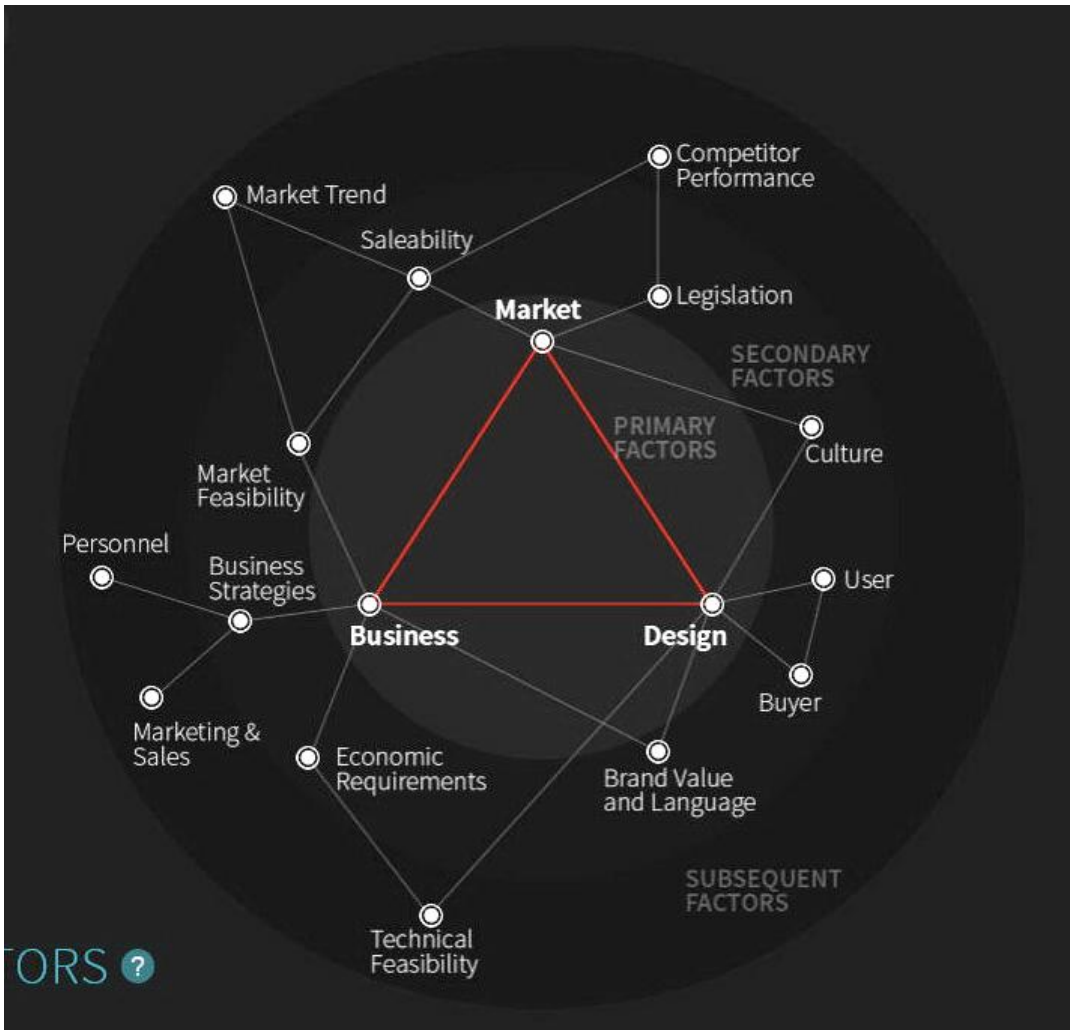


Figure 4.39 The interactive chart for managing the considerations in writing a design brief

Part 3. Plan

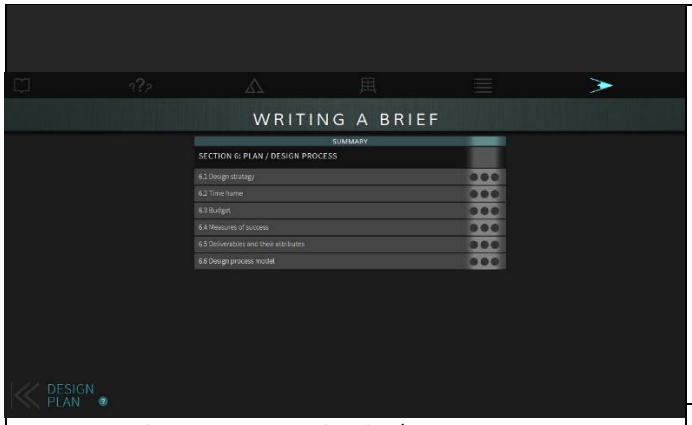


Figure 4.40 The Context page The Plan/Design Process page

With the design task clarified, the design commissioner and the design team leader settle on the design process as well as the resources required. Information such as design strategy, time frame, and budget are entered on the Plan/Design Process page, to consolidate the whole briefing process (Figure 4.40).

See Appendix M. Figure 4.40

The interface of Section 6 'Writing a Brief'

There are a number of grey bars which represent the key factors in defining a design task. By

selecting any of the bars, a sliding portion will be revealed for completion. Instructions are provided on the sliding portion to explain what needs to be entered and will be replaced by a text entry box when rolling the mouse cursor over it. At the bottom right of the text box, there is an Insert button, which enables documents to be attached. The input will be saved automatically by the toolkit (Figure 4.41).

