Design-led future forecasting model for mobile communications

A thesis submitted for the degree of Doctor of Philosophy

By

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Abstract

Since the establishment of the wireless sector, design has been playing a wide range of roles. Specialized literature has been extensively reporting the use of this discipline associated with NPD, focusing on hardware and software development in the mobile communications. On the other hand, evidences of its use to support forecasting are scarce and generic. Finally, formal publications addressing future forecasting from a design perspective in the context of mobile communications have never been reported, leading to a knowledge gap that needs to be addressed.

This research investigates the strategic roles, applications and contributions of design and designers for future forecasting in the wireless telecom sector. As a comprehensive discipline, it is used to examine and identify a number of factors that might influence/impact in the development of visionary solutions supporting the design team of traditional handset manufacturers to make better decisions in order to 'shape' the future in the wireless industry. Considering these ideas, the aim of this research is to create a 'design-led future forecasting model for mobile communications' to assist and support traditional manufacturers' design team.

This PhD study relies on a qualitative methodology comprising a number of data collection and analysis tools (e.g. literature review, case studies analysis, in-depth experts' interviews, workshops and Grounded Theory). To create the intended framework, extensive secondary and primary data; theoretical and practical inputs were brought together, analysed and combined.

The proposed model was evaluated through two rounds of experts' interviews complemented by two workshops with potential users (e.g. design students) to check and explore its practicalities when applied to design for the future.

Finally, this study bridges future forecasting and the wireless telecom through the use of design to address the literature gap. The richness of the developed model provides practical assistance to traditional manufacturer's design team informing about a broad spectrum of aspects that should be considered when designing for the future in the mobile telecom industry, supporting strategic decision making in different stages of the future-led design process.

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'The best way to predict your future is to create it'
(Abraham Lincoln, 1809-1865)

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1 Introduction

1.1 Introduction

The Introduction is the first chapter (out of eight in total) that this research report comprises. It is divided in three parts. The first section introduces an overview of the changes occurring in the wireless telecom industry since its pre-internet period until the present days, highlighting the collapse of traditional manufacturers and the rise of new players. Next, the motivations and reasons for conducting this study are discussed alongside with the research aim, objectives, research scope and its main beneficiaries. Finally, a brief outline of this research is presented underlining the issues and topics covered in each of the eight chapters.

1.2 Prelude of changes in the wireless telecom sector

The establishment of the wireless communications sector can be traced back to 1984 when the first mobile handset, the DynaTAC 8000x model was introduced in the market by the American firm Motorola. (Motorola, 2012; Motorola, 2014).

Despite of being a pioneer in this new industry through the creation a unique product for that period of time, Motorola did not capitalize immediately on its outstanding invention. The reasons behind this fact are related to a combination of factors. Firstly, a series of strict policies with respect to mobile telecom sector issued by local governments, characterizing a monopolist approach (Steinbock, 2003). After that, the lack of an efficient wireless signal infrastructure resulting in extremely limited service availability. Finally, the market segmentation for this type of solution limited to a wealthy niche of consumers that could pay a high price for this novelty (Steinbok, 2003; Peppard and Rylander, 2006).

Although Motorola was the first company to produce and launch a mobile phone placing the foundations of this industry; it was the Finnish company, Nokia, that established itself as the major player in this dynamic business sector. After almost 15 years and several dramatic changes in the wireless landscape, Nokia became

the biggest handset manufacturer in the world in 1998. At that particular year, this firm sold an extraordinary number of nearly 41 million mobile phones across 130 countries worldwide. These extraordinary figures led Nokia to become the market leader regarding mobile handsets and operating system (e.g. Symbian) (Steinbok, 2001; Nokia Annual Report, 1998).

A number of aspects supported Nokia's telecom business successful expansion around the globe. For example, its heavy investments in overseas R&D (Research and Development) centres that assisted the company to start operating in international markets; the establishment of strategic partnerships with firms within and outside the wireless sector such as Ericsson and Sony; the development of an unique and comprehensive market segmentation considering different attributes ranging from social up to financial factors and the progressive integration and use of design as a competitive asset to create ground breaking products (particularly concerning form factor and materials) to address specific market niches and their requirements (Steinbok, 2001; Steinbock, 2005)

In addition, in that particular year (1998), Matti Alahuhta, president of Nokia´s mobile phone division, pointed out that 'we are rapidly proceeding towards the era of a wireless information society. It all begin with technology based on human needs, solutions functioning seamlessly together and people being able to be connected whenever and wherever' (Nokia Annual Report, 1998).

Based on his statement, it is possible to deduce some possible future directions of the mobile telecom sector. First of all, a 'wireless information society' can be associated with an unprecedented information exchange facilitated by innovative technologies that allow people to inform and also be informed in non-traditional and more convenient ways (for example, virtual and intangible media platforms). Next, by 'being able to be connected 'whenever and wherever', users will be able to reach each other without being limited to space or time, enabling wireless communications (both voice and data) being ubiquitous.

Therefore, as the internet establishes itself as a robust public platform, it started gaining momentum and progressively has been integrated into the mobile telecom sector. At that time, the 'mobile internet' was already regarded as an issue with great potential to transform the wireless industry. However, it was premature to

clearly define the scope of its impact and realise its potential in this developing business area.

1.3 The (digital) revolution in the wireless sector

Almost one decade later, in 2007, Apple, a firm originally from the computing industry, launched a new product named ‘iPhone’ to compete in the wireless industry. Combining different technologies, this innovative gadget drove users’ experience to a new level, promoting a revolution in the mobile telecom sector. In terms of hardware, the iPhone displayed a full touch screen interface, no physical buttons, digital camera and powerful wireless internet protocols enabling users to always be ‘online’. Moreover, the handset runs Apple’s proprietary operating system (iOS) that was fully integrated with other exclusive services such as iTunes and App Store, where users could buy multimedia content (e.g. music and movies) and mobile apps, respectively (Mickalowski et al., 2008; Want, 2010).

In comparison to other handsets produced by traditional manufacturers (e.g. Nokia, Motorola and Samsung), the iPhone was far beyond its competitors in terms of embedded resources and performance, at that time.

After the introduction of this innovative device in the market in the end of 2000’s, the wireless industry witnessed a progressive penetration of firms from different business areas, particularly from the computing sector.

Another example of new entrant is Google. The American corporation known by its online search engine (www.google.com), is a software based firm that also ventured in the expanding mobile telecom industry following a different strategy: it launched a mobile operating system (OS) called ‘Android’, based on the open source platform, Linux (Butler, 2011). Through a number of partnerships with several manufacturers, Google has been distributing Android through a wide range of handset models, covering a broad spectrum of the market. In addition, this platform is also linked to an exclusive online service, named ‘Play Store’ that offers multimedia content and apps for Android phone users (working in the same way as Apple services) (Holzer and Ondrus, 2011).

Fig. 1.1 - iPhone (first model) (left) and HTC Dream, first device running Android (right)

The previous examples highlighted opposite business approaches employed by these two firms originally operating in the same industry (computing) to explore emerging opportunities in the wireless sector. While Apple achieved tremendous success almost immediately after the iPhone´s market release; Google struggled to gain *momentum* with its Android OS. Nevertheless, through time, both strategies proved to be efficient to take advantage of the expanding mobile internet, leading these firms to set new competition standards in the dynamic mobile telecom business.

1.4 The current wireless landscape

1.4.1 From handset manufacturers' oriented perspective

Less than a decade after the entrance of global software based corporations, Apple, Google and Microsoft, in the mobile telecommunications, this sector has been dominated by these companies supported by innovative products and services.

The following tables display evidences highlighting the strong power of these firms in the current wireless scenario.

Table 1.1 - Mobile operating system (OS) market share (Gartner, 2013)

Operating System	3Q13 Units	3Q13 Market Share (%)	3Q12 Units	3Q12 Market Share (%)
Android	205,022.7	81.9	124,552.3	72.6
iOS	30,330.0	12.1	24,620.3	14.3
Microsoft	8,912.3	3.6	3,993.6	2.3
BlackBerry	4,400.7	1.8	8,946.8	5.2
Bada	633.3	0.3	4,454.7	2.6
Symbian	457.5	0.2	4,401.3	2.6
Others	475.2	0.2	683.7	0.4
Total	**250,231.7**	**100.0**	**171,652.7**	**100.0**

In terms of mobile operating system (OS), the three major firms originally from the computing industry present an unrivalled dominance. Android dramatically improved its market participation and currently it accounts for more than 4/5 of mobile OS total share. Together, Google alongside with Apple and Microsoft hold more than 97% of all mobile software market shares through Android, iOS and Windows Mobile, respectively.

Table 1.2 – Mobile phone manufacturers' market share (Gartner, 2013)

Company	3Q13 Units	3Q13 Market Share (%)	3Q12 Units	3Q12 Market Share (%)
Samsung	80,356.8	32.1	55,054.2	32.1
Apple	30,330.0	12.1	24,620.3	14.3
Lenovo	12,882.0	5.1	6,981.0	4.1
LG Electronics	12,055.4	4.8	6,986.1	4.1
Huawei	11665.7	4.7	7,804.3	4.5
Others	102941.8	41.1	70206.8	40.9
Total	**250,231.7**	**100.0**	**171,652.7**	**100.0**

Considering a manufacturer point of view, the Korean company, Samsung, is the current leader in handset sales with nearly 1/3 of total market share. After that, the computing firm, Apple, appears in second position with 12% of total share. An important factor is that Apple relies only in one product, the iPhone, to compete in the wireless market. Together, Samsung and Apple account for almost 45% of the total handset sales.

Placing these figures in context, Android presents robust market participation due to numberless partnerships established between Google and mobile phone firms,

resulting in a comprehensive distribution of this software through different handset lines and models. Conversely, Samsung ranks first in global handset sales because it works with a wide product portfolio offering solutions extending from low to high end market segments.

Proceeding to a more careful analysis of the information depicted in the previous tables, the most surprising aspects are related to a firm that is barely mentioned in these diagrams, Nokia. To begin with, Symbian, Nokia's flagship mobile software developed with a pool of companies including Sony, Ericsson and Panasonic during the 90's, has been progressively falling behind in terms of competitiveness, year after year. In the current scenario, it has a marginal market presence with only 0.2% of share. Moreover, the Finnish firm is not even placed among the top five global mobile phone manufactures (in sales).

Summing up, Nokia's presence in the wireless telecommunications sector has been exponentially decreasing, year after year. From its supremacy as the biggest player in the market to a position where it struggles to operate and compete, it has been outperformed by the ascension of other manufacturers (such as Samsung) and, particularly, by the entrance of new players from the computing industry, Apple and Google.

1.4.2 From users' experience oriented perspective

During the first years of the mobile telecommunications, when the first handsets were created and wireless signal structure was under construction and expanding, voice was the only service available. Later, during the 90's the introduction of SMS (Short Message Service) enabled users to go one step further in mobile communications (Steinbock, 2003) allowing them to reach their peers by sending 'text messages' through their handsets using 160 characters (maximum). In the beginning, major stakeholders within this sector were sceptical about the adoption and acceptance of this new service (Funk, 2009). Nevertheless, the SMS (also known as 'text message') is still regarded as a prominent communication channel (Constantiou, Dasgaard and Knusten, 2007).

The rise of the internet in the wireless telecom landscape encouraged the entrance of new players particularly from other sectors such as Apple and Google. In order to take advantage of the internet expansion, these companies created innovative strategies, handsets and related services to address emerging opportunities. These products drove competition to a level beyond, leading software based firms to dominate this sector, opening new possibilities for mobile phone user experience.

Due to the rapid development of new technologies, a number of resources have been embedded in mobile phones (Stieglitz, 2003). As a result, current handsets are considered converged devices since they integrate different technological features and services (also from different industries) allowing users to access different information resources (Chang, 2009; Rangone and Turcone, 2003). Aligned with these ideas, Sarker and Well (2003) explain that hybrid mobile phones present voice and data capabilities. Finally, this new breed of wireless solutions also known as 'smart phones' integrate pervasive computing resources, for instance, location-based services and context-aware applications (Want, 2010).

With respect to seniority of the users, the younger segments consider the level of innovation that a product or service offer more important than other factors such as the level of simplicity/difficulty of usage/interaction. On the other hand, users in a more advanced age present a strong preference for products and services whose features are straightforward and practical (Pagani, 2004). For example, handsets' basic services can be used to highlight these facts. While making phone calls is favoured by middle aged users (40-50 years old), particularly workers; the use of SMS ('text message'), is more popular among the young users (18-24 years old), usually students (Constantiou, Dasgaard and Knusten, 2007).

In addition, young consumers tend to use their mobile phones for an extensive variety of activities in comparison to their mature counterparts (Chang, 2009). Apart from traditional services (e.g. phone call and text message), this particular segment is interested in using multimedia features (for example, MP3 players and cameras), internet (e.g. e-mail and online shopping) and entertainment resources (such as offline and online games) (Constantiou, Dasgaard and Knusten, 2007; Chang, 2009).

More than never, the increasing diffusion of high-end mobile phones (e.g. smart phones) is directly related to the usage of different social media platforms (Hutton and Fosdick, 2011). Lee and Cho (2011) reveal that since these devices offer high levels of mobility and interactivity, they influence and contribute to an attitude towards innovation, affecting the use of social network services such as Facebook and Twitter, particularly among youngsters. Furthermore, the interdependence among users of a 'two-way' communications system (e.g. social media) plays a key role regarding the adoption of this type of handsets creating a critical mass of users (Rogers, 1995).

Pagani (2004) argues that as mobile phones become multipurpose devices, users are able to access and enjoy a wide range of services such as voice (phone calls); data (internet); and video (multimedia). Nevertheless, despite of the increasing number of resources offered by a handset, they do not necessarily exploit all of their functionalities (Chang, 2009). The reason behind this fact is that the users' degree of interest is directly related to the degree of knowledge presented about a specific service or feature (Pagani, 2004). In addition, not only the degree of knowledge about a given resource; but also, the lack of skill prevents users to access advanced functions of their devices (for example, camera, mp3 players and internet) (Chang, 2009). These evidences share a relationship (in some extension) with the facts introduced earlier in this section by Pagani (2004) that youngesters are interested and driven by how innovative a product/service is; while mature users prefer simple and practical solutions that do not require too much time and effort to use and master.