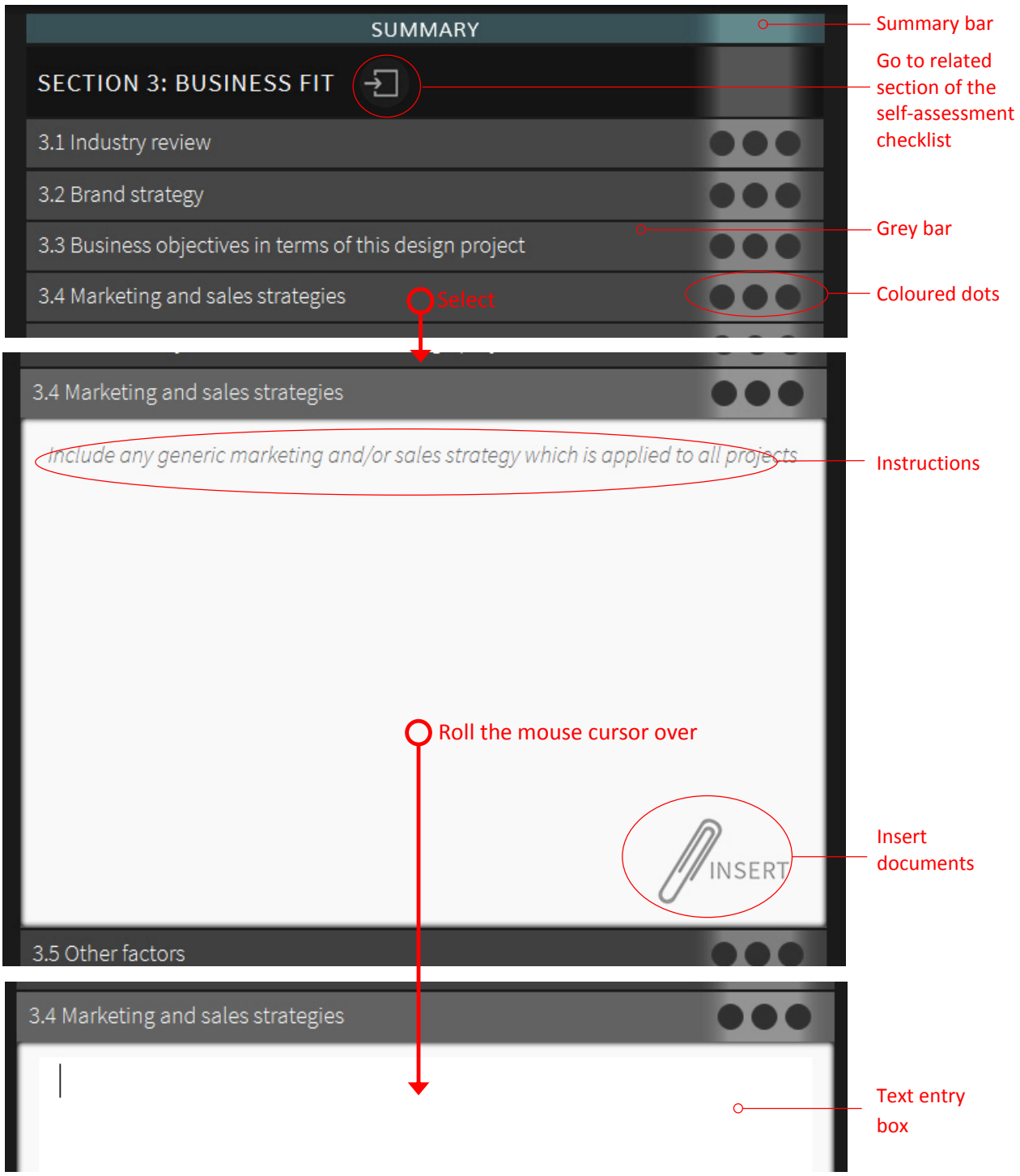


Figure 4.41 The Plan/Design Process page

To facilitate the process of writing a brief, there are three status indicators on each grey bar

(Figure 4.42), skip, incomplete and completed. Depending on the project, some factors listed in the toolkit may not be relevant in which case they are marked with 'skip'. When a textbox is written in, the associated middle dot will turn to amber (under development) automatically. Once a text box has been completed and has been agreed by all stakeholders, it needs to be marked with 'completed' (Figure 4.42). This also removes the item from Incomplete Steps (Figure 4.45).

Figure 4.42 Coloured dots show the status of completion

Efficient communication between author(s) of a brief and other stakeholders is essential in a strong briefing process, e.g., a new project manager may not be fully aware of the company background or there may be insufficient market research. The need to create and track assigned tasks is addressed by the Task panel with what, who, and when activities, which can be unfolded by selecting any the Under Development dot on the Key Factors page (Figure 4.43).

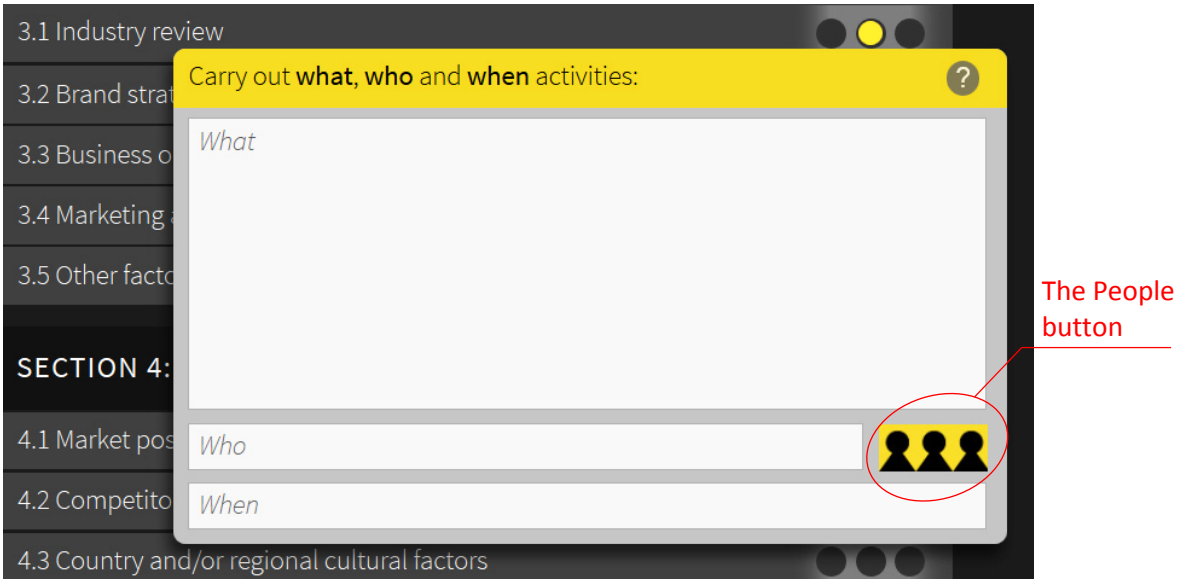


Figure 4.43 The Communication panel

The People button on Task panel links to the Communication panel, in order to quickly find the right person/people and his/her contact. It also allows direct communication by text message between the authors and other employees (Figures 4.54 – 4.57).

Screenshots of Communication panel:

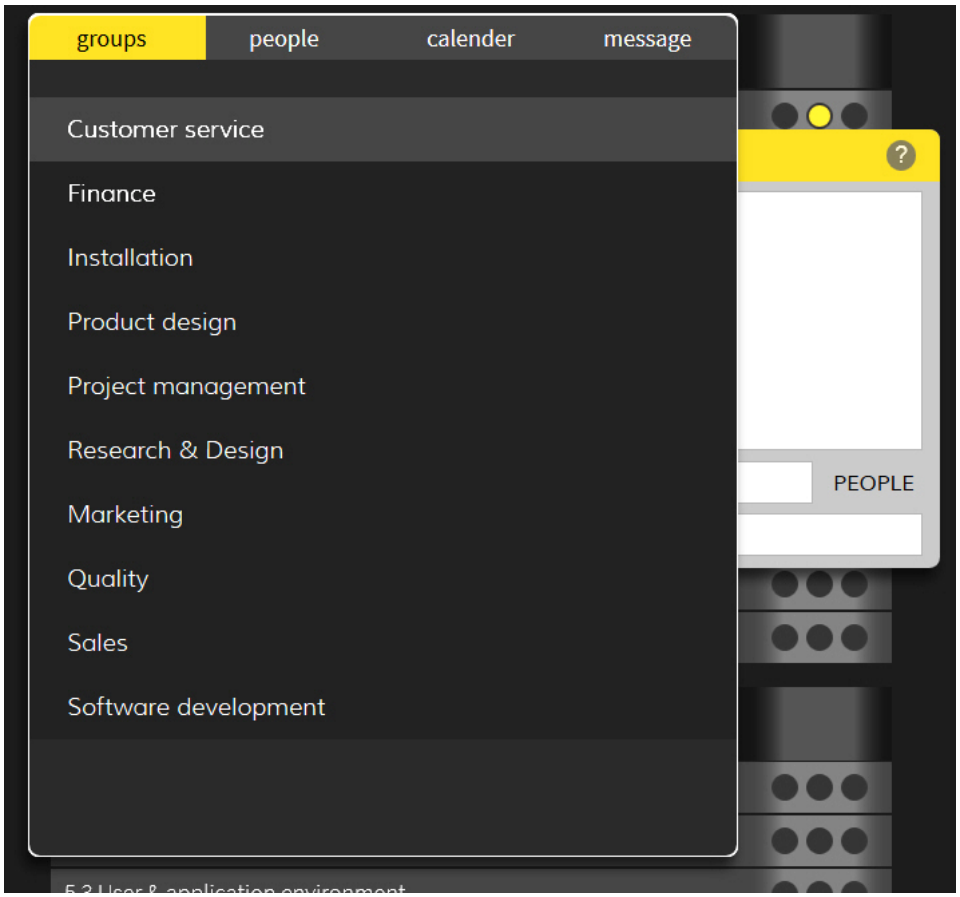


Figure 4.44 The Communication panel (1)

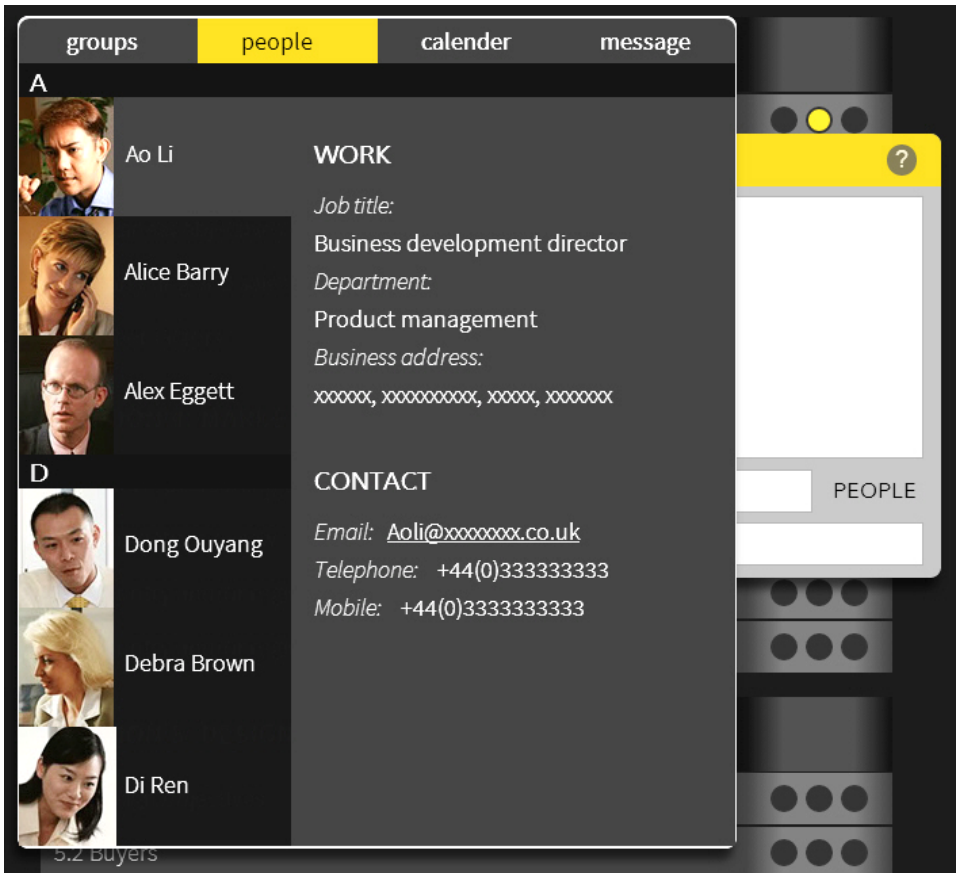


Figure 4.45 The Communication panel (2)

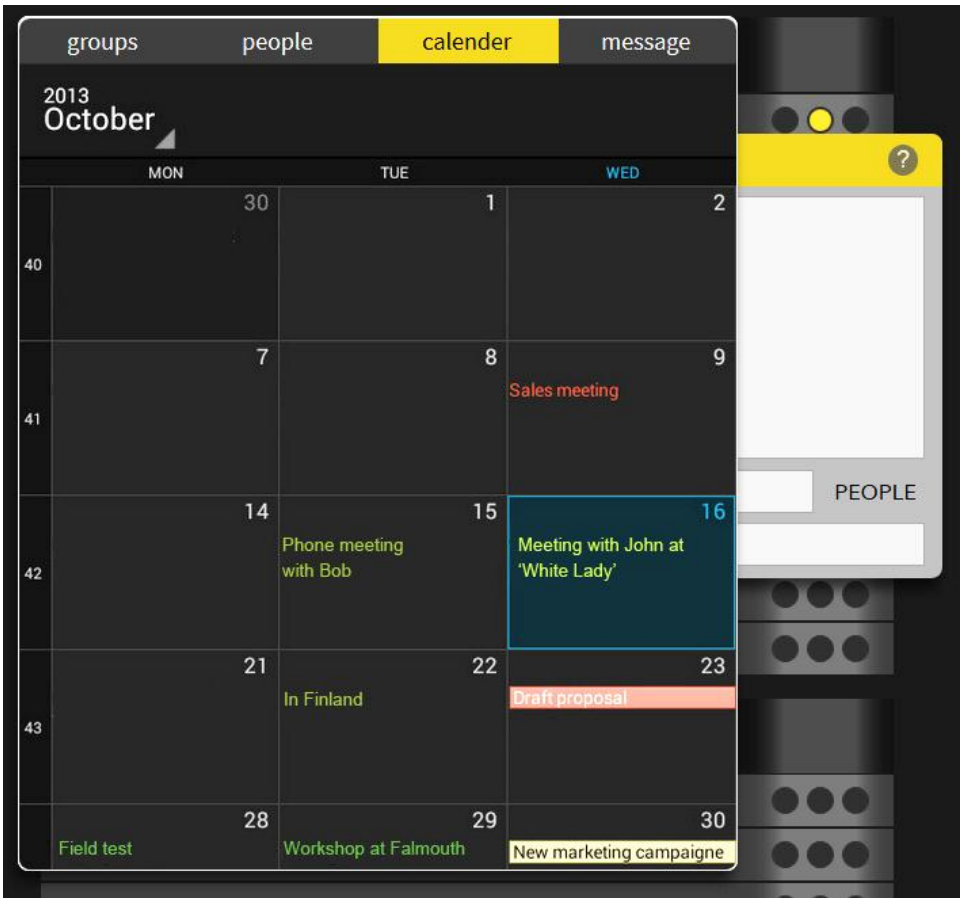


Figure 4.46 The Communication panel (3)