Last but not the least, the quality of wireless signal provided (e.g. strength and coverage) and also the type of plan contracted can deliver an impact, facilitating or inhabiting the overall user experience with their handsets. Limited or unreliable network capabilities can prevent them to access services, contributing for reduced sense of freedom and trust (Sarker and Well, 2003). Moreover, handset interaction can be compromised when users have a high-end device (e.g. smart phone) but, use a basic service plan or vice-versa Finally, users that have converged devices (e.g. smart phones) tend to subscribe to premium service plans in order to take full advantage of their mobile phone resources (Chang, 2009).

1.5 Understanding the changes in the mobile telecom sector

Based on the previous evidences, it is possible to say that the current wireless landscape is characterized by high volatility and speedy transformations. Overall, the extension of the changes is massive, delivering huge impacts on the industry's structure; nature of competition and users' experience. In addition, alterations in this sector tend to be particularly abrupt, due to innovative and fast technological developments that play paramount roles shaping this industry.

With respect to the new entrants, software based firms such as Apple, Google and Microsoft, are ruling mobile telecommunications less than a decade after they launched their first product in this sector. As important as highlighting the reasons for their success; it is also necessary to explore and understand the reasons for traditional manufacturers such as Nokia to fail and decline, since all these issues are intimately connected.

Taking Nokia as an example (due to its robust past business performance), some key facts can be introduced. Firstly, Nokia (like other manufactures at that time), presented a heavy engineering-led mindset associated with strong hardware development expertise and constantly seeking for innovation in this area. Next, associated with this corporative philosophy, Nokia underestimated the importance of software and, consequently, the on-going transition from standard to smart phone business (e.g. handset with computing related capabilities). After that, when Apple successfully launched the iPhone in the market, Nokia remained attached to both the power of its brand (linked to innovative hardware design) and the already dated proprietary mobile operating system, Symbian, to attract new consumers. Finally, when the Finnish firm decided to change its strategy to deal with competitors, Apple and Google (supported by cutting-edge solutions), it already had lost a substantial amount of market share in the mobile telecom sector (Wired, 2012; BBC, 2013; The New Yorker, 2013)

Conversely, Apple and Google have been flourishing in the wireless industry. What are possible factors behind their remarkable success? To begin with, both companies entered in this industry supported by an extensive computing know-how. Apple redefined the concept of a handset with the iPhone, a full touch screen and application-based smart phone running a new type of software (iOS); while

Google, create the Android operating system that rapidly spread in the market embedded in different handsets. At the time, the introduction of these products led to an increasing consumer's demands for smart phones as they opted for 'pocket-sized computers' instead of a 'fancy' hardware with limited internet capacity and resources (Wired, 2012). Therefore, the combination of a different corporative background (e.g. computing-led); innovative technological solutions and ground-breaking business models put an end in those established paradigms of the mobile telecom industry shaping and changing the future of this sector.

The two previous examples depicted the reasons that led these companies to fail (e.g. Nokia) and triumph (e.g. Apple and Google) in the mobile telecom arena, respectively. Taking into account the positions that they occupied in this industry at that particular time, (while Nokia was the market leader; Apple and Google were the new entrants), they selected different strategies to compete. Nokia aimed to hold its market dominance; while Apple and Google took advantage of their background and expertise to create products aligned with the expansion of the internet. Consequently, 'the high-tech era has taught people to expect constant innovation; when companies fall behind, consumers are quick to punish them' (The New Yorker, 2013).

1.6 Addressing the changes in the VUCA world

The mobile telecommunications is a clear example of a very dynamic industry that is in constant transformation. Since the environmental changes are speedy; their impacts cannot always be perceived, measured or forecasted.

According to Johansen (2007), these transformations are a characteristic of the VUCA (an anachronism for Volatility, Uncertainty, Complexity and Ambiguity) world that both companies and consumers live in, today. In order to tackle them, firms should create business approaches aiming to be ahead of competitors, if not at the right time (when their business capabilities become 'aligned' with market opportunities); at least with good timing to gain commercial advantages.

The examples introduced in the last section concerning Nokia and Apple, highlighted the differences regarding corporative culture/mindset and business

strategies that these two companies presented in 2007 (when Nokia was the market leader and Apple, the new entrant). In the first case, Nokia hold strong to its commercial principles without leaving room for flexibility to address emerging changes in the landscape. Furthermore, it witnessed (and apparently ignored for some time) the emergency of the new trends, the entrance of new players in its own industry and waited long time to develop strategies to tackle these issues, losing *momentum* and; therefore, business performance. In opposition, Apple spotted clear market opportunities and was visionary, acting in the right time to explore these landscape phenomena (before its competitors) creating successful and innovative solutions to address them.

Therefore, dealing with the uncertainty, volatility and unpredictability of the future, especially in a sector in continuous renovation, is not an 'exact and precise science' whose requirements lay exclusively on figures and statistical data. In fact, Johansen (2007) points out that to efficiently approach the future or foresight, it is necessary to 'sense' what could happen before it actually takes place in order to identify potential opportunities to innovate. As a result, this process is based on the development of a strategic vision that drives a firm from its current position to where it want to be in the future, supported by distinct milestones and procedures to assist it achieving proposed goals.

1.7 Forecasting and shaping the future: the contributions of design

In the last section (1.6), the need of sensing or foreseeing the transformations before they happen was introduced. In practical terms, this 'expertise' can be associated with techniques employed to investigate, track and indicate possible directions and changes regarding different environmental factors. In that sense, forecasting approaches are used to plot in a future time scale (e.g. days, months or even years), the pace, direction and length of landscape shifts.

Traditionally associated with New Product Development (NPD), particularly concerning new technologies, features and other physical attributes of consumer goods (e.g. shape, size, colours and materials), more than never, design assume new functions to tackle a wider scope of issues across different industries.

Among its several roles, Evans (2011) explains that this discipline is committed with the future. As designers are considered futurists, they take proactive roles to develop new possibilities about how the future might be by carefully planning ahead all the steps and procedures to shape it in a desired and optimistic way (Evans, 2011; Seymour, 2008). To accomplish that, they rely on a number of research methods, including techniques from other fields, for example, social sciences and business (Lunefeld, 2003) to identify and explore several aspects (e.g. environmental phenomena; audience needs; market landscape and experts' opinions) when required. Based on the data collected, designers working in multidisciplinary teams are able to synthesise and analyse these findings and, ultimately, propose directions and potential future scenarios where feasible and innovative solutions can be developed.

Based on exposed evidences, Design can deliver substantial contributions to visualize and create the future yet to come. Furthermore, more than investigating and exploring a broad range of issues in the landscape, designers take one step ahead empathising with the future and working diligently to shape and create it. Since designers are supposed to define the future, they hold an enormous power. Therefore, they should 'wield it' with responsibility, imagination and wisdom (Seymour, 2008)

Finally, despite of the scarce and generic attempts in literature to tackle the wide range of factors and the potential contributions of design and designers to address the future, none of them clearly synthetize in a holistic manner using a graphic approach (such as a model or framework), the numerous applications of design, particularly in the context of the wireless communications.

1.8 Research motivation

The wireless telecom sector has been through dramatic transformations, especially in the last decade. The emergence of the internet associated with the arrival of firms with computing background for example, Apple and Google in this business area, brought serious consequences and impacts particularly for traditional mobile phone corporations such as Nokia and Motorola.

As this industry evolves, the use of design by traditional handset manufactures to address a wide range of issues also increased. Among the several applications of this discipline in mobile telecommunications, those related to the new product development comprising hardware (e.g. materials and new wireless technologies), software (e.g. operating system) and also related services, have been frequently reported in the media and extensively discussed through several academic and business publications (e.g. McCullagh (2006); Steinbock (2005); Mickalowski, *et al.* (2008) and Butler (2011).

As it was introduced and briefly discussed in the last section (1.7.), Design can deliver valuable contributions to firms working in future-led projects. However, the use this discipline to support forecasting activities and engaging with the future in the wireless sector has not been formally reported yet.

In broad perspective, Evans (2003) reveals that there is little or limited information available about the use of Design, its distinct roles and contributions when applied to shape and create the future. The main reason for the lack of publications addressing this particular topic is related to commercial sensitiveness. Design-led firms and consultancies use design discipline as a key business asset for their market operations. As competition is based on the development of unique and proprietary approaches, tailored plans and insightful proposals to address specific business requirements (for example, from a commissioning company to tackle a specific user segment), detailed information describing these procedures and milestones are seldom released to public by these firms.

Therefore, the motivation for this research is two-folded. From an academic point of view, there is a literature gap that leads to a latent need for the development of a formal study that identifies and explores the use of design to support future forecasting approaches, in the context of the wireless sector, identifying and explaining its applications and potential contributions. From a more commercial perspective, companies operating in the wireless telecom industry, particularly traditional handset manufacturers can benefit from a formal piece of research that addresses future forecasting from a design perspective, assisting and supporting them to make better informed decisions in order to compete in a more steady way.

1.9 Aim and objectives

The aim of this research is to develop a design-led future forecasting model for mobile communications. In order to accomplish it, this study presents a set of six key objectives.

• To examine the mobile communications industry in order to identify current players, products, landscape phenomena as well as future design directions.

• To review existing future forecasting theories and frameworks, used by design-led companies.

• To explore the roles of design and the contribution of this discipline to future forecasting

• To identify the key stakeholders' opinions about the use of design, current market issues and future opportunities/challenges in the wireless industry that will influence the creation of new products and services.

• To develop a design-led future forecasting concept framework for mobile communications

• To evaluate the proposed model with key stakeholders.

1.10 Scope and beneficiaries of this research

In order to define the scope of this PhD study, the expected research outcome (e.g. the 'design-led future forecasting model for mobile telecommunications') is used as a main reference point. By clarifying the distinct aspects related to the intended model, it is possible to set the boundaries of this particular study. In this section, the key expressions used to describe, it will be examined to provide a detailed rationale about this study scope.

1.10.1 What ‘design-led’ means?

From a business point of view, design-led corporations embrace design as part of their corporative culture, placing it in the centre of value generation processes to support continuous competitive advantage. First of all, these companies employ design to drive the marketplace and constantly challenge their business practices, revising their products to optimize profits. In addition, they value curiosity to absorb new ideas and possibilities emerging from consumers segments, landscape trends, technologies and new business approaches. They employ non-traditional marketing research techniques including ethnography, observations and in-depth interviews to gather diversified data. Also, these firms use scenarios to visualize concepts of future products and access different aspects that might influence their development as well as final user experience. Last but not the least, design-led companies seek to create better products and improve users’ lives instead of creating ‘me-too’ solutions (Beverland and Farrelly, 2007).

In this PhD research, from an academic point of view, ‘design-led’ means that the study is conducted in the design domain supported by design-related methods to produce and deliver outcomes supported by design approaches. Concerning model development, design is explored considering a strategic perspective (rather than emphasizing its traditional operational applications), supporting future-led process in different ways. For example, as a problem solving approach; as a philosophy or ‘way of thinking’ (e.g. design thinking); investigating and exploring a wide range of topics through data collection (e.g. competitive analyses, ethnography, PEST analysis and Delphi panel) and analysis methods (e.g. personas and scenarios) that lead to the development of innovative propositions and future solutions´ visions.

1.10.2 What ‘future forecasting’ stands for?

As it was described before (in sections 1.6. and 1.7), future forecasting is about scanning/identifying emerging environmental changes and employing a set of procedures to promptly address them in order to obtain business advantage. To accomplish these goals, companies must have a clear idea about where they want to be in the future (e.g. strategic vision). To do so, they should develop a detailed

plan covering the key milestones and related processes to achieve their objectives. These processes should include the use of interdisciplinary research methods from design, social science and business fields, for example. Last but not the least, the use of multidisciplinary teams of professionals (including designers from different backgrounds) is a crucial factor to not only understand the current landscape; but also, to propose innovative future solutions.

Across this study, 'future forecast' is related to examining distinct environmental issues (such as trends in the wireless industry, users' inputs and opportunities in the mobile telecom sector); identifying and categorizing research methods used to address them taking into account different stages of the future-led design process and; finally, exploring and discussing the distinct roles and contributions of design and designers (such as collecting and translating data into actionable insights) for designing for the future in the wireless telecom sector.

1.10.3 The definition of 'model'

According to the Oxford English Dictionary (2014), the word 'model' presents a wide range of definitions. When employed to describe a process (in here, as a 'verb'), it can assume several roles including giving shape; outlining; describing in details; classifying; arranging; and, creating a theory of the structure (of something). In contrast, 'model' is also related to the outcomes of actions (as a 'noun') such as a conceptual or mental representation; abstraction; description and summary of a structure and related factors. Therefore, 'model' is a multifaceted and meaningful term able to describe a broad scope of issues from procedures (as a 'verb') to results (as a 'noun').

In this PhD study, 'model' is directly associated with the creation of a rich and comprehensive graphic representation/platform that takes into account different factors including design as key driver to assist in future-led assignments in the wireless telecom sector.

1.10.4 Scoping the mobile telecommunications

The mobile telecommunications is a multimillion industry that comprises a complex network of companies including handset manufactures, operating system, application developers, service providers, retailers and others. With respect to mobile phone manufacturers, they occupy a very strategic position in the value chain, producing the most tangible (and potentially the most desired) wireless consumers´ solution, handset devices. As it was introduced and discussed earlier in this chapter (in sections 1.4.1 and 1.5), traditional mobile phone manufacturers have been losing power and substantial market share, particularly to software-based firms. Despite the not so favourable current market situation, phone makers still play an important role in this industry producing tiny high-tech devices that, more than never, bridge users to an increasing pool of services, most of them internet related. Thus, taking into account their solid know-how and industrial expertise developed through many years operating in this sector, their capabilities should never be underestimated, even on difficult times.

Considering the transformations in the mobile communications landscape, handset manufacturers are those companies that had to considerably adjust their business strategies to stay competitive in a sector dominated by software based firms. Taking into account the complexity of this industry, this PhD research restricts the scope of wireless telecommunications by focusing only on traditional handset manufacturers that, ultimately, produce the only tangible consumer value along the current value chain, the mobile phone.

1.10.5 Definition, scope and beneficiaries of the 'Design-led future forecasting model for mobile communications'

Considering the exposed facts, the proposed 'Design-led future forecasting model for mobile telecommunications' that this study aims to deliver can be described as a rich, detailed and conceptual graphic representation of a future forecasting process that places Design (as its comprehensive applications) in its core. It focuses on identifying and exploring a wide range of environmental elements, that influence and impact on this type of procedure when conducted in the domains of

the wireless telecommunications. In addition, it displays a number of design related approaches and methods (including their relationships) used not only to investigate the landscape; but also, to propose innovative visions of the future. All these steps and milestones aim to provide assistance to the design team (design managers and designers) of traditional handset manufactures (such as Nokia and Motorola) when engaging in a design-led project towards the future (for example, creating the next generation of mobile handsets).