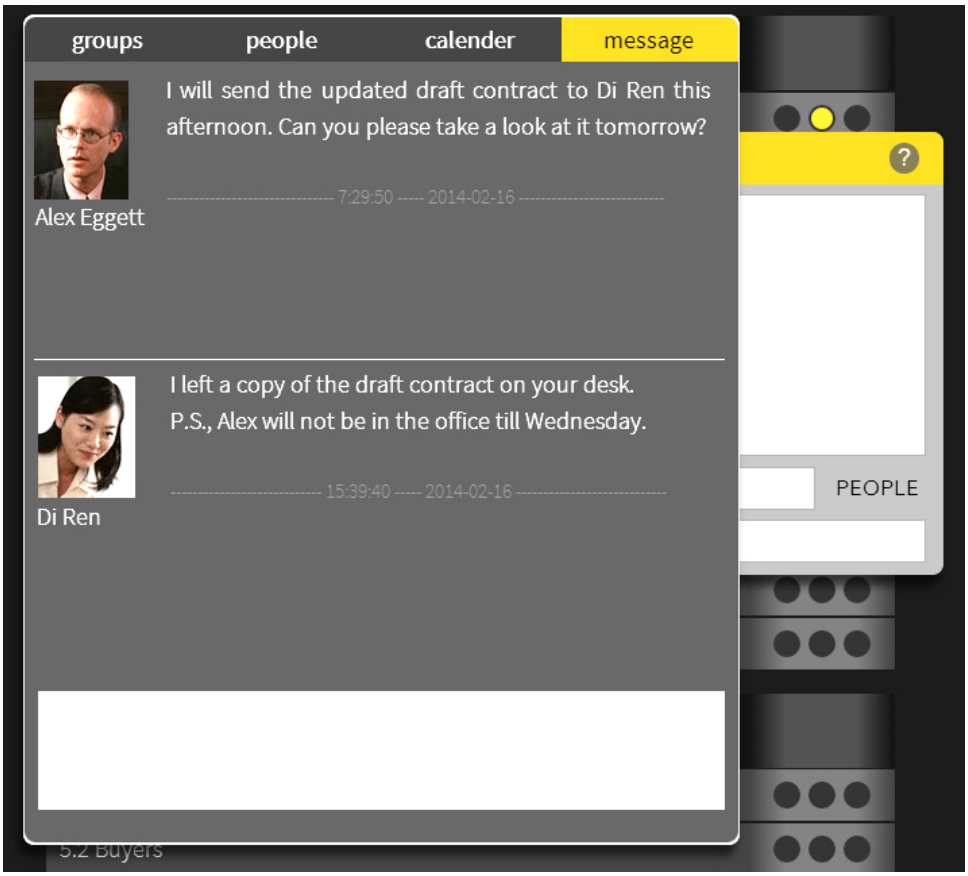


Figure 4.47 The Communication panel (4)

To allow quick retrieval and completion of the design brief, all the items marked with 'under development' are listed under Incomplete Steps in the Summary panel (Figure 4.48). The assigned tasks are collated under Action Plan, and can be printed as a single document via the Print button (Figure 4.48). This feature is designed specially to support the Research & Development stage of the proposed briefing process (Refer to Chapter 4.1.5). It is not available on Context and Plan since the two steps/pages are expected to be completed by the brief authors alone.

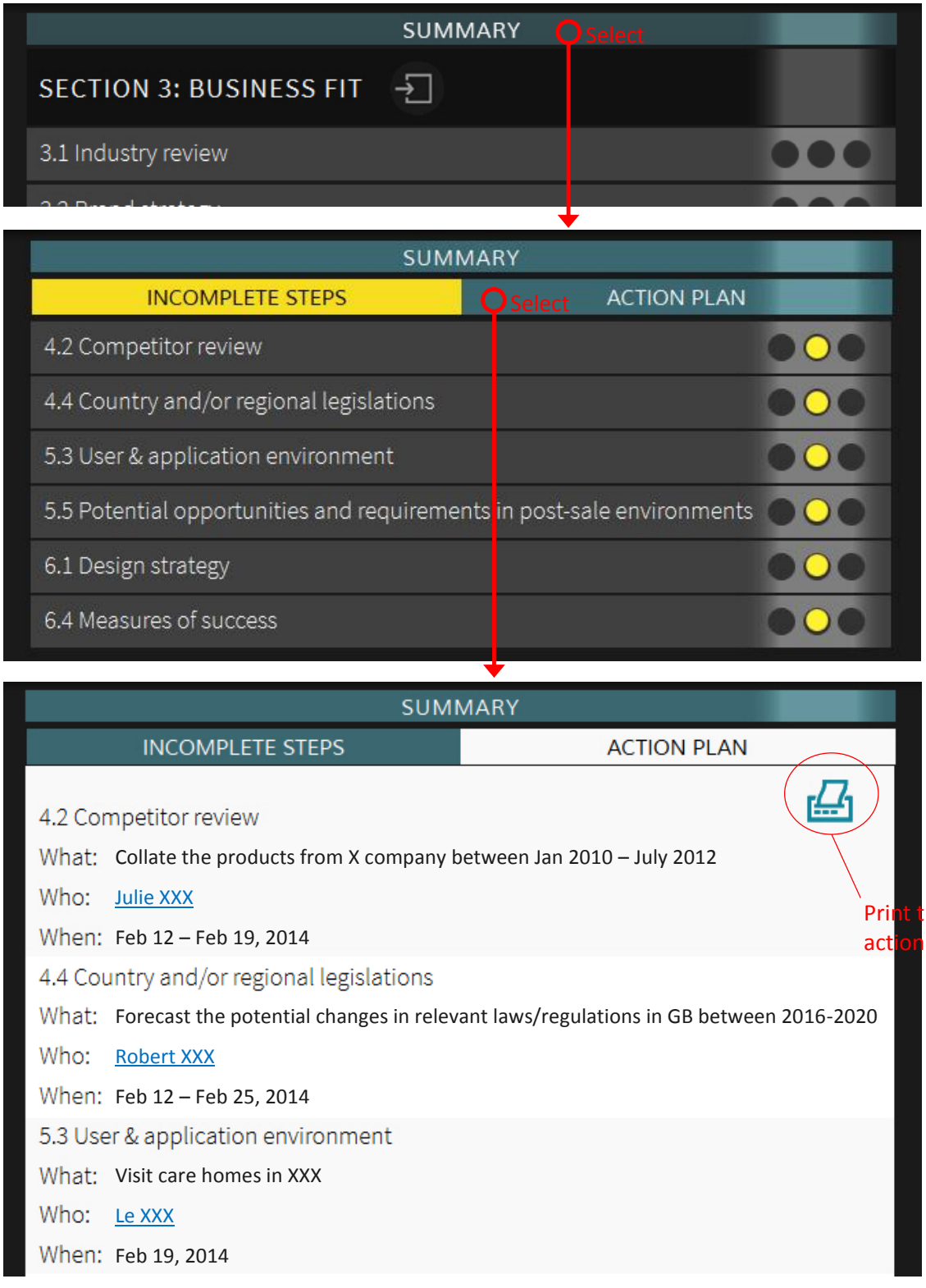


Figure 4.48 The Summary panel

Compact Disk (CD)

There is a CD with the toolkit on it for the reader of the thesis to reference.

Online Toolkit

For a limited period of 18 months (Oct 2014 - March 2016), the reader can also choose to review the toolkit online:

http://designbriefingtoolkitv2.businesscatalyst.com/

This alpha prototype has been used for the workshop and evaluation sessions with external partners as described in this thesis. Please note that as a prototype its purpose is to introduce the thinking and navigation behind the toolkit, as well as enabling the reader to view the structure and brief development process. As such it has been built using Adobe MUSE and it is not intended to have all the functionality of a database driven site which would be beyond the scope of this research project.

Recommended Browsers and Screen Resolutions

Mac users should not use Safari for online browsing, but a recent version of Fire Fox.

PC users are recommended to user Fire fox and Google Chrome for browsing the toolkit.

The best screen resolution for the toolkit is: 1680x1050 or higher.

4.2.4 EVALUATIONS

There are three stages to the evaluation process: an 'in-house' evaluation, evaluation with external experts, and then with target companies.

4.2.4.1 IN-HOUSE EVALUATION

The in-house evaluation took place towards the end of the development, and tested the toolkit using data from an existing home healthcare product that was explored during the workplace research (See the fictitious brief in Appendix J). This was to ascertain whether all the information required to create a brief is included in the Toolkit, and to assess whether each stage is presented in a logical order.

4.2.4.2 EVALUATION WITH EXTERNAL EXPERTS

The expert evaluations had a design-oriented focus and looked at the user interface, user interaction, structure, functions, and feasibility under their current company procedures. The primary purpose was to define areas for further improvement.

Interviews were conducted individually with 5 experts in product innovation management, quality management, and academic writing (Figure 4.49), to obtain feedback from various disciplines related to brief creation and application. Individual interviews allow for detailed communication with each interviewee, and provide rich and tacit feedback.