Last but not the least, an important remark should be made. Through the course of this study the words ‘model’ and ‘framework’ are used as synonyms. Among the definitions that the Oxford English Dictionary (2014) presents to describe ‘framework’ (e.g. ‘structure made of parts joined to form a frame’; ‘underlying structure’ and ‘a conceptual scheme or system’); some of them share similarities with those used to define ‘Model’ (presented above in section 1.10.3). Since both words can be used to describe ‘*a conceptual representation of a structure (or something),’* they have been employed in an interchangeable way to refer to the intended outcome of this study, the ‘design-led future forecasting model for mobile communications’.

1.11 Research outline

In total, this report is divided in eight chapters starting from the introduction of the research topic up to the development of the model and its final considerations. The structure of this thesis and a brief introduction of each chapter are presented in the following pages.

• Chapter 1: Introduction

The introduction chapter starts by presenting a brief review of the transformations in the wireless landscape, from handset manufacturers perspective to the potential reasons for the success of new entrants (e.g. software-based firms) and the plunge of traditional mobile phone corporations (for example, Nokia). Next, strategic and practical approaches for firms to deal with environmental changes are discussed.

After that, the roles of design, its benefits and potential contributions to aid and support companies' future forecasting activities are presented. Subsequently, the motivations for conducting this research as well as its aim, objectives and scope are explained in details. At last, an outline of this PhD report presenting an overview of each chapter's content is introduced.

• Chapter 2: The mobile telecommunications landscape

This chapter covers the mobile telecommunications sector and is divided in three main parts. The first segment introduces the transformations that this industry has been through since its early years until the present days, focusing on background and structural changes that have been shaping and influencing this business area. After that, the second part addresses several environmental phenomena that are occurring nowadays, delivering an impact in the wireless telecommunications. It explores a number of issues ranging from social trends that have been shaping users' behaviours up to new technologies that have been progressively integrated on mobile devices. Finnaly, research question framework depicting possible lines of enquiry for this PhD study is presented in the last section.

• Chapter 3: Design and Future forecasting

Chapter Three discusses the applications, roles and contributions of design for future forecasting. It reviews different perspectives and frameworks about the design process and related aspects. After that, the forecasting topic is introduced and a relationship between this subject and design is presented. Supported by theoretical and practical inputs gained through the analysis of future forecasting approaches and case studies, the contributions of design for these forecasting related activities are exhibited (e.g. key factors, techniques and the roles of designers). At last, the final part of this chapter is dedicated to present and explore a wide range of interdisciplinary methods (from data collection to data analysis) employed by designers (and the design team) when engaging design-led future forecasting assignments.

• Chapter 4: Methodology

Chapter Four addresses research strategies, methodologies and techniques adopted in this PhD study. First of all, it reviews different types of background research strategies encompassing both generic and design related approaches as well as specific methodologies applied in the field of design research that helped to define the scope, characteristics and methodology for this particular study. After that, a relationship between objectives and employed research methods is introduced. Next, the data collection instruments selected for this study (e.g. literature review, case studies and expert's interviews) are presented. Finally, a rationale about the data analysis method used (e.g. Grounded Theory) is discussed and explained.

• Chapter 5: Findings and analysis

Chapter Five presents and analyses the main findings gathered from the primary research (e.g. experts' interviews). Basically, it is divided in two segments. The first part covers the main topics derived from the experts' interviews. For example, the uses and applications of the Design for business; the wireless sector landscape including trends and users' handset experience drivers. In the second part, the information collected is synthesized, analysed and arranged in specific theoretical clusters. This process helped the researcher to have a comprehensive perspective about the evidences collected, establishing new links among the abstractions (and their meanings) within and across the different information groups created.

• Chapter 6: Discussion

The Chapter Six focuses on discussing and integrating the main findings that emerged from the exploratory experts' interviews. Divided in four sections, it starts by exhibiting an overview of the transformations taking place in the wireless industry ranging from structural changes to value delivered to users (e.g. products and services). Next, it introduces the current situation of traditional manufactures in the market, including general strategies employed and emerging opportunities. After that, the contributions of design for business are presented and highlighted.

Finally, the last segment addresses the uses of the design discipline by handset companies including its numberless roles and contributions when employed to design for the future in the wireless sector.

• Chapter 7: Model development and evaluation

Chapter Seven is fully dedicated to explain the milestones related to the creation of the design-led future forecasting model from mobile communications (aim of this study) and its contributions for traditional handset manufacturers. Firstly, it introduces the inspirations, drivers and processes that led to model formulation. Next, model drafts were created and submitted to experts' evaluation through a series of in-depth interviews. The feedback collected assisted the researcher to enhance the developed drafts and also collect any missing information. In order to complement the experts' assessment, the final version of the model was tested by groups of potential users (e.g. design students) aiming to explore its practicalities. The model's final version is a comprehensive and integrated visual map depicting issues and processes that a mobile phone manufacturer's design team should consider when designing for the future in the wireless sector.

• Chapter 8: Conclusions and future work

In this last chapter, an overview of the processes and milestones that this study comprises is introduced. Firstly, the objectives proposed for this research are revised and the processes, actions and instruments employed to tackle them, explained in details. After that, the lines of inquiry (e.g. research questions) are addressed followed by a brief summary of the whole investigation process. Next, the major contributions for body of knowledge that this PhD study delivers are highlighted and discussed. The following section deals with the limitations faced by researcher during the course of this study. Last but not the least, a set of recommendations for potential future researches having this study as a starting point is presented.

2 The mobile telecommunications landscape

2.1 Introduction

Since its establishment, the mobile telecommunications industry is in constant change. From a consumers' point of view, these transformations can be easily observed, since they lead to the creation of new products and market solutions. In the last chapter, the evolution of wireless sector including the emergence of new players, handsets, mobile operating systems and related services was examined.

This chapter is divided in three parts. The first section will explore several factors (ranging from the shifts in the market competition up to the introduction of new business models) that supported the development of the entire wireless industry infrastructure in a local and global perspective. In the second part, a collection of landscape trends (e.g. technological, social and economic phenomena) that have been influencing and shaping the wireless telecom arena will be presented. Finally, based on the previous discussed issues, lines of enquiry for this PhD study (e.g. research questions framework) will be introduced.

2.2 Review of the wireless industry structure

2.2.1 The early years: from local monopolies to open competition

The beginning of the mobile telecommunications industry is dated back to nearly forty years ago when the first mobile phone was created by the American firm, Motorola, in 1973. However, it was only introduced in the market one decade later, in 1984 (Motorola, 2012; Motorola 2014).

Fig. 2.1 - Dr. Martin Cooper, creator of Motorola's first handset (DynaTAC 8000x).

At the time, different geographical markets such as North America (e.g. United States), Western Europe (e.g. United Kingdom and Nordic countries) and Pacific Asia (e.g. Japan) developed independent approaches to expand their local markets. Local governments played significant roles in this process. As regulators, they were responsible for issuing policies to set and manage the evolution of this sector. On the other hand, they (e.g. local authorities) had a strong presence in the market, through the National network providers (e.g. AT&T in United States, British Telecom in United Kingdom & NTT in Japan). Overall, the scenario was the same regardless the geographical cluster. National network providers were the strongest player in the value chain, working together with both public and private firms (e.g. suppliers and manufacturers) to develop their domestic markets (Steinbock, 2003).

Overall, in that particular period, the mobile telecom sector was characterized by strict industry regulations and heavy monopoly where local authorities had a tight control over the supply chains, manufacturers and contractors´ activities affecting in a deep way the relationships between market and customers (Steinbock, 2003).

After a period of time marked by severe market guidelines, the wireless sector went through a progressive deregulation and liberalisation. The national network providers such as AT&T (United States), British Telecom (United Kingdom) and NTT (Japan) had to cope with substantial challenges due to new policies issued to promote competition. Consequently, some players (e.g. AT&T and NTT) faced strong rivalry from private companies emerging in their local markets. In the UK, the impacts of the new laws drove British Telecom towards privatisation, moving it gradually to open market competition (Li and Whalley, 2002).

These new policies offered opportunities for new service providers to enter in the wireless sector. These factors forced National network operators to lose, in some extension, their power. Nonetheless, they still remained strong enough to control and bridge different players across the mobile telecom value chain (Peppard and Rylander, 2006).

In the early 90's, overall market penetration was low since service operators were still installing the network infrastructure and improving connection performance. As a result, handset sales focused on high-end market segments through premium prices in order to recover previous substantial investments. However, revenues were still marginal (Steinbok, 2003; Peppard and Rylander, 2006).

During the 90's, the mobile telecommunications was expanding quickly and an increasing number of companies entered in this business areas (Steinbock, 2001), leading to a reduction in the handsets' retail prices; consequently, attracting more consumers to buy their first device. Aligned with these new market conditions, manufactures changed their business approach moving from traditional volume based sales (e.g. economy of scale) to market segmentation in order to gain competitive advantage over other competitors. Finally, network providers also improved their product portfolio and offered more competitive prices aiming to expand their costumers' base (Peppard and Rylander, 2006).

With respect to industry structure, it remained the same without going through any radical changes. Regardless the nature of players (either manufacturers or service providers), these firms developed their business strategies based on the Value Chain concept. This theory was firstly introduced by Porter (1985) and, basically, deals with the sequence of value-adding activities across the chain within a company. Regarding this definition, several authors (e.g. Funk, 2009; Steinbock, 2003 and Peppard and Rylander, 2006) explain that the wireless industry was based on two semi-independent value chains; one from handset manufactures and the other from service provides. This arrangement was a major characteristic of the wireless communications sector during the 90's worldwide.

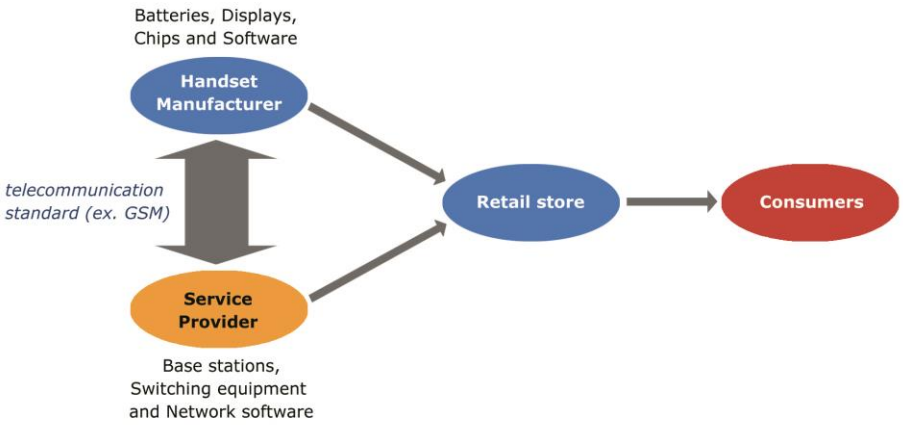


Fig. 2.2 - The 'old' wireless value chain - Developed based on the original model created by Funk (2009) with additional information from Steinbock (2003); Peppard and Rylander, (2006)

The diagram above (Fig. 2.2) is a generic representation of how value is produced and delivered to consumers through the wireless value chain. In addition, it describes the value-adding activities for both handset manufactures (including batteries, displays, chips and software) and service providers (comprising base stations, switching equipment and network software). Finally, it displays the complimentary relationship between these two parts of the telecom value chain.

2.2.2 The emergence of the internet: shifts in the wireless industry

In the late 90's the internet emerged in the mobile telecommunications landscape and promoted a revolution in the entire sector. In the early 2000's, Japanese users already could access their personal e-mail accounts (Funk, 2001) and download mobile content such as screensavers, wallpapers and ringtones that were, basically, used for handset customization (Steinbock, 2001; Funk, 2009).

As the wireless sector expands towards digitalization leading to an unprecedented sector growth, some geographical markets already reached maturity. In these areas (e.g. North America, Western Europe and Pacific Asian), the domestic markets became saturated by the presence of numberless players. In addition, the original consumers' demand moved from new products to replacements (Steinbock, 2001; Steinbock, 2003).

The deregulation of the wireless industry, supported by public policies during the 1990's moved completely this sector from regional monopolies to open global competition (Steinbock, 2003). These legal measures strongly supported not only the entrance of foreigner firms into local markets; but also, the internationalization of corporations such as Nokia. In addition, stakeholders acting in different parts of the wireless value chain (e.g. manufacturers and network providers) established partnerships to offer exclusive deals, services and products for their audience.

At that time, business partnerships were not restricted only to companies offering a complimentary package of services and products to consumers. These ventures also encompassed firms from different backgrounds. For example, the Swedish phone maker Ericsson and the Japanese electronic devices' manufacturer, Sony, collaborated to create the Sony Ericsson brand, aiming to develop an exclusive portfolio of products to compete in the European wireless market (BBC, 2001).

The expansion of the internet in the wireless landscape encouraged the entrance of companies operating in distinct industries (particularly those from computing sector) in this dynamic market (Li and Whalley, 2002). Microsoft was the first firm to enter this industry in the early 2000's developing the first Personal Data Assistant device (PDAs) and smart phones that enabled users to access both phone and computer resources in the same device, on the go (Steinbock, 2005).

In 2007, two other companies also originally from the computing industry, Apple and Google, entered the mobile telecom sector, pursuing different strategies. While the first released a new handset, the iPhone, a full touch screen device embedded with an exclusive mobile platform named iOS linked to Apple's proprietary services (e.g. iTunes and App Store) (Mickalowski et al., 2008; Want, 2010); the latter launched an open source mobile operating system called Android (based on Linux platform) that has been used by distinct handset manufactures in their products (Holzer and Ondrus, 2011) and, due to its scalability, it has been regarded as a 'commodity' software platform for mobile handsets.

Since that period of time, the wireless market has been characterized by high fragmentation levels and an increasing presence of computing based firms (e.g. Apple and Google). In addition, as value produced and delivered to consumers are becoming more 'intangible' (e.g. mobile applications and social media services),

different authors (e.g. Li and Whalley, 2002; Funk, 2009) argue that the Value Chain concept is not suitable to describe the dynamic relationships of the current industry anymore. Therefore, the Value Network concept was introduced in order to explain and describe how value is co-produced by a combination of different companies (Peppard and Rylander, 2006).

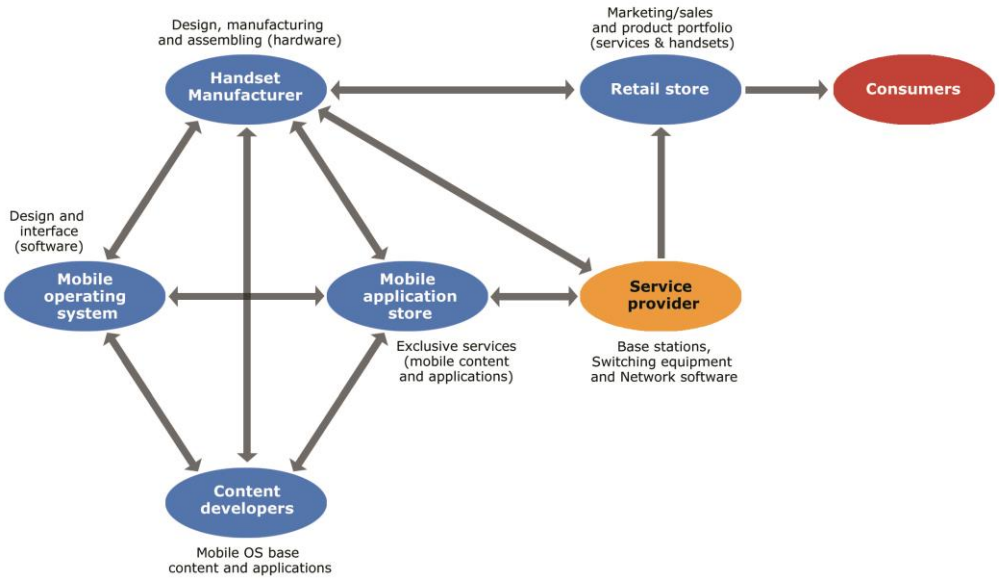


Fig. 2.3 - 'Current Value Network' - Original model developed by the researcher based on information from Funk (2009); Peppard and Rylander (2006); Holzer and Ondrus (2011), inspired by the figures proposed by Funk (2009); Peppard and Rylander (2006)

The previous diagram (figure 2.3) represents a generic wireless telecom Value Network. In comparison to the Value Chain (explained at section 2.2.1), the Value Network is far more complex and comprises more firms. In addition, each 'node' in the Value Network (just like in Value Chain) corresponds to a specific type of player and its value-adding activities (e.g. mobile operating system: software design and interface). However, due to the high fragmentation of the current market, firms are more specialized in terms of products and services developed. Thus, the value generation process can only be achieved and its benefits delivered to end-users through the sum of different stakeholders' business efforts.

2.2.3 The 2000's/2010's wireless sector landscape

In the current stage, the internet already became an established wireless telecom channel. As the demand for this service dramatically increases, experts such as Gartner Research (2011) forecasts that in 2015 there will be 7.4 billion mobile connections, producing $552 billion in revenues.

There are several reasons that contribute for this phenomenon, including the growth of handsets sales worldwide (particularly smart phones) (Jain, 2011); the increasing access to mobile data networks (Gartner, 2011); and, the expansion and usage of social media services (such as Facebook and Twitter) through mobile devices that, according to Mike Short (vice-president of R&D at O2 network provider R&D's vice-president) already overtook fixed line connections (cited in Edwards, 2010).

With respect to the new entrants in the wireless industry, Apple and Google are gaining *momentum* supported by ground-breaking market solutions and innovative design strategies. Consequently, they are successfully expanding their mobile business ecosystems (Gueguen and Isckia, 2011). This commercial approach is a landmark of the current mobile telecom sector, encompassing both traditional handset manufacturers and computing firms.

2.2.4 Summary of findings in this section

The review of the wireless industry structure highlights important milestones that this sector has been through. The shift from local monopolies to the open market global competition and later, the emergence of the internet promoted significant challenges and opportunities for both established companies and new entrants. Moreover, the progressive integration of the World Wide Web in the mobile telecommunications triggered radical changes in this sector. From a commercial point of view, new business model suppressed and replaced outdated approaches (from Value Chain to Value Network). Regarding user experience, 'software' replaced 'hardware' as a key driver for users' handset experience. As a result, the number of firms operating in this market soared and new players (originally from

other sectors, for example, computing industry) such as Apple and Google have been dominating the landscape creating innovative wireless products and services.

Table 2.1 - Overview of major shifts in the mobile telecom sector

	Business model	Competition	Handset (type)	Services	Value (users)
Beginning (1G/2G)	Value Chain	Local	Standard	Voice + SMS	Hardware (mobile phone)
Drivers	INTERNET →	New entrants (e.g. Apple and Google) →		Convergence (industries + technologies) →	Mobile Ecosystems
Current (3G/4G)	Value Network	Global	Smart phone	Internet + Voip	Sotware (Apps + OS)

Taking into account this complex scenario, corporations face a challenging task to plan for future product development. Apart from internal factors (such as budget and technical know-how), more than never, companies also must address several external elements present in this highly networked industry. In this case, new handsets must be conceived to meet and combine existing standards and operating systems, complimentary products and related services. Moreover, instead of just exploring current factors, firms should take a step further and focus on developing new technologies that can be used as a platform for long-term future solutions.

2.3 Current trends in the mobile telecom sector

2.3.1 Trends: definition and key aspects

First of all, there are several definitions for the term ‘trend’. The online version of the Oxford English Dictionary (2011) defines this word as a general course or direction in which something (an action, thought, event or behaviour) is moving developing or changing. On the other hand, the Trendwatching report (2008), presents a more specific view about ‘trend’: ‘a manifestation of something that has unlocked or newly serviced an existing (and hardly ever changing) consumer need, desire, want, or value’. Finally, trends are described as social, emotional and commercial currents that flow through the present to the future (Popcorn, 2009).

Apart from these definitions, there are other key factors about these dynamic manifestations that must be stressed. Firstly, trends are in constant transformation, evolving and gaining momentum over time. During this process, they might stop or change due to the presence of other external factors (such as new technologies, economic downturns, political arrangements and social traditions) forcing them to reshape and re-adapt to new market conditions (Popcorn, 1992). Next, trends are patterns deeply rooted in society (Vejlgaard, 2008). These social manifestations not only shape people lives (due to the complexity and diversity of people needs and requirements); but also, are themselves shaped by individuals responses to them (Popcorn, 2009). Last but not the least, 'trends are never *OR*, they're always *AND*' (Trendwatching, 2009). This means that these events do not occur alone in the consumer arena; they are part of a whole (Popcorn, 1992). Regarding their nature, they are linked to other trends and, often, overlap each other. Thus, they present an inclusive rather than exclusive character.

The chart below exhibits the trends addressed in this study. The trends' list is rather illustrative than exhaustive. In the following pages those phenomena will be introduced and discussed in details.

Table 2.2 - List of trends addressed in this research

1 Convergence	2 New mobile revenue sources: internet & data transaction	3 Social Media & Social Networking	4 Powerful mobile operating system (OS)
10 Cloud Computing	Trends in the wireless sector		5 Mobile business ecosystems
9 LTE: Long Term Evolution	8 AR: Augmented Reality	7 NFC: Near Field Communication	6 Customization

• Key trend 1: Convergence

According to a number of authors (Poole and Simon 1997; Olla and Patel, 2002) the integration of a number of functions in a single product (e.g. mobile handsets) and the combination of traditionally independent customers' services such as data services (internet) and voice communication is a trend already underway.

The following chart exhibits how this trend occurs concerning mobile phones.

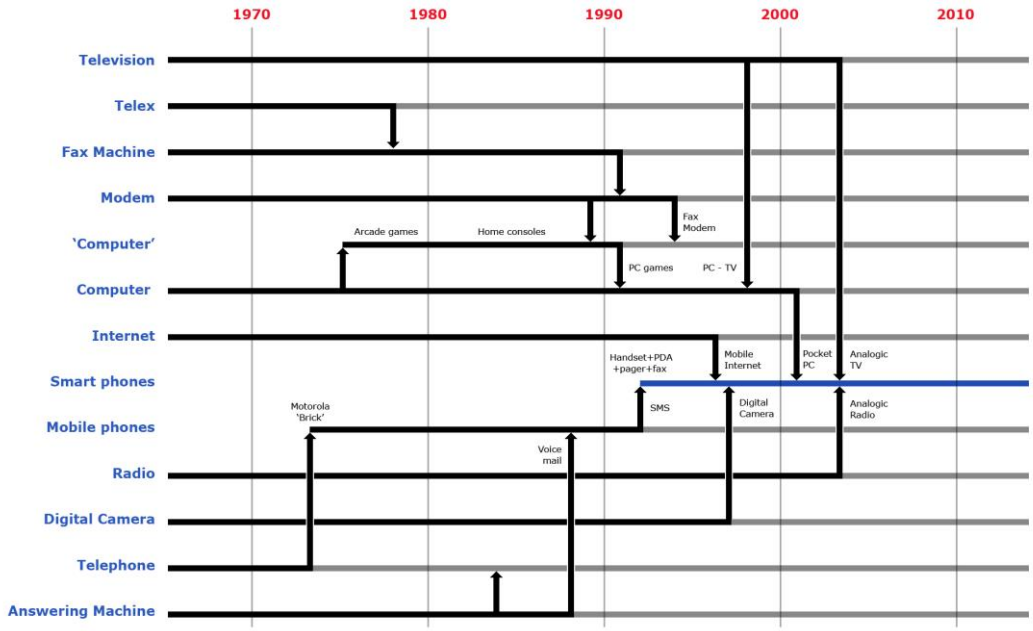


Fig. 2.4 - Convergence (trend) on handsets (based on Poole and Simon, p. 241, 1997).

Basically, Convergence happens in two different levels, industrial (macro) and technological (micro) and also through the combination of these two dimensions, resulting in more complex and sophisticated products. With respect to industrial level (macro), Poole and Simon (1997) explain that telecommunication devices have been incorporating more elements from the computing industry and vice-versa, resulting in multi-functional products. In contrast, at the technological level (micro), 'technology convergence integrates different features and services into one converged device providing the capacity to access different information resources' (Katz, 1996; Rangone and Turcone 2003). In addition, Chang (2009) states that technology and, in particular, the internet eventually evolve towards convergence enabling consumers to use products in completely different ways.

Finally, Steinbok (2005) explains that current mobile handsets (e.g. smart phones) enable users to make phone and video calls with high-quality performance, access internet, send/receive messages, use location-based service, access online content and entertainment services and make financial transactions.

• Key trend 2: New mobile revenue sources: Internet & data transaction

In early 2000's, Anssi Vanjoki, Nokia's Vice President and Multimedia chief (cited in Steinbock, 2005) stated 'we are moving from business of ears to business of eyes'. His statement was clear evidence that mobile telecom industry was going through radical changes and the internet was going to play a key role in these transformations.

Just after the introduction of the internet in the wireless market in the late 1990's, voice and SMS (Short Message services) were still the biggest revenue sources for mobile operators (Steinbock, 2001). This panorama started to change with the introduction and widespread use of new and faster standards (e.g. 3G protocol) that allowed users to access and download larger files such as games, clips and movies (Steinbock, 2001; Olla and Patel, 2002). The expansion of data services resulted in a progressive decline on voice and text message services revenues for network operators (particularly in mature markets), urging these firms to look for new business models to address these changes (Olla and Patel, 2002).

As the number of handset sales increased worldwide (Jain, 2011), the access to mobile internet expanded. According to Qualcomm's CEO, Paul Jacobs (cited in Edwards, 2010), the mobile data traffic already surpassed voice usage worldwide. Moreover, the data traffic generated through mobile services is expected to increase 66-fold from 2008 to 2013 (Cisco, 2009 cited in Trendwatching, 2009).

The current wireless scenario is characterized by a number of internet and data related services that generated $314.7 billion in revenue only in 2011. In addition, these services are expected to grow as mobile networks are getting faster and more ubiquitous. Consequently, the number of users accessing internet related services through their mobile phones will expand at the same time that the amount of data per user will grow (Gartner, 2011).

• Key trend 3: Social Media & Social Networking

Violino (2011) explains that the use of social networking services is becoming more prevalent around the world, regardless the countries´ economic development levels. McCafferty (2011) makes clear that there are numberless reasons for users to engage and use online social tools. For instance, connecting friends (and social activities), writing personal diaries, journalism, financial and business related activities. Moreover, among the internet users worldwide, nearly two-thirds use some kind of social media service and websites such as Facebook and Twitter and the figures continue to grow.

With respect to Facebook, this platform is a good example of a powerful social media service. Alone, it generates the second biggest daily internet data traffic staying behind the search engine website, Google (McCafferty, 2011). According to O2 Vice-President of Research & Development, Mike short (cited on Edwards, 2010), users accessing this platform through mobile handsets already overtook those using a fixed-line to connect it. The following chart displays some examples of social media services and estimated number of users worldwide.

Table 2.3 - Social media and network services (based on Socialnomics, 2011).

facebook	twitter	LinkedIn	foursquare
Social profile service	*Micro blog service*	*Business network service*	*Geotagging/location service*
750.000.000 registered users	*200.000.000 registered users*	*100.000.000 registered users*	*10.000.000 registered users*

As mobile phones achieve high penetration rates worldwide, users are able to enjoy a myriad of benefits through wireless connection (Chang, 2009). In addition, the ‘internet revolution’ associated with the boost of mobile communications are resulting in an remarkable phenomena of networking, socializing, shopping and mingling, characteristics of the current the digital Era (Trendwatching, 2010).

Finally, not only users; but also, private and public institutions in different parts of the world have been using social media services to inform, engage and reach their

audiences. The following chart presents some facts and examples of utilization of these platforms.

Table 2.4 - Examples of social media applications and benefits.

Peer-to-Peer 90% of users trust their friends' recommendations displayed on Facebook. *(Exact Target, 2010 cited on Trendwatching.com report, 'The F-Factor', 2011)*
Business B2C corporations have been using twitter for public relations (PR). In addition they are sending news, starting marketing campaigns and establishing a closer and real-time mass 'conversation' with their customers. *(Trendwatching 'Foreverism' report, 2009).*
Public sector In 2009, the Brazilian Transit Authority started using twitter to update Sao Paulo and Rio de Janeiro motorists and pedestrians about road and traffic conditions. Also, users can share their own experiences about local traffic and transport conditions. *(Trendwatching '10 Crucial consumer trends for 2010' report, 2009).*
Mobile commerce Shopsavvy (for Android phones) and SnapTell (for iPhone) are two mobile applications. While the first allows users to scan the barcode of a product using the phone's camera to find the best deal across 20.000 online and local retailers and after that present the best way to reach the closest store (using Google maps); the later application enables users to take a picture of the product with their mobile phones' camera, upload it in a specific website for reviews, recommendations and best price deals *(Trendwatching 'Nowism' report 2009).*

• Key trend 4: Powerful mobile operating system (OS)

To begin with, an 'operating system' (for mobile phones) can be defined as a software platform in which other programs called 'applications' can run on top of it. Operating systems can be found in several mobile gadgets including mobile phones, smart phones, PDA's and handhelds (Mobileburn, 2009). Examples of different mobile OS include Symbian (Nokia), Windows mobile (Microsoft), iOS (Apple) and Android (Google).