Participants	Background	Format
Expert 1	Post – doctoral researcher in innovation management	Via Skype
Expert 2	Senior Project Manager of a leading automotive manufacturer	Face-to-face
Expert 3	Professor of automotive reliability engineering; Director in quality improvement	Via Skype
Expert 4	Academic support advisor at a British university[1]	Face-to-face
Expert 5	Associate dean of research & enterprise at a British university	Face-to-face

Figure 4.49 Interview participants

Each session was approximately two hours. It was divided into three stages: introduction of the project context (15 minutes); presentation of the toolkit prototype (45 minutes); discussion and questions (1 hour). The sessions were either face-to-face or via Skype, or by email correspondence. Each interviewee was asked for feedback on the visual design, User-interaction design, the briefing process presented in the toolkit, the ability to create a strong brief, Format and Feasibility.

1. She acted as a participant with the aim of helps to evaluate the readability of the toolkit.

	General impression	Visual design	User interface	User interaction	The proposed briefing process	The "triangle thinking framework"	Aids in creating a strong design brief	Format (Webtool)	Feasibility
Expert 1	2	2	1	1	1	1	1	2	2
Expert 2	1	2	1	2	1	2	2	1	0
Expert 3	1	2	1	2	1	1	1	0	1
Expert 4	1	1	2	1	2	1	1	1	1
Expert 5	1	1	1	2	1	1	2	1	1
Meanvalue	1.2	1.6	1.2	1.6	1.2	1.2	1.4	1	1

Figure 4.50 Summary of evaluation results

Figure 4.50 sets out the results of the evaluation (See Appendix K in detail). In general the toolkit received very positive responses from all of the interviewees - the average score for each considerations/item in the chart is equal to or above 1.0 (Good). They were pleased with the proposed briefing approaches and principles, as well as the visual and interactive design. The doubts were only about feasibility and the webtool format. They also provide valuable comments for further improvement, for example:

> *'… I suggest improving the connections, the links between the process and the methods bank. This way, people will see the methods bank part as a set supporting research. However, keep method bank as a separate section without a complete integration of both. If you embed the methods bank in the process, the user might not be aware of its importance as a stream in researching the problem ….'*
>
> *'… Integrate the tool into a company's management system ….'*
>
> *'… Users would benefit from jumping directly to the briefing part, without having to go through the theory…'*

Improvement

Addressing the comments received from the evaluation with experts, improvements were

made in many different aspects, for example, some visual elements were either repositioned or redesigned; ‘see more details’ buttons were added to different sections to build a tighter link between coaching function and the brief creation function; and a formal home page (Figure 4.52) was created to replace the menu (Figure 4.51) which was integrated in the front page.

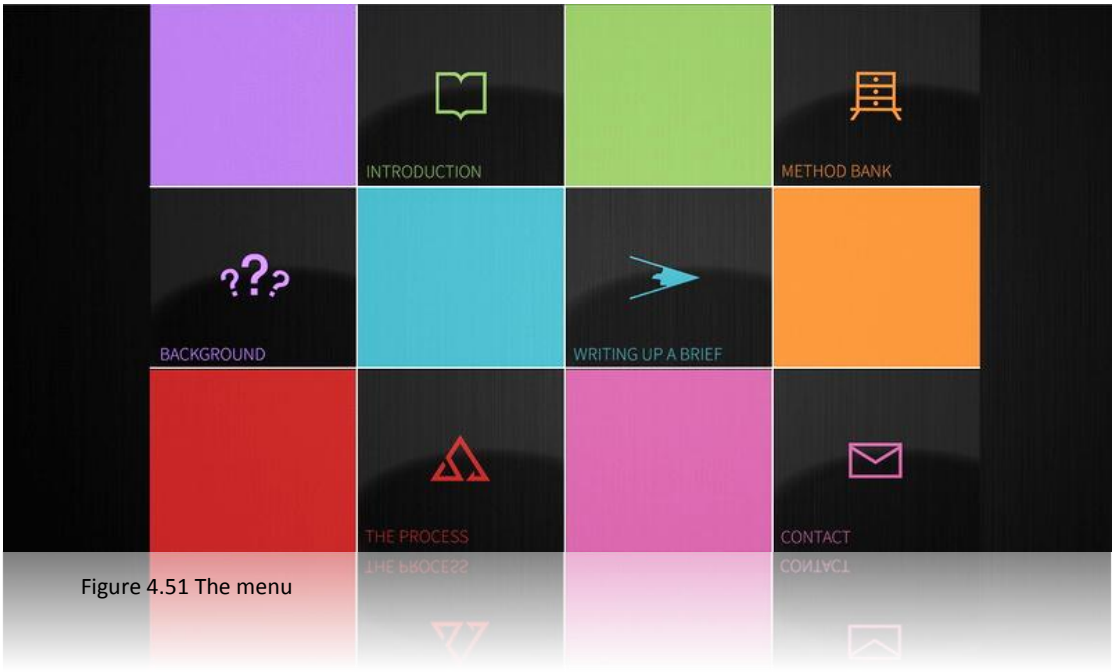


Figure 4.51 The menu

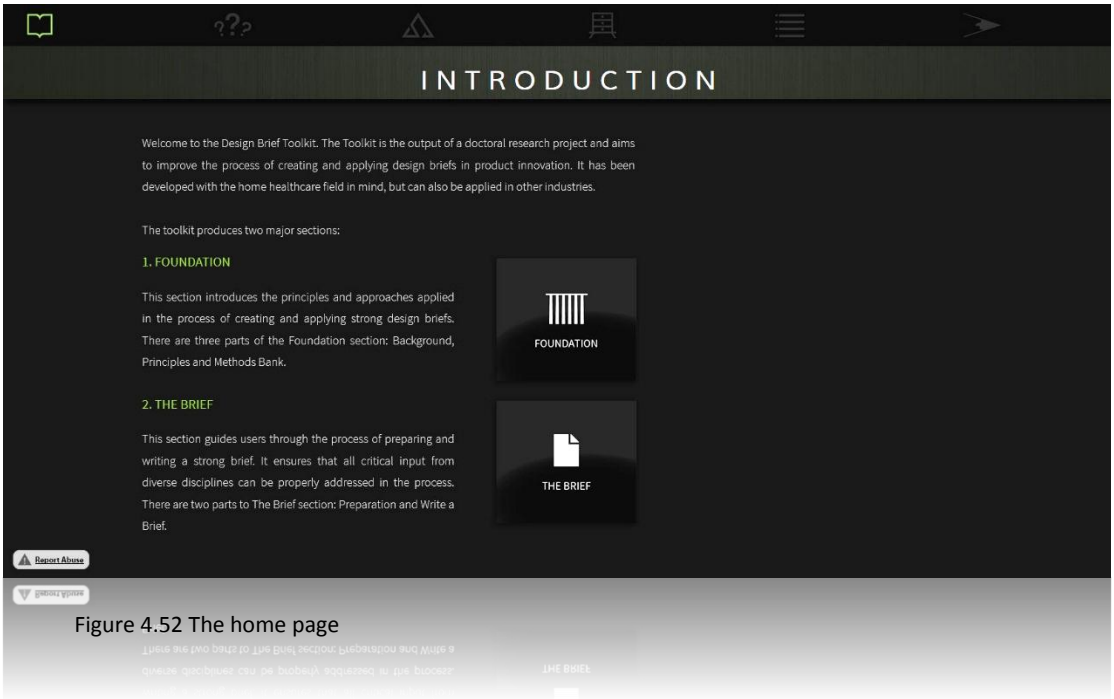


Figure 4.52 The home page

4.2.4.3 EVALUATION WITH TARGET COMPANIES

The optimised toolkit was then tested in a workshop with representatives from 4 small and

medium-sized home healthcare product suppliers based in or close to Cornwall, who are the main target audience of the toolkit and the research focus of this study (Participants 2 – 5 in Figure 4.53). It was also tested with a senior project manager from a leading automotive manufacturer who participated in the previous round evaluation (Participant 1), considering the expected users include companies of other types and from other industries. This was also to assess the improvements on the older version toolkit.

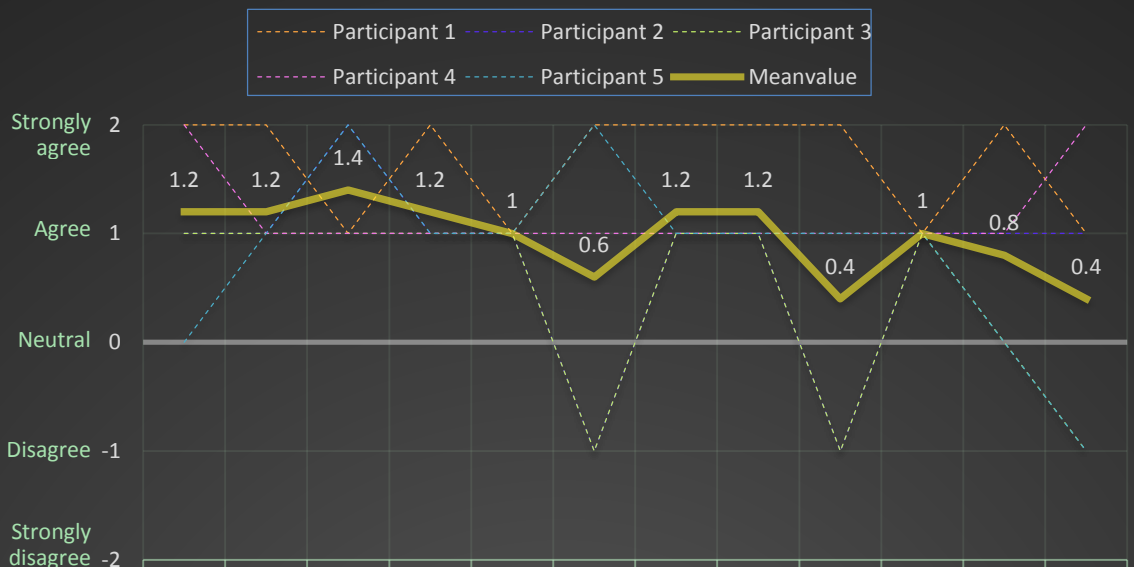
Participant	Responsibility
Participant 1	Senior project manager of a leading automotive manufacturer
Participant 2	Senior product manager in a home healthcare product supplier
Participant 3	Product development director in a home healthcare product supplier
Participant 4	Hydration nurse of peninsula community health (She participates in product development for patients with long term conditions)
Participant 5	Business development manager of a healthcare product supplier

Figure 4.53 The workshop participants

Summary of results

The workshop took around 2.5 hours, during which I first demonstrated the toolkit, then had a discussion with each participant on its visual design, functionality and feasibility. After the workshop, the participants were requested to fill out a questionnaire. The completed questionnaires with comments are available in Appendix L. The feedback has been outlined in Figure 4.54.

All workshop participants either agree or strongly agree with the design briefing process and its associated approaches promoted in the toolkit. Their views diverged most sharply on the design of the interface and on its applicability for current company procedures - 2 of the 5 participants are very much in favour of these items, while 2 of the remaining 3 were not convinced. Fortunately, the average score on each item/consideration is above 0 (the yellow line), and the mean value of the average scores on all items is 1.0 (Agree), which shows that the companies which took part in the test are inclined to accept the toolkit.

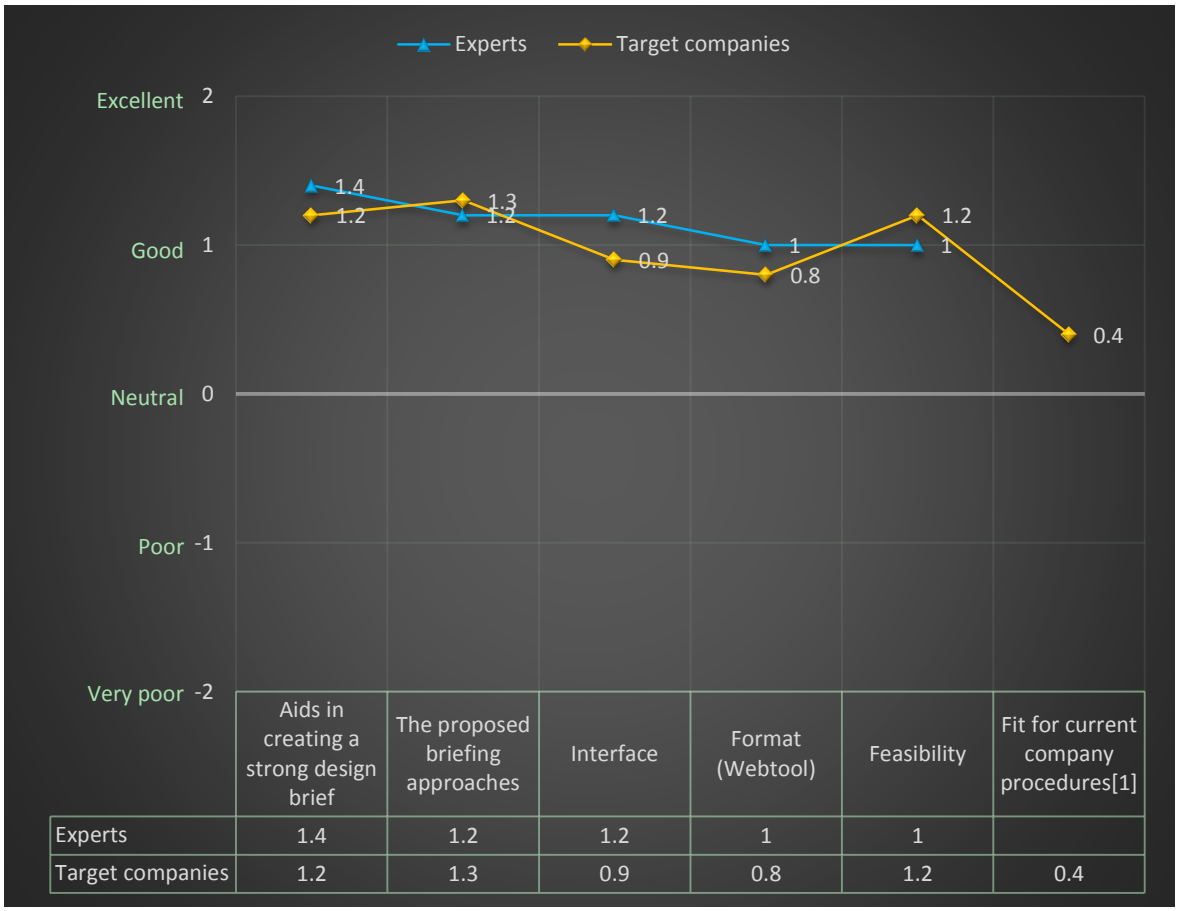


	Q. 1	Q. 2	Q. 3	Q. 4	Q. 5	Q. 6	Q. 7	Q. 8	Q. 9	Q. 10	Q. 11	Q. 12
Participant 1	2	2	1	2	1	2	2	2	2	1	2	1
Participant 2	1	1	2	1	1	-1	1	1	-1	1	1	1
Participant 3	1	1	1	1	1	-1	1	1	-1	1	0	-1
Participant 4	2	1	1	1	1	1	1	1	1	1	1	2
Participant 5	0	1	2	1	1	2	1	1	1	1	0	-1
Meanvalue	1.2	1.2	1.4	1.2	1	0.6	1.2	1.2	0.4	1	0.8	0.4