The first mobile operating system that achieved high popularity in market was the 'Symbian'. It was developed by a joint venture of companies including Nokia and Ericsson. At that time, the aim was to offer this software across a wide range of products manufactured by the firms involved in this particular partnership. In addition, Nokia intended to make Symbian an open platform where third party developers could create related applications and also use them in its future mobile services (Nokia and Symbian OS - White Paper, 2002). When the Finnish firm became the global leader in handset sales (40.8 million devices sold in total) in

1998, (Steinbock, 2001; Nokia Annual Report, 1998), Symbian also achieved the top market share in mobile OS utilization worldwide.

Fig. 2.5 - Different versions of Symbian OS on Nokia devices: 8290 (left) and N8 (right)

In the late 2000's, the introduction of the internet on mobile telecommunications sector supported the entrance of new players majorly from the computing sector. Apple launched its flagship handset, the iPhone. This device introduced an unique operating system, iOS, responsible for managing all its functions was considered very intuitive and user friendly (Mickalowski et al., 2008). The iOS state-of-art interface allowed the mobile phone to be fully controlled by users' hands gestures (e.g. sliding to change pages and pinch to zoom in/out). Finally, web browsing was considered smooth and the text entrance was done through a virtual keyboard that appeared on demand. Finally, the link between iOS and Apple's proprietary services, iTunes and the App Store contributed to delivered high standard user experience (Want, 2010).

Fig. 2.6 - iPhone 4S (black and white versions) running iOS (Apple's proprietary OS)

In the same year (2007), another entrant in the wireless sector, Google, adopted a different strategy and release the ‘Android’, a mobile operating system (Google, 2011) based on the open source platform, Linux (Butler, 2011). Google takes the concept of ‘open source’ one step ahead by supporting its community (including firms, partners and developers) to cooperate in order to create new ‘applications’ and code upgrades (Android, 2012). Also, Google allows Android to be used by different firms, particularly in touch screen mobile phones (e.g. smart phones) accessing high speed internet connection to provide cutting edge user experience. Finally, this platform is associated with Google’s online service ‘Play Store’ (former ‘Android Market’) where users can buy exclusive content and ‘apps’ (Holzer and Ondrus, 2011).

Fig. 2.7 - Different mobile phones running Android OS.
From left to right: HTC Sensation XL, Samsung Galaxy SII and LG Optimus 2X.

As the time passes by, Android OS market share is increasing fast due to its high scalability. According to a recent report, Android already passed Apple’s iOS market share. In addition, it presents potential to become the most used mobile platform in the market in the next years (Gartner, 2010).

Table 2.5 - Forecast for mobile OS market share distribution (Gartner, 2010).

OS	2009	2010	2011	2014
Symbian	80,876.3	107,662.4	141,278.6	264,351.8
Market Share (%)	46.9	40.1	34.2	30.2
Android	6,798.4	47,462.1	91,937.7	259,306.4
Market Share (%)	3.9	17.7	22.2	29.6
Research In Motion	34,346.8	46,922.9	62,198.2	102,579.5
Market Share (%)	19.9	17.5	15.0	11.7
iOS	24,889.8	41,461.8	70,740.0	130,393.0
Market Share (%)	14.4	15.4	17.1	14.9
Windows Phone	15,031.1	12,686.5	21,308.8	34,490.2
Market Share (%)	8.7	4.7	5.2	3.9
Other Operating Systems	10,431.9	12,588.1	26,017.3	84,452.9
Market Share (%)	6.1	4.7	6.3	9.6
Total Market	**172,374.3**	**268,783.7**	**413,480.5**	**875,573.8**

• Key trend 5: Mobile business ecosystems

First of all, the Oxford Dictionary (2012) describes the term 'ecosystem' as 'a biological system composed of all the organisms found in a particular physical environment, interacting with it and with each other'. Considering a commercial point of view, Teece (2007) explains that a 'business ecosystem' is a 'community of organizations, institutions, and individuals that impact the enterprise and the enterprise's customers and suppliers. Applying these concepts in the context of the high fragmented wireless market, a *mobile business ecosystem* can be used to describe the complex relationships among different stakeholders in this sector and their impacts on companies and their customers.

In order to describe this concept, Apple and Google were selected as examples due to their remarkable innovative solutions and progressive market dominance. Moreover, despite of following distinct strategies towards their mobile business ecosystems, they present some similarities.

In 2007, both Apple and Google entered the wireless market. The first company released a mobile phone, iPhone, running an exclusive operating system (iOS) (Mickalowski et al., 2008). In contrast, the latter introduced its flagship mobile platform, Android (Google, 2011) based on Linux open source software (Butler, 2011) that has been used by a number of manufacturers in their products since

Google does not create its own mobile handset devices (Holzer and Ondrus, 2011). Furthermore, the iPhone is completely supported by Apple's exclusive services, iTunes and App Store (Want, 2010). In similar way, Google created the 'Android Market' (recently rebranded as 'Play Store') to offer content for Android phone users (Holzer and Ondrus, 2011).

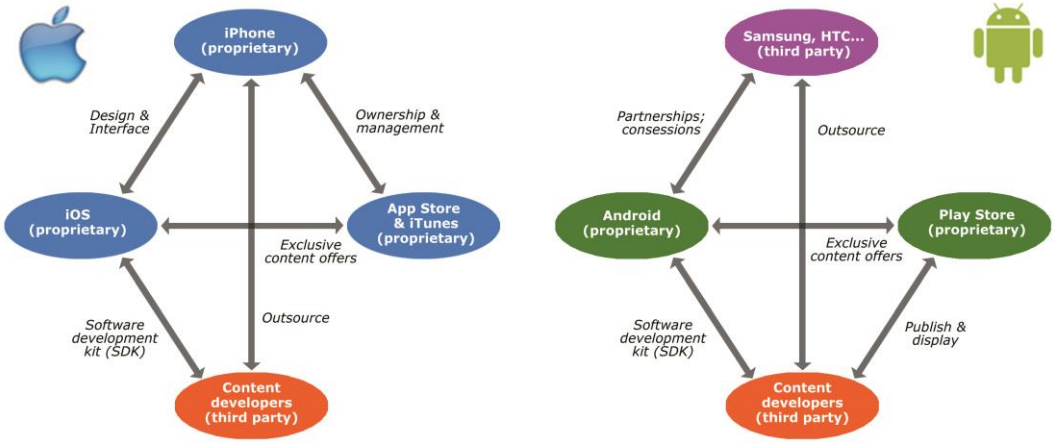


Fig. 2.8 - Mobile business ecosystems. Apple (left) and Android (right) - original model developed by the researcher based on Holzer and Ondrus (2011).

Through time, both platforms' services (e.g. App Store and Play Store) have been expanding. As a result, they have been attracting more developers interested in designing new contents and applications for these services (Mickalowski et al., 2008; Holzer and Ondrus, 2011).

The distinct strategies adopted by these companies also impact directly on their mobile business ecosystems' *modus operandi*. According to Holzer and Ondrus (2011), Apple follows a 'close technology' approach towards its products and services. The iPhone only runs Apple's iOS and contents (e.g. music, video and applications) offered exclusively by the company´s proprietary services, iTunes and App Store (Feinberg and Thomke, 2009; Want, 2010). In contrast, Google pursues an 'open technology' philosophy towards Android. Since this platform is an open source standard, it has been used by several mobile phone manufacturers on their wireless solutions (Holzer and Ondrus, 2011).

With respect to quality control over their online stores, again, Apple and Google present different management approaches. While content developers must submit their 'apps' to Apple, undergoing a 'quality' assessment before being published in

the App Store; they can design and publish content at the Play Store without Google's evaluation beforehand (Butler, 2011; Holzer and Ondrus, 2011).

Finally, more recently, the traditional handset manufacturer, Nokia (once a market leader and mobile OS developer pioneer) (Nokia and Symbian OS White Paper, 2002), established a partnership with another computing firm, Microsoft, to regain market space. This specific alliance puts together Nokia's handset manufacturing expertise and Microsoft´s software proficiency to create a new mobile ecosystem aiming to compete with the new entrants, Apple and Google (BusinessWeek, 2011a; BusinessWeek, 2011b).

• Key trend 6: Customization

Customization in mobile phones is a trend that started long time ago. Funk (2009) reports that the first wave of customization started in early 2000's in Japan (the first country to provide internet through mobile phones to end-users). The internet allowed costumers to download ringtones and screensavers to personalize their handsets (Steinbock, 2005). The success of this phenomenon was associated to the social historical needs of personalization that occurs mostly among young people. Nevertheless, due to technological restrictions at that time, mobile handsets' customization could only be achieved in a very limited way (Funk, 2009).

The introduction of digital cameras in mobile phones enabled users to go one step ahead and personalize their devices' background with their own pictures. Later, further technological improvements (e.g. faster chipsets and improved storage capacity) associated with the widespread use of new software (such as Java and Flash) allowed them to play video games and download high quality movies and audio tracks (songs) that could be used as ringtones in their gadgets (Funk, 2009).

Recently, the rise of more flexible and powerful mobile operating systems (e.g. Android and iOS) enables customers to achieve high levels of personalization. Supported by exclusive services such as Play Store (for Android based phones) and the iTunes/App Store (for Apple's iPhone), end-users can access numberless mobile applications from a wide spectrum of categories. For instance, Android OS

is based on the ‘replace-and-reuse’ philosophy allowing users to always look for more practical and relevant applications to replace old ‘apps’ (Butler, 2011).

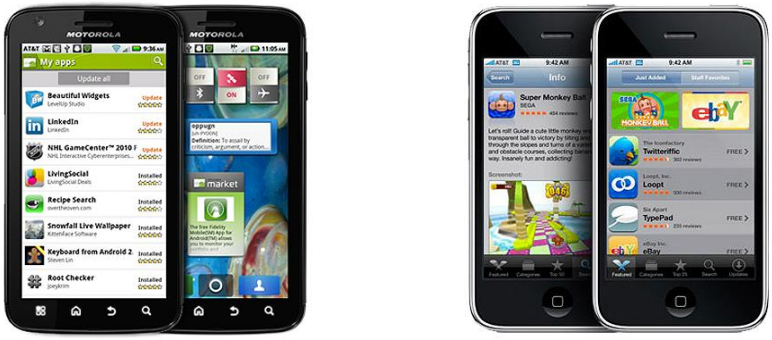


Fig. 2.9 - Mobile applications market:
Android’s Play Store (left) and Apple’s App Store (right) interfaces.

Based on the evidences presented, different from the first stage when handset customization was restricted to a ‘superficial’ level, basically related to aesthetical changes (e.g. ringtones and screen savers); current approaches occur in a ‘deeper’ level and are strongly associated with software (e.g. applications) that run on top of mobile operating system (OS).

• Key trend 7: NFC - Near Field Communication

The Near Field Communication (NFC) is a wireless transmission technology that enables electronic devices to communicate in short range distance (Morak et al., 2009; Junior, 2006). Basically, devices embedded with NFC standard can work as contactless cards (passive) or readers (active); thus, transferring and reading data (Junior, 2006).

The NFC is a Radio Frequency Identification (RFID) based standard that operates at 13.56 MHz (Want, 2011; Morak et al. 2009). Due to its very limited operating range (around 10 cm) it can only transfer 424 Kbits (Want, 2011).

Junior (2006) explains that NFC was developed by Philips and Sony in 2002. Yet, it is only after a decade that its potential was revealed. Numerous applications of this technology have been described covering fields such as entertainment; public and private transportation; advertisement; (Want, 2011), tourism; (Borrego-Jaraba

et al., 2010), clinical research and medical care; (Morak et al. 2009); and finally, commerce and banking (Ondrus and Lyytinen, 2011).

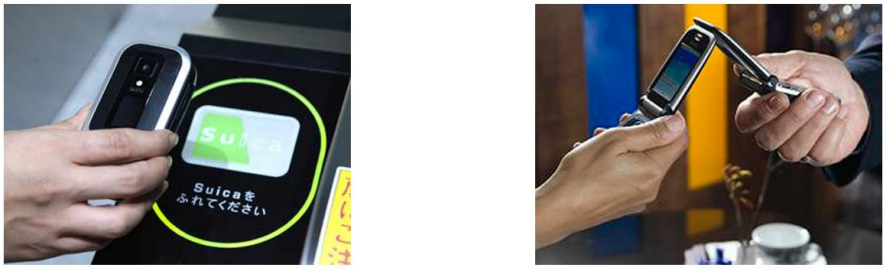


Fig. 2.10 - Examples of NFC usage: tickets' payment (left) and files exchange (right)

Among the several uses of NFC, arguably, those related to financial transactions are the most expected. At the same time, they are the most complex and intricate to establish due to the wide range of stakeholders involved in the process. For instance, network operators currently do not receive incentives to embrace NFC, since customers are not demanding this function in their phones. In addition, NFC uses credit card payment systems to bypass cellular networks; therefore, cutting a percentage of network operators' revenue per transaction made. Meanwhile, Google and Apple already demonstrated interest to support this standard for financial transactions; however, customers are still very concerned about security issues (e.g. fraud and identity theft) when using this system to make payments (Ondrus and Lyytinen, 2011; Want, 2011; Junior, 2006).

Despite of some social and industry barriers for NFC adoption, this standard has a good potential to achieve the mass market due to the emergence of new data transmission technologies (e.g. LTE) and more powerful mobile devices (Ondrus and Lyytinen, 2011).

• Key trend 8: AR - Augmented Reality

Augmented Reality is a technology that superimposes and combines virtual data over a real world landscape providing users with an extra dynamic 'layer' (in real time) of computer generated information about spatial resources (Bernardos and Casar, 2011). Even though this concept was introduced by Sutherland (1968), the

way that this terminology is employed today was described by Caudell and Mizell (1992) in a study for the airline industry.

In the mobile phones, AR technology is supported by both hardware and software components. The combination of bigger screen displays, compass and GPS (Global Positioning System) with Augmented Reality based applications can offer rich and more immersive user experiences (Bernardos and Casar, 2011).