Q. 1	In general, the toolkit has real value to companies in the new product development process.
Q. 2	There are clear opportunities to use the toolkit specifically related to our work, which would improve our NPD process.
Q. 3	The proposed four-step design briefing process is clear and beneficial.
Q. 4	The 'two triangle process model' is helpful to the briefing process
Q. 5	The 'thinking model'
Q. 6	The toolkit interface is clear (after a short introduction).
Q. 7	The toolkit process and structure for writing a brief is in a logical order.
Q. 8	The interface icons have clear meaning
Q. 9	The colours used in the interface are sympathetic to the user and aid navigation.
Q. 10	The toolkit interface can be improved
Q. 11	The toolkit is a good format in realising the intended functions?
Q. 12	The toolkit will fit well into current company procedures?

Figure 4.54 A review of answers the workshop results

A comparison of the results of the two tests



	Aids in creating a strong design brief	The proposed briefing approaches	Interface	Format (Webtool)	Feasibility	Fit for current company procedures[1]
Experts	1.4	1.2	1.2	1	1	
Target companies	1.2	1.3	0.9	0.8	1.2	0.4

Figure 4.55 A review of answers the workshop results

The questions discussed in the two evaluations have been summarized into 5 categories for consideration: Aids in creating a strong design brief; the proposed briefing approaches; interface; format; and feasibility.

Figure 4.55 sets out the similarities and differences between the average scores on each the five categories, received from the two groups. This diagram concludes that:

- First of all, all the of research participants believe that the toolkit can realise its primary function, which is to aid companies in creating a strong design brief.
- The company representatives are more positive than the experts in the academic fields, on the feasibility of the toolkit. However, the former were not fully convinced that the toolkit can be easily integrated into their current company procedures.
- Most of the participants of the two evaluations liked the user interface design. Company representatives tended to consider more from an operations perspective. Some of them have worries that some visual elements may not facilitate day-to-day use. For example, a

1. Fit for current procedures/applicability was discussed with the company representatives only.

senior product manager (participant 2 in Figure 4.51) pointed out that the interface colour might not aid navigation while highlighted in an email that he '…Really like the toolkit as it is. Great bit of UI design …' (See the email in Appendix L)

- Overall, the toolkit won approval from the two groups of participants.

4.2.5 LIMITATIONS OF THE EVALUATIONS

As a practice based PhD the evaluation stage was reliant upon having a convincing and working software prototype. The design and development time to realise the software was demanding and evaluation of its usefulness had to come at the end of the research study when the online tool was at a presentable state for testing purposes.

Nevertheless, there were three rounds of evaluation. An in-house evaluation and an evaluation with external experts was carried out mainly to support the on-going development of the toolkit. A final workshop evaluation was held with representatives from companies in the sector. Only 5 companies took part in evaluating the final toolkit, which was not enough to represent the industry. The workshop was a controlled session and a limitation of the evaluation of the current toolkit is that it has not been validated in a real world situation. This is the major limitation of the evaluation.

The 'evaluation with experts' showed that the toolkit might also be effective in large companies though it was developed with particular attention to the needs of SMEs. It was regretful that no large company was available to participate in evaluating the final toolkit.

Despite the limitations, the evaluation demonstrated that the design briefing toolkit strongly interests HHCP suppliers. It also provided firm foundation for ongoing studies.

Beyond this study, the toolkit could be further tested by companies of various types in daily NPD practices. This target group include not only SMEs and large suppliers in the HHCP sector but also companies in other industries. Within individual companies, the toolkit should be used in both projects of designing new product solutions and in projects of optimising existing ones. It is also worthwhile to explore the potential of the toolkit in other design fields such as service design, interaction design and graphic design.

During the procedures, I should be present to support the use of the toolkit, to fix potential technical issues and to discover drawbacks for improvement. Besides, support from experts in software engineering, interface designs and UX designs is substantial enough to improve the performance of the toolkit and to transfer it into a ready-to-market solution.

5 CONCLUSION

5.1 REFLECTION ON RESEARCH OBJECTIVES

There are four major objectives in this study (See Chapter 1.2):

1. To explore the appropriateness of UCD methods for all stakeholders of the HHCP in question, with the aim of improving the design of HHCPs

Research on UCD methods was carried out via desktop research and as company case studies. The significance of UCD in HHCP development was demonstrated through analysing the reality of the HHCP industry. Popular UCD methods were evaluated during the field trial of a new product of the 'company partner'. They were compared in terms of application, output, time cost, expertise, sample size and control level (Refer to Chapter 3.4.5), with particular attention to the features of small and medium sized suppliers dominating the HHCP sector.

2. To gain a general insight of the HHCP industry, such as the product suppliers' type, size, motivation and development trend, with particular attention to Cornwall

This study shows that the home healthcare sector is experiencing fast growth, whilst the potential for error and the accidents that may result is ever present. HHCPs, as one major component of the HHC system can be improved in terms of product usability and user safety (Refer to Chapter 2.2).

Cornish social context, demography, and health and well-being make the area an excellent testing area for this research (Refer to Chapter 2.3).

3. To understand the real situation of HHCP development, to identify the root causes of the poor performance of HHCPs on the market, and to unveil the opportunities for improvement

It has been found in this study that the poor performance of many existing HHCPs was related to various factors in the fuzzy front end stage of a project cycle such as information management, user engagement and the control of the development process, apart from the common absence of effective user input (Refer to Chapters 1.3 & 3.4).

To improve the whole, this paper proposes strategies which improve the final product solution by addressing five key factors: research-based consensus and understanding, transparency, presentation and access, and centralized management (Refer to Chapter 3.4). It further concludes that an effective process of generating design briefs is highly effective in driving the adoption of the proposals and at minimum cost.

4. To generate effective and feasible solutions for the key problem areas, and to evaluate the solutions generated in the research

The design brief has a critical influence on the design outcomes yet is undervalued and even ignored in many NPD cases. As well as the brief itself, its initiating process is related to various key factors in the NPD process and hence provides an opportunity to improve the whole (Refer to Chapter 3.4.7). Based on this understanding, a new approach to creating design briefs was developed in this study, to realise safer and more user centred HHCPs for patients and carers as well as to improve business efficiency (Refer to Chapter 4.1). This new approach was tested by experts from academia and industry (Refer to Chapter 4.1.4).

A lot of effort was invested in transferring the proposals into a working tool. The outcome is the online toolkit that manages the development of a robust design brief and clearly communicates the key information to stakeholders.

This toolkit has the tutorial function which communicates the proposals to users, and the brief writing function which creates ready to use briefs. The testing of the toolkit received very positive feedback, but the evaluation was not fully completed to the point of statistical significance (Refer to Chapter 5.3).

5.2 CONTRIBUTION TO KNOWLEDGE

To improve HHCP product development outcomes, this thesis examined design issues from the new perspective of business management. It focuses on generating a cost effective implementation strategy, to drive the adoption of existing research and design methods and principles.