In general, Augmented Reality is still unknown by most part of handset users. Nevertheless, manufacturers like LG and Samsung already include pre-installed mobile applications (e.g. Layar) on their products (Bernardos and Casar, 2011). In addition, the Juniper 'Three to Watch for 2011' report (2011) states that global brands and independent developers are getting more interested in designing specific AR based 'apps'.

Fig. 2.11 - Example of an Augmented Reality (AR) 'app' used to explore a city

At last, Bernardos and Casar (2011) argue that AR applications are diverse and cover different areas including travelling, entertainment, games, sports, and transportation. Furthermore, as Augmented Reality gains momentum, Juniper Research (2011) predicts that related applications will reach 1.4 billion downloads in 2015 generating a sum of $1.5 billion.

• Key trend 9: LTE - Long Term Evolution

LTE (or Long Term Evolution) is a short terminology that stands for 'Long Term Evolution of Terrestrial Radio Access'. LTE is a mobile technology developed by

a collaborative group of international standards institutions and mobile technology companies including Nokia and Ericsson (Nokia LTE report, 2006)

The Long Term Evolution is an expansion of the GSM family of mobile network standards that will coexist with previous technologies such as 2G and 3G (Nokia LTE report, 2006; 4G Americas, 2011). In addition, it is appointed by several companies (e.g. network operators, handset manufacturers and content providers) as the wireless standard of the future, since it will bring outstanding benefits for users and corporations (4G Americas, 2011).

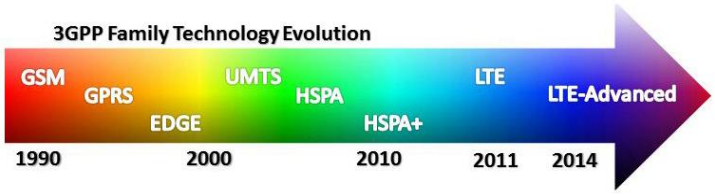


Fig. 2.12 - Evolution of mobile data transmission technologies (4G Americas, 2011)

Among the advantages that LTE offers in comparison to previous technologies, is the extremely fast connection that reaches up to 300Mbps. At the same time, the LTE system works to prevent possible connection delays, resulting in a more reliable system performance. Moreover, due to its flexible structural design, this platform operates in a wide spectrum (from 1.25MHz up to 20MHz) allowing companies to choose the best frequency to deploy their services. These factors contribute to increase system capacity, create new services and reduce network complexity that leads to economies of scale for service operators. (Nokia LTE report, 2006; 4G Americas, 2011; Dahlman et al. 2008)

Finally, the first commercial LTE network was launched in Northern Europe (e.g. Sweden and Norway) in 2009. Since its introduction, it has been running on several trial schemes in order to be fully operational by 2011 (4G Americas, 2011).

• Key trend 10: Cloud Computing

The cloud is a new type of computing model that aims to provide secure, fast and convenient way of storing data and accessing online computing services (Zhang et al., 2010).

In a general perspective, the major difference between the current approach and the Cloud computing, basically, is related to how and where users' data is stored and managed. In the traditional way, users place their files in local, personal and physical devices (e.g. desktop computers, laptops and mobile phones) having full control over their assets. In the Cloud, these data is kept in distant virtual servers (in many cases, more than one machine/server) that are controlled by third party companies, reachable only via internet (preferably through wireless connection) (Hayes, 2008; Kumar and Lu, 2010).

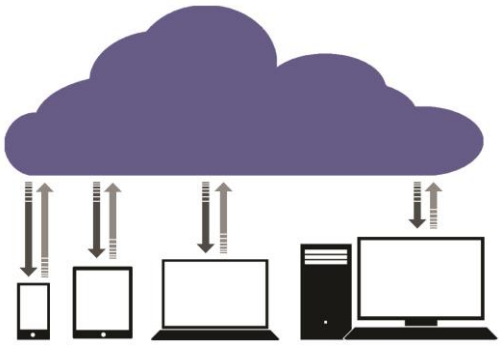


Fig. 2.13 - The Cloud is a convenient way for users to store and access their data through different computing devices

According to Zhang et al. (2010), the Cloud is a complex system that requires the alignment of numerous factors to deliver high quality service, including a strong and reliable network able to connect several mobile devices (such as laptops, tablets and handsets) to servers; clusters of computers supported by robust data storage capacity; cutting-edge distribution technologies (for instance, LTE) and the widespread of the Web 2.0 standard.

As it gains *momentum*, the Cloud Computing presents several benefits. It offers large storage space for users to keep their files (e.g. documents and mobile applications) in secure data centres spread worldwide. Due to its networked structure, files stored in this platform can be remotely accessed and managed

through any terminal (e.g. desktop, laptop or mobile phone) connected to the internet (Zhang et al., 2010). In addition, its flexibility helps software developers to quickly deploy, test and fix any mobile application (Hayes, 2008). As a result, they can be easily downloaded into different devices and shared across gadgets running distinct operating system (OS). Finally, due to its high scalability, service providers can design better deals to meet personal and corporative demands (Juniper 'Three to Watch for 2011' report, 2011)

On the other hand, there are some crucial issues that the Cloud computing must address to become a solid service platform. Since data is stored in third-party servers, there are no guarantees that it is really safeguarded. Another issue is related to possible computer virus or hacking activity that can result in data theft or misuse. In addition, the system is completely dependent of wireless internet connection. Therefore, in places that lacks of signal, the service can be limited or completely inaccessible (Kumar and Lu, 2010).

2.3.2 Summary of findings in this section

The list displayed in the last section informs about current trends in the wireless market. Apart from describing and contextualizing these manifestations, their importance relies on how firms operating in this sector can address and explore these phenomena to obtain competitive advantages.

While some of them are already widespread (e.g. convergence, powerful mobile operating systems and mobile ecosystem); others are still gaining momentum (e.g. LTE, NFC and Cloud Computing).

In fact, all these manifestations are associated with the integration of the internet into the wireless communications. As it becomes a key communication channel for handsets, it can be considered a paramount asset in this industry.

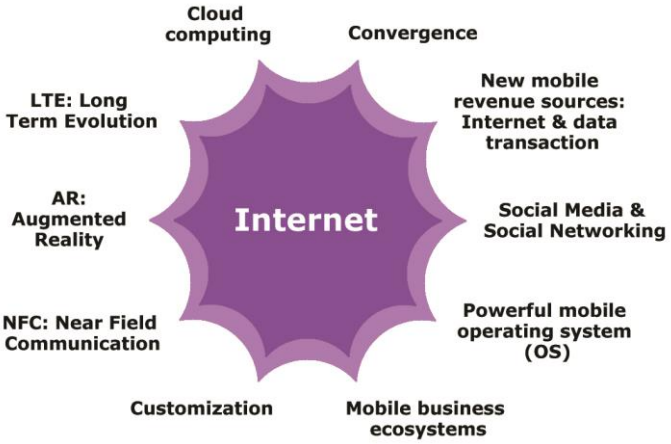


Fig. 2.14 - Current trends in the wireless sector are internet related.

Those companies that already embraced some of these landscape trends (through their products) were able to develop substantial commercial advantages and are clearly performing well, dominating the market (for example, the new entrants, Apple and Google). On the other hand, traditional manufacturers, such as Nokia and Motorola, lost *momentum* (particularly the former) and are struggling to compete in a business where, once, they were strong players. Thus, by addressing these events, manufacturers can create outstanding market value resulting in solid competitive advantages.

Based on the review of the major trends in the mobile telecom sector, a holistic approach aiming to explore these issues considering their influence and potential impacts for the development of future wireless products can be taken into account as part of a comprehensive future-led design research process.

2.4 Conclusions and research questions framework

Based on the evidences presented in the previous sections, there are a number of key elements that companies operating the wireless sector, particularly handset manufacturers should monitor in order to stay ahead of competition and remain relevant in this dynamic industry.

Firstly, among all the issues introduced, the emergence (and later expansion) of the internet in the telecom industry can be regarded as a ‘game change’ factor triggering a revolution in this sector, pushing firms to adjust their *modus operandi*

and business approaches not only to take advantage of raising opportunities; but also, to avoid potential threats. In addition, apart from internal issues (for instance, financial budget, technical expertise and market positioning); there are other external aspects that companies should pay close attention and monitor such as new environmental trends, competitors´ strategies, new business models, products, services, value (for consumers) and users´ (experience) requirements. These wide range of factors influence companies´ performance, affecting how they design for the future in the wireless industry.

At the first glance, these aspects seem to be 'independent', one from another due to their nature. Yet, a closer look reveals that it is the interconnection among them that can deliver impacts on business. For instance, the 'Convergence' (trend) puts together different industries, technologies, hardware and software into a single product unlocking new ways of handset user experience and the development of innovative business models and services (e.g. social media platforms and cloud computing). The previous example shows that different elements, in fact, share a deep connection and do not stand alone in the landscape.

As a result, it is possible to say that, apart from their individual characteristics, these aspects can be part of a more complex and holistic 'system or network'. Together, they influence and shape the creation of ground breaking strategies for future products, directly impacting on overall firms' performance.

From a research perspective, the wide range of issues discussed in the previous sections (and their roles as potential drivers for firms to engage in future-led design ventures in the wireless sector), can be used as 'inspiration', guiding the researcher to pinpoint possible lines of investigation in order to have a better understanding about them and their relationships in future related projects.

Based on these ideas, the researcher formulated a simple framework to introduce possible lines of enquiry. The following chart displays the research questions of this PhD study.

Table 2.6 - Research questions framework (lines of enquiry)

1. Key dimensions
(Q1.1) What are key dimensions that handset manufacturers should constantly monitor to design for the future?
(Q1.2) What are the interrelationships of these key dimensions? How do they affect and/or influence each other?
2. Types and sources of information
(Q2.1) What types of information do handset developers require to identify emerging opportunities in order to plan new offers and make better design decisions?
(Q2.2) Where and from whom the information can be acquired and/or captured?
(Q2.3) How should these types of data be used to inform future-led design process?
3. Methods and approaches for information retrieval
(Q3.1) What design research approaches, tools, methods and/or models can be used to capture information required for design-led future projects?
(Q3.2) Does one tool inclusively collect one type of data? Or can one tool be used to gather more than one type of information?
(Q3.3) Is there any approach, tool, method, framework or model comprehensive enough to integrate all these required features to help a company to design for the future?
4. Stakeholders and roles of design
(Q4.1) Which stakeholders are involved in identifying opportunities and planning future products?
(Q4.2) Does a multidisciplinary approach is employed in future-led design process?
(Q4.3) How design can contribute to plan and create future products?

3 Design and future forecasting

3.1 Introduction

This chapter is dedicated to identify and explore the roles of design in the future forecasting processes. Considering its wide array of applications, ranging from ‘a way of thinking’ (or a philosophy) to market solutions (e.g. products and services), more than never, design plays utmost roles in defining and shaping the (desire) future yet to come.

In order to address the multiple aspects of design associated with future related (research) process, this chapter is divided in the following parts. Firstly, different definitions of the term ‘design’ are introduced. After that, the use of this discipline as a ‘process’ and as a ‘way of thinking’ is explored taking into account distinct perspectives. Next, a number design-led future forecasting approaches and case studies are reviewed in order to investigate how design support firms to create strategies and future solutions as well as the contributions of this discipline (and designers) in these processes. At last, key dimensions and an extensive collection of research tools and methods employed to design for the future are presented and discussed.

3.2 Design: origins and definitions

The origins of word ‘design’ are rooted in the original Latin noun *designare* whose meaning can be translated as ‘to draw’ and ‘to designate’. In English, ‘design’ kept its meaning and can refer to a ‘plan, project, process’ or a ‘sketch, model, visual composition’ (Borja de Mozota, 2003). Depending on the context of use, the term ‘design’ can be employed to describe an activity/process (as a verb, ‘designing’) and also the final product/outcome of a given process (as a noun, ‘a design’) (Borja de Mozota, 2003; Best, 2006).

As important as tracking the origins of this word, it is to understand its definitions. The American modernist, Charles Eames (cited in Laurel, 2003) states that design

is ‘a plan for arranging elements in such a way as to best accomplish a particular purpose’. This straight forward explanation situates design as a problem-solving discipline. On the other hand, the ICSID (International Council Societies of Industrial Design) (cited in Verganti, 2009) explains that ‘Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life cycles. Therefore, design is the central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange’. In this research, the definition of ‘design’ goes beyond the description of the activity itself, informing about related process and also its impacts and benefits for business and society.

In conclusion, the term ‘design’ can be associated with a wide range of activities depending on the context that it is applied. Therefore, this discipline makes use of different ‘processes’ aiming to develop ‘creative’ and ‘innovative’ ‘services’ and ‘objects’ (‘outcomes’) to fulfil the unique needs and requirements of ‘people’ and ‘businesses’ improving society as a whole.

3.3 Design process and design thinking

In a broad perspective, ‘design’ can be related to both ‘processes’ and ‘outcomes’. This duality, ‘process-outcome’, is the foundation supporting any design process employed to strategically plan, create and deliver new market solutions (Cooper and Press, 1995). Therefore, design can add and create value (Best, 2006).

Due to its relevance, design process is a topic that has been widely discussed. Several authors and practitioners developed theories and models to address its distinct stages, procedures and goals.

To begin with, the design process model proposed by Cooper and Press (1995) takes into account the designer’s internal creative perspective when addressing a problem. Since creativity does not follow a linear route, the designer may need to go back to a previous stage (any) to amend this step first, for example when new information emerges or a design needs upgrading. As a result, this simple five steps approach does not consider a broader context and management factors such as methods and procedures.

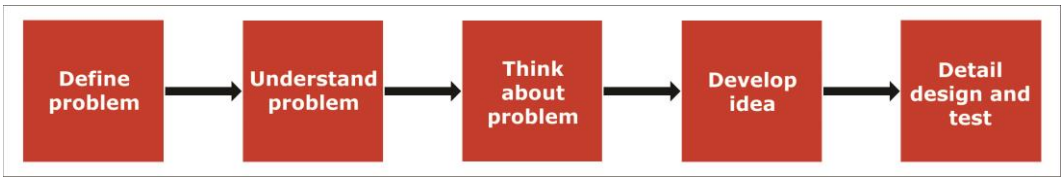


Fig. 3.1 - The internal creative process of design (Cooper and Press, 1995)

After that, Borja de Mozota (2003) also discusses the design process considering a creative point of view. The author proposes a model based on the creative process; however, it presents a wider and more complete approach. Basically, it consists of three main phases: an analytical stage related to scoping and exploring the field under investigation; a synthetic stage, where ideas and concepts are developed and; in the last stage, a final solution is selected and created. The following chart exhibits the design process model.

Table 3.1 - The Design Process (Borja de Mozota, 2003)

PHASES	*Investigation*	*Research*	*Exploration*	*Development*	*Realization*	*Evaluation*
OBJECTIVE	*Idea*	*Concept*	*Choice of style*	*Prototype Detail*	*Test*	*Production*
VISUAL OUTPUTS	*Brief*	*Visual Concept*	*Rough of ideas; Sketches; Rough of presentations; Reduced-scale model*	*Technical drawings; Functional model; 3D mock-up for visual correctness and working capabilities*	*Document execution; Prototype*	*Illustration of the product*

The model developed by Borja de Mozota (2003) presents two important aspects: first, in each stage a clear objective is set and; second, based on these objectives, a visual output or outcome must be produced and delivered.

Best (2006) points out that the design process consists of a sequence of methods that are employed together to address a design project considering its unique characteristics. From a visual viewpoint, the model developed by the author seems to ‘combine’ the two frameworks introduced earlier (e.g. Cooper and Press, 1995 and Borja de Mozota, 2003, respectively). The chart bellow displays the entire process and its main stages.

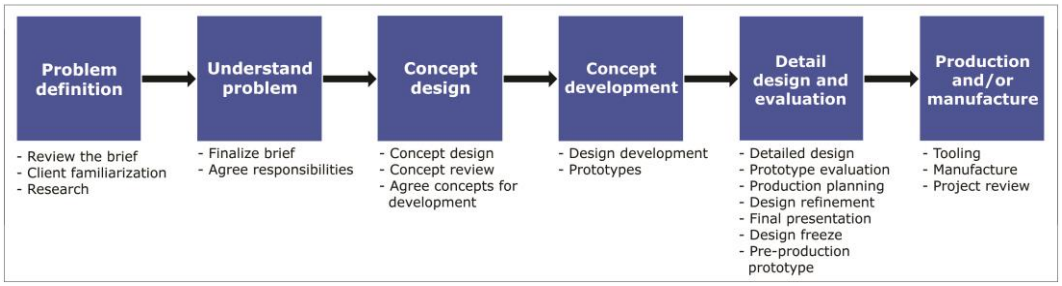


Fig. 3.2 - Overview of the design process key stages (Best, 2006)

The model created by Best (2006) comprises six steps ranging from problem identification up to solution implementation. Despite its linear perspective, the author explains that the process itself presents an iterative and dynamic character with feedback loops to provide room for new ideas generated through the several stages in order to address clients and users requirements. Finally, it acts as a map informing the design team about the steps to be taken and the actions related to each stage.

Finally, the British Design Council, a public institution that supports design across different academic and industrial levels in the United Kingdom, also massively contributes for the discussions around the design process topic. Design Council (2007) has its own views and proposed a comprehensive model to describe the design process.

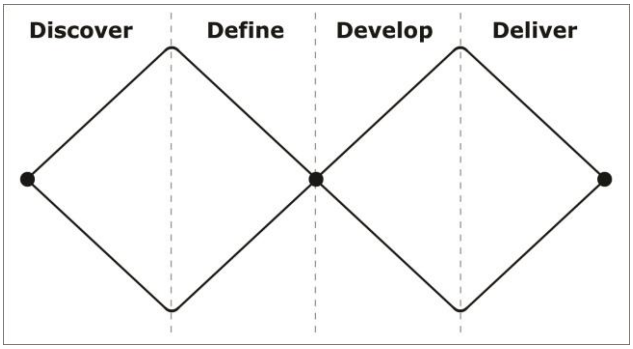


Fig. 3.3 - Design Council's design process double diamond (2007)

The double diamond shaped framework portrays two major parts comprising divergent and convergent phases and four main stages named 'Discover, 'Define', 'Develop' and 'Deliver'. Despite the over simplistic visual, the model rationale is very detailed and comprehensive. For example, each section covers a specific set of actions and proposes clearly deliverables: 'Discover' - problem definition and

data collection; ‘Define’ - data synthesis and concepts’ definition; ‘Develop’ - manufacturing and product tests and ‘Deliver’ - product launch and evaluation.

Based on these models, it is possible to point out some similarities among them. Overall, they encompass the following stages: definition of the problem or issue; the selection of research methods to collect and analyse data; development and refinement of ideas/concepts; manufacturing and production; prototypes’ tests; product release in the market and; finally, performance evaluation.

Nevertheless, due to the iterative and non-linear character of the design process, researchers were not able to develop a conclusive framework that describes in a satisfactory way all the stages that a design process comprises (Best, 2006; Design council, 2007).

Drew (2009) explains that the flexibility of the design process, that lays on the use of multiple approaches to create a solution, is the major strength of ‘design thinking’, whose objectives are related ‘to create something new; to challenge the given problem; to be comfortable with the ambiguous; to connect with people; to create multiple solutions using various methods; and to visualize intangible concepts, models or ideas’. Moreover, the author states that these ideas are related to the three fundamental areas that the design thinking comprises: consumer-centricity, orientation towards the future and the focus on challenging the norm.

Based on the comprehensive review of design, this discipline is recognized by its flexibility and wide spectrum of applications. Throughout this PhD study, design is addressed from a strategic rather than operational point of view, associated with ‘planning’ and ‘processes’ that leads to future ‘products’ and ‘outcomes’. Thus, its principles are rooted in the design thinking helping to efficiently plan and define steps and milestones; identifying key issues to be investigated; selecting appropriate actions and suitable approaches (e.g. research methods), supporting decision making and, finally, assisting in the creation of new value propositions that leads to potential future solutions.

3.4 Forecasting

As society evolves and the future tends to be rather different than the present; the level of uncertainty raises. Evans (2011) explains that as the future is neither set nor pre-ordained, the more time an effort we spent trying to understanding it, the more possibilities we will have to define and create it. In order to reduce the level of these uncertainties and take advantages of emerging opportunities, forecasting becomes a fundamental activity to deal with numerous variables (Futures, 1969).

Makridakis (1998) argues that, the major contribution of Forecasting is to support efficient planning. In order to create a well-organized plan to achieve an objective, researchers and forecasters can apply a wide selection of instruments to firstly explore the issue. These tools can be categorized according to the information employed or required. The following chart displays these categories.

Table 3.2 – Categories of forecasting approaches (based on Makridakis, 1998).

Quantitative	- Requirements: Sufficient quantitative data (e.g. statistics) must be available. - Example of method: 'Time series' is used to predict the future of an event based on its past historical patterns. Assuming that this phenomenon will continue over, Time Series extrapolate this trends or patterns into the future.
Qualitative	- Requirements: Insufficient quantitative data accessible but an abundant qualitative knowledge. - Example of method: Methods applied depend on the situation/context. Frequently, researchers' personal inputs (such as judgements, accumulated experience and knowledge ih the field) are incorporated throughout the process.

Forecasting is an activity that has been used widely employed in a number of fields to address distinct topics. For example, the quantitative instrument 'time series' was used to predict electricity production in Australia from 1956 to 1995. Based on monthly trends' analysis (also including seasonal variation) throughout the years, the Australian government could forecast an increase in internal demand and plan ahead the upgrade or construction of facilities to cope with these increasing requirements (Makridakis, 1998). In contrast, qualitative methods have been employed to investigate trends. For example, the British design consultancy Seymour Powell Foresight (SPF) used 'scenario building' to assist Samsung on a European market project. After collecting data using different methods, 'scenario

building' was employed to create a set of narratives including visual (e.g. images and mood boards) and textual information (e.g. simple and straightforward words). This approach helped the design team to identify landscape phenomena, providing indications about their future trajectory. Alongside with other instruments, this descriptive tool helped Samsung to define and create a visual language for their future products to engage customers in a more emotional way (Evans, 2003).

Based on these evidences, forecasting becomes as crucial activity supporting both efficient planning and decision making processes. Therefore, companies are able to select appropriate strategies to deal with distinct factors, evaluate potential impacts on their business and achieve proposed goals (Makridakis, 1998)

3.5 Design and future forecasting

According to Evans (2011), Design is a discipline committed to look ahead and engage with the future. Thus, designers are regarded as futurists. They consider the future as an intrinsic part of their activities by empathizing with consumer needs and taking a proactive role in creating the future for them. Furthermore, they are able to change user's perceptions about the future by looking at different possibilities concerning how it can be.

To achieve these goals, designers should think ahead of the curve, envisioning and fostering promising futures. In other words, they must have a clear direction and set up a comprehensive plan that supports the whole process, starting from 'now' until the 'desired future scenario' (Seymour, 2008).

Taking into account the definition of 'design' that is related to both 'processes' (e.g. 'plan, project and process') and 'outcomes' (e.g. 'sketch, model, visual composition') (Borja de Mozota, 2003) and the main contribution of 'forecasting' that is associated with 'planning in an efficient way' (Makridakis, 1998), it is possible to draw some relationships between these two disciplines.

While Forecasting activities support efficient planning in order to define the most appropriate course of action to address a given situation (Makridakis, 1998); Design goes further encompassing not only these strategic functions (in here, as

‘processes’); but also, engaging with the creation and delivery of a final solution (‘outcomes’) (Borja de Mozota, 2003; Best, 2006). Therefore, both ‘design’ and ‘forecasting’ are activities committed with the future.

In practical terms, as design ‘encompasses’ (due to its wider scope) forecasting related activities; design can be considered a means of future forecasting. As a result, ‘designers design for the future. They are called upon to provide solutions that have yet to occur’ (Evans, 2003).

3.6 Future forecasting in the design field

3.6.1 Design-led future forecasting approaches

As it was mentioned in the last section, due to its comprehensive character, design can be considered as a way of future forecasting since it is directly associated to ‘processes’ and ‘outcomes’. Design, as a holistic discipline, is at the core of a wide range of social projects and industrial developments. Thus, based on the past evidences, public and commercial ventures that involve ‘planning’; ‘research’; ‘methods’; ‘decision making’; ‘strategy’ and ‘solutions’ either physical (e.g. product) or immaterial (e.g. guidelines) are systematically applying the principles of design to understand and explore current situations/problems to develop future solutions to tackle those issues.

In this section, practical examples of how design approaches and instruments have been employed in the real world to devise future solutions in different domains (e.g. social and industrial context) are introduced and explored.

• Scenario building

One of the most established tools to investigate and ‘predict’ the future is called ‘scenario planning’. In the modern Era, the American Herman Kahn (1967) and the French Bertrand de Jouvenel pioneered futurism studies and scenario planning. While the first focused on investigating the degree of likelihood or probability that a given event might happen; the latter, gave emphasis to what *should* happen in

the future considering qualitative approaches and plausibility (Wilkinson and Kupers, 2013; Lindgreen and Bandhold, 2009). Since that period, scenarios have been widely discussed by different authors leading to several attempts to create a typology to classify them. Yet, no consensus about a complete categorization was ever reached (Borsejon et al., 2006).

Lindgreen and Bandhold (2009) explain that scenarios can be considered as a platform for future planning and learning involving a number of participants within and from outside (ex. consultants and experts) a firm in their development. In addition, scenario building is a creative; however, heavily research data based process. Frequently, a scenario comprises both qualitative and quantitative data and through its different phases (divergent and convergent), it requires the use of intuitive and analytical thinking in their analysis. In addition, scenarios can be applied in either short (e.g. trend-based) or long term period of the time taking into account levels of uncertainties and discontinuities. Summing up, Schoemaker (1995) explains that 'scenario planning is a disciplined method for imagining possible futures that companies have applied to a great range of issues'. Through rich narratives, scenarios aim to capture a great amount of data and display a wide scope of possibilities, delivering strategic support to stakeholders and decision makers in order to consider changes and 'see' beyond the current mind-set.

Among the several companies that have been using this powerful and visionary technique, the multinational oil company Shell, is a remarkable example. Dating back to the 1970's, Shell has been developing scenarios based on expert scenario team insights from different areas to maximize business opportunities. Shell's approach towards scenario development considers the plausibility (rather than probabilities) of the future. Thus, it is not intended to predict it; but, to promote knowledge and information awareness about any fact that might impact the oil industry landscape. To create its scenarios, Shell employs storytelling a as key component supported by distinct visual elements including charts, images, memorable phrases and future outlooks in order to inspire the audience through interviews, workshops and other engagement tools (Wilkinson and Kupers, 2013)

Through time, Shell shifted its approach towards the development of scenarios. While in the early years, the company used to create up to seven models; today,

two scenarios are proposed. Although scenarios require up to date inputs and quantitative information to add value, rigor and consistency to them; they also encourage the use of more subjective approaches. ‘An intuitive understanding of the world precedes and frames the analytical understanding that follows’. As a result, a combination between rational analytics and personal judgement shapes the creation of scenarios giving room the uncertainties of the future to be unfolded (Wilkinson and Kupers, 2013).

An example of Shell’s scenarios is presented by Kahane (1992). This particular study was published in 1992 and focused primarily in addressing three major areas of changes: geopolitics (e.g. reunification of Germany and breakdown of Soviet Union); economics (e.g. GDP *per capita* by continents and the raise of uni and/or bilateral trading agreements) and environment (such as environmental degradation and green house/global warming effects). Based on the data analysis, the company created the following model that comprises two scenarios (bellow):

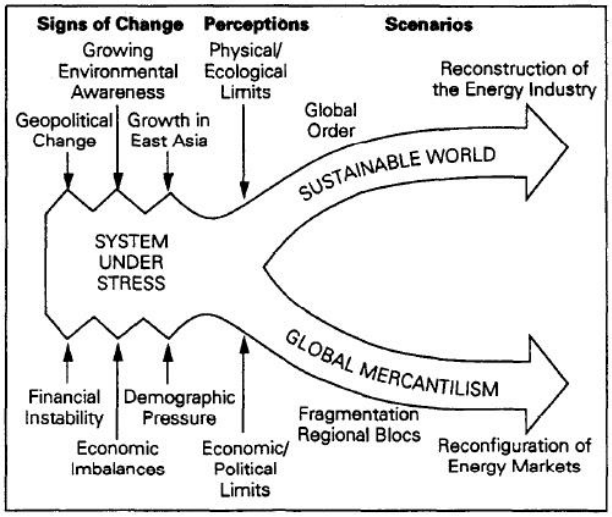


Fig. 3.4 - Example of scenarios created by Shell (Kahane, p. 41,1992)

The first scenario, ‘global mercantilism’ deals with the end of the ‘cold war’ leading to political instability and economic downturns. This reflects directly on the trades dominated by the regionalization and the formation of economical blocks (e.g. European Community) to face the economic shock. Governments implement protectionist measures; yet, promotes privatization (in some sectors) leading to market deregulation and a more volatile scenario reinforcing the critical

needs for intra and extra blocks' commercial deals. Overall, as the international commerce changes, they impact on the energy industry, having oil as a key commodity. Thus, the dynamics of market shifts to guaranty both regional and local self-sufficiency. Moreover, the liberalisation of some markets also brings instability for oil prices that tend to swing (but not to a high price for a long period of time). Finally, other energy providers such as gas and electricity firms tend to be less controlled by States, facing strong competition from new entrants.