To design and project management theories

Specifically, Chapters 2.2 and 3.2.4 reviews the existing knowledge and practices related to healthcare product design, such as the user-centred design theories (e.g., Norman 1986, Glen 1994, Shneiderman 2000, Rodríguez et al. 2006, Rodriguez et al. 2007, Stappers & Szita 2009, Lang et al. 2013, IEC 62366:2007, ISO 2007, ISO 9241-11:1998 and ISO 9241-210:2010), and the popular NPD approaches, such as the Stage-Gate® Innovation process and the PACE® method. It concludes that these existing standards and methods are not sufficient to result in high quality HHCPs since they are not specific to complex HHCP development, do not provide appropriate details to guide specific NPD activities in projects of various types, and rarely provide a holistic solution which addresses broad considerations such as efficiency and cost. This finding led to the workplace study which further explored the issues that hindered companies in the sector from carrying out successful product innovations (Refer to Chapter 3.3).

The workplace study revealed that the FFE stage of the overall NPD process gives the greatest opportunity for improving the innovation capacity of HHCP suppliers including the 'company partner' in this study. The identified issues centre in FFE while Chapter 3.2.3 has shown that the performance in this particular stage has a significant influence on NPD success. Unfortunately there is a general lack of specification of the FFE activities. This partly explains why the critical front-end activities of the company partners' NPD projects were found in this study to be often poorly enforced or even missed out, even though that the company partners' principal NPD process was created based on the Stage-gate approach.

In light of the findings from the workplace study, Chapters 3.4 'Lessons Learnt and Identified Issues' proposes detailed strategies guiding the 'company partner' in improving their NPD and management approaches by focusing on the 5 key factors:

1. The generation and management of the NPD process (Chapter 3.4.2)
2. The engagement of stakeholders (Chapter 3.4.3)
3. Design influence in company culture (Chapter 3.4.4)

4. User engagement in the fuzzy front end (Chapter 3.4.5)
5. Data and information management (Chapter 3.4.6)

Each key factor is discussed in an individual chapter. For example, Chapter 3.4.2 'The Generation and Management of the NPD Process' discusses why and how to forge and adopt a formal NPD process. It concludes that the company partner's principal NPD process can be improved by:

- reducing the complexity of the process
- adopting a platform strategy
- placing great emphasis on front-end research
- providing guidance on methods to be applied in research and design
- improving design influence in the process
- assessing the company's NPD process regularly to see whether it fits the current situation.

and leads on to a new FFE process model (Chapter 3.4.2.3). This new process outlines NPD activities in 3 layers to give a greater control of its performance and also to make it more prescriptive. It was created based on the infrastructure of the company partners' existing NPD process (Chapter 3.3.4) to make it easier to follow.

Following Chapter 3 which concludes that engaging a well-established design briefing process should provide a highly cost-effective approach to improve the whole, Chapter 4 explores how to do so by addressing the characteristics of individual projects, companies and industries.

The final solution was a new process of creating design briefs (Refer to Chapter 4.1.5). This process can bridge common gaps between design and other functions within an NPD team. It solves the problems in both design and business operations. For example, the process determines the participation of all divisions in evaluating design proposals, which both reinforces message synchronization throughout the whole project and meets the requirements of participatory design.

To the industry

This study first reviewed the home healthcare industry and revealed that HHCPs in general needed to be better designed to meet people's real needs, the main cause of which was that SMEs dominating the market neither possessed adequate skills, experience and resources to carry out paramount front-end research, nor were they promoted to do so (Chapters 2–3.1).

To understand the real situation, study was carried out within a carefully selected Telehealth

& Telecare company. It both produced improvement strategies focusing on the issues within this company, and also concluded that engaging a well-established process for creating the design brief was the linchpin for solving the general problems in HHPC innovations.

The significance of the design briefing process and the lack of a design briefing tool led to the creation of the on-line design briefing toolkit. It drives the adoption of the proposed theoretical model and guides users in writing up a robust design brief step-by-step (Refer to Chapter 4.2).

This toolkit provides a cost-effective solution for managing the FFE of the NPD process, which is in general ignored by the existing management tools. It highlights the consideration from the user and the design viewpoints in project planning and management which can spur the generation of innovative and user friendly product solutions. Furthermore, it pays particular attention to the features and needs of SMEs, for example, it provides a method bank to guide those who are not familiar with research methodologies in practice.

The evaluation of the toolkit received positive feedback from product suppliers in both the HHCP field and other industries. It shows that there is value in the further development of the toolkit after the completion of this doctoral research.

5.3 LIMITATION AND FUTURE RESEARCH

Regarding the research process

First of all, the improvement of the NPD process is a complicated topic relating to a large number of factors and involves various disciplines. However, the research data analysis and its interpretation was based on just one researcher, which was likely to lead to bias because of my knowledge background and professional experiences. For example, the importance of the design needs might be over emphasized while much less consideration was given to human resources management and operations.

Secondly, departmental barriers hindered me acquiring some key information during the workplace research. For example, I was not able to get in touch with the company partner's CTO and CEO to validate some hypotheses relevant to board-level strategy, and the design company was not encouraged by some project managers of the 'company partner' to provide comments on issues within specific projects. This information is important in unveiling the reality of HHCP development.

Thirdly, the broad aim and scope of this project revealed complementary strands of meaningful

research, some of which could only be briefly tackled, such as:

- improving information management in SMEs
- creating approaches for effective user research with the presence of neither a researcher nor a designer
- identifying the influence and new requirements resulting from a business strategy change such as providing products and services
- generating criteria for analysing the performance of an NPD process
- designing with patients having long term conditions

Regarding the toolkit for creating a design brief

- The toolkit development was based mainly on analysing the output from one major HHCP product supplier. Unexpected issues may surface when the toolkit is applied in other company environments.
- The toolkit needs further testing by/with product suppliers in day-to-day work. It is believed to be at a stage where it can be improved with their input to make it into a useful and powerful tool. Unfortunately, this could not be realised owning to limitations of resources (Refer to Chapter 4.2.5).
- It can be reinforced with an editable glossary to create a common language shared by users from different disciplines and roles. It has been observed in the evaluation stage that the participants coming from different backgrounds have different understanding of some terms (e.g., Design Specification, Product Strategy and Platform Strategy) currently used in the toolkit.
- More freedom could be given to users, on editing, adding, and deleting items. For example, the checkbox in the 'preparation' section.
- Evaluation participants had very different views on which type of company the toolkit suits best. Some believe that it benefits SMEs or even new entrants of the markets most. However, there were also two experts who pointed out that the toolkit was more helpful for large companies and was easier to be adopted in their practices. Furthermore, the toolkit received very positive feedback from a senior project manager of a large non-medical manufacturer. This may lead in a new direction for future development.

- The interviewed experts and companies were all interested to see other functions being integrated into the toolkit. Thus, it could be expanded for other purposes besides creating a design brief, in future development. For example, it could be built in a modularized fashion to meet different user needs, such as personnel management, financial management and design process management.
- More exploration needs to be conducted on how different companies can easily adopt the toolkit to their present NPD procedures. For example, whether integrating the toolkit as part of a company's existing management system can improve work efficiency rather than using a separate package?
- The toolkit was built independently by the researcher to demonstrate the thinking behind the toolkit and its potential. It is not fully functional in its present state, for example, a server is required for storing data. To bring the toolkit onto the market, support from experts in computer engineering is also needed, for solving a few technical issues and coding the toolkit in a format suitable for delivery in a business context.
- The design briefing toolkit created in this study provides an excellent starting point for the next stage of development which is to test the toolkit in various types of NPD projects in companies having different characteristics, and then to further improve the toolkit with the purpose of brining it onto the market.

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