The second scenario named 'sustainable word' deals with different propositions addressing mainly public and international concerns related to environmental degradation such as global warming. Posing a serious global threat, developed countries try to engage with developing nations to assist them considering their dependence on natural resources through financial and technological investments. However, these same developed countries can apply economical restrictions and impose a drastic rearrangement of global trade, security and green protocols affecting poor nations. In addition, the introduction of new taxes and regulations can provide a source of investment for green innovation and new economical ventures. This scenario can deliver a series of impacts to the energy sector, particularly to the oil industry. They might include the redesign of the whole energy system (comprising housing and transportation); stricter regulations on the energy industry (affecting refineries and power plants); shifts to cleaner fuels (e.g. gas and biomass) and the development of more fuel efficient devices (including cars and light bulbs).

The narrative above describes how 'scenarios' have been used in a disciplined and comprehensive manner to support a global scale company business. Those stories serve for the purpose of creating awareness, informing and supporting Shell's CEO and executives to make better corporative decisions considering, more than never, social, economic and environmental issues that can deliver impacts on Shell's businesses worldwide (Wilkinson and Kupers, 2013).

• Roadmap/Technology Roadmap (TRM)

Another well-known future-led approach is called ‘roadmap’. When this flexible tool is applied to support the development of long term technology strategies, it is known as ‘technology roadmap’. Phaal, Farrukh and Probert (2001) explain that technology roadmaps share similarities with other visionary techniques such as forecasting, foresight, Delphi, scenario planning and backcasting as they are, basically, future oriented.

Galvin (1998), former Motorola’s executive and advocate of this technique, argues that a technology roadmap can be broadly defined as ‘an extended look at the future of a chosen field of inquiry composed from the collective knowledge and imagination of the brightest drivers of change in that field. Roadmaps communicate visions, attract resources from business and government, stimulate investigations and monitor progress. They become the inventory of possibilities for a particular field…’. From a technical point of view, a technology roadmap is a time-based chart displaying different dimensions in a number of layers, usually including technological and commercial perspectives as well as several links and nodes that connect each of them highlighting their relationships. (Phaal, Farrukh and Probert, 2001).

Technology roadmaps (TRM) can be classified according different perspectives: purpose (ex. product and strategic planning) and format (ex. multiple layers and tables) (Phaal, Farrukh and Probert, 2001); analysis process (e.g. retrospective or prospective) (European Industry Research Management, EIRMA, 1997; Kostoff and Schaller, 2001); and, process development (e.g. expert-based, software-based or hybrid) (Kostoff and Schaller, 2001). The diversity of categories can be related to the fact that firms design their own technology roadmaps to fit their exclusively needs considering current context, capabilities and commercial objectives (Phaal, Farrukh and Probert, 2001)

Technology roadmaps have been used across different sectors by several firms such as Motorola, Philips and the American Semiconductor Industry Association (SIA). For example, SIA (Semiconductor Industry Association), part of NEMI (National Electronics Manufacturing Initiative, USA) used a technology roadmap to better understand and define alternative strategies for the use photolithography

on future semiconductor solutions. To tackle this assignment, it employed a multinational group of specialists and experts that were allocated in distinct technology working groups (TWGs) covering a wide range of areas comprising design; packaging; lithography; environment; and, safety and health from different social levels (e.g. industry, academia and government) (Kostoff and Schaller, 2001). SIA incorporated the use of technology roadmaps as a regular and on-going strategic tool to support its business (SIA, Semiconductor Industry Association, 1999 cited in Kostoff and Schaller, 2001).

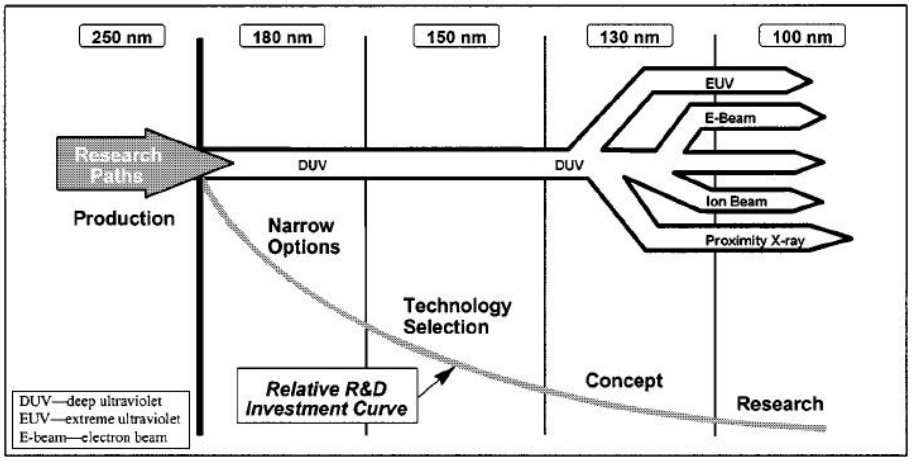


Fig. 3.5 – SIA's roadmap for semiconductor technologies development (1997) (model presented by Kostoff and Schaller, 2001)

Based on the example mentioned, creating an efficient and comprehensive TRM is a laborious and time consuming task that demands a series of 'requirements'. First, it is necessarily to have a sense of future purpose since this strategic tool should be aligned with a firm business plan to generate sustainable competitive advantage. As a result, plotting changes in the environment in the mid/long term and understanding the company's resources is critical to design a roadmap, setting milestones and feasible actions to reach future goals. In addition, 'roadmapping' (the act of creating a roadmap) involves social interaction and strong commitment of participants. Ranging from a small scale (e.g. a firm that relies on its workforce experience and external experts to support the development of its TRM) up to a large scale project (e.g. involving cross-industry sectors, international firms and governmental bodies), the number and diversity of stakeholders (from different

backgrounds) increases as the nature of the venture become more complex (Phaal, Farrukh and Probert, 2001; Kostoff and Schaller, 2001).

As technology 'roadmapping' brings different people together (internal employees, external consultants and field specialists), it offers an excellent opportunity to exchange insights and perspectives about business problems and opportunities. Therefore, the main benefits are not only associated with the outcomes (e.g. the roadmap itself and related documents); but also, with the process as stakeholders acquire a consensus thinking framework about potential and leading strategies within a specific timeframe assisting them to make better informed decisions (Phaal, Farrukh and Probert, 2001; Kostoff and Schaller, 2001)

• Backcasting

Backcasting is also another visionary approach used to address future time frames. The origins of backcasting can be tracked to the 1970's when Lovins (1976) employed the 'backwards-looking analysis' as an alternative method for energy related future studies. The term known as 'backcasting' was firstly introduced by Robinson (1982) and defined as a method concerned about how desirable futures can be reached (or build) rather than investigating how it will look like or what will happen. In addition, the author states that backcasting is '…explicitly normative, involving working backwards from a particular desirable future end-point to the present in order to determine the physical feasibility of that future and what policy measures would be required to reach that point.'

In a different perspective, Dreborg (1996) argues that backcasting should not be regarded as a method, but as an approach. By comparing this approach with other traditional methods such as forecasting, the author explains that this tool (e.g. forecasting) only focuses on the analysis of dominant trends without considering new events and other externalities to generate solutions. Conversely, backcasting is better suited to deal with complex and long-term problems taking into account social and technological transformations due to its normative and problem-solving nature (Quist and Vergragt, 2006). Based on these evidences, backcasting focus on solving a problem rather than investigating current conditions, issues and

trends. Thus, backcasting and other forecasting techniques show a complementary character (Dreborg, 1996; Hojer and Mattsson, 2000).

Backcasting is a methodology that uses scenarios to provide radical images of the future and extend the range of possible solutions, desired or not. Yet, Dreborg (1996) clarifies that not all scenario studies can be considered as a backcasting study. According to the author, scenarios have been widely used by different companies such as Shell in order to address changes in the landscape that might affect their businesses. On the other hand, there are firms that apply scenarios to support their visions depicting where they want to be in the future. Those are clear applications of backcasting to assist companies' business.

As a future-driven methodology, Robinson (1988) highlights the roles of learning (or unlearning current and dominant ideas) in backcasting, broading participants perspectives about the future (without the constraints of today's perspectives). Thus, it can be considered as a constructive-oriented participatory process that involves inputs of several actors. The outcomes of a backcasting study should be addressed and communicated to a wide scope of stakeholders that might include different official government bodies, organisations, companies and general public Quist and Vergragt, 2006).

Backcasting approach has been used to address commercial and social issues. An example of a large scale social project where this methodology was used is the SuSHouse project, a 'spin-off' of the Dutch Sustainable Technology Development programme (Quist and Vergragt, 2006; Green and Vergragt, 2002).

The SuSHouse project aim was to provide an opportunity for the government, companies and NGOs to conduct their own analysis about household functions through the identification of opportunities for business, products, systems and social innovations by creating scenarios involving different stakeholders (e.g. industry, users and government) and assessing their viability and feasibility. The project lasted for two and half years covering five countries (Germany, Hungary, Italy, Netherlands and UK) focusing on several household functions: shopping,

cooking and eating (food); heating, cooling and lighting the house (shelter); and, clothing and clothing care (clothes) (Green and Vergragt, 2002).

The SuSHouse project employed a comprehensive methodology that starts with the selection of stakeholders for the two workshops that took place in each of the five mentioned countries considering their relevance in household activities and 'supply chain' as well as *future* participants that could be 'living' in these future scenarios. While the first workshop focused on generating desired visions of the future and scenarios of sustainable solutions; the second 'backcasting' workshop dealt with scenarios' evaluation by 'old' and 'new' stakeholders; identification of gaps in knowledge previously researched; development of proposals for concrete projects considering policy recommendations and stakeholder cooperation taking into account their implementation. The design-oriented scenarios (DOS) intended to create radical visions of the previous mentioned household functions focusing on 2050, using a storyboard approach reflecting on the development of proposed projects for both future products and services. After that, they were assessed considering environmental impacts (e.g. strong and weak points); economic impacts (e.g. business opportunities, viability and regulations changes) and user acceptance (e.g. probability for scenario adoption and potential barriers). The analysis revealed that large scale changes in both industrial and economical levels were necessary to accomplish the full potential of the proposed scenarios. With respect to environmental impact, the evaluation was promising but not satisfactory to reach proposed standards. In addition, the stakeholders' assessment (conduct through focus groups and workshops) demonstrated that, in some cases, the combination of some scenarios could be more appealing, delivering further environmental impact reductions. After proceeding with the scenarios' evaluation, they were clustered (based on similar characteristics) in five major groups: 'easy care'; 'care outsourcing'; 'high care'; 'care socializing' and 'soft care'. The chart below displays how they are positioned in a two axis matrix for further analysis (Green and Vergragt, 2002).

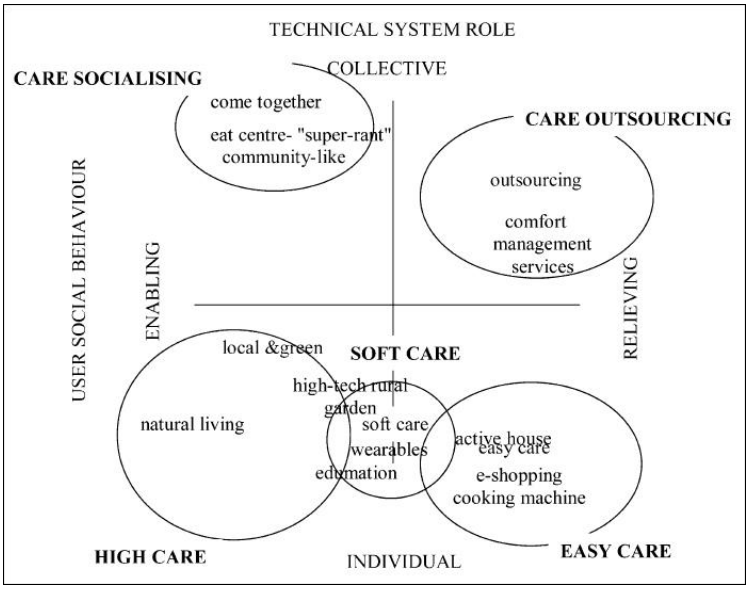


Fig. 3.6 - SuSHouse project DOS clusters (Green and Vergragt, 2002).

To conclude, the SuSHouse project employed a methodology that emphasized the interaction and participation of both current and future stakeholders to generate potential future household scenarios instead of technological solutions. To achieve the project goals, it was necessary to have a deep understanding of household functions (at that time) as well as social attitudes to implement changes in social-cultural, industrial and governmental levels to realise the potential of proposed scenarios. In addition, since the project's methodology was design-oriented, it provided a horizon of feasible opportunities for firms, NGOs and government regarding the creation of sustainable innovative future products, systems and services rather than developing future policies (Green and Vergragt, 2002).

• Strategic Niche Management (SNM)

Strategic Niche management is also another approach designed to anticipate/shape up the future. Its origin can be tracked back to the 1980´s in Netherlands and its background is related to studies in the technology field, focusing on technological development processes considering an inclusive and integrative perspective resulting from the interaction between users and technology. The term was crafted by Arie Rip, Dutch philosopher and sociologist interested on the technological domain and social-technical change (Loorbach and Van Rack, 2007)

According to Hoogma (2002), the SNM can be summarized and defined as a process of purposively creating, developing and managing the formation of a niche (market) using a series of social experiments with a given new (sustainable) technology. In a broad perspective, the strategic niche management approach aims to align the technology part within a social context. In that sense, the experiments with a particular technology lead to new social-technical arrangements where several actors from different levels (e.g. users, institutions, regulators, enterprises and suppliers) of the system co-evolve. Based on this process, usage patterns (directly related or not) with that specific technological innovation might emerge and new practices rooted in these technical-social experiments will help to define the scope of the niche.

From an practical point of view, the SNM model relies heavily on the knowledge generated by involved stakeholders to support technological innovation process through an integrated learning process (considering users' preferences, technical improvements, complementary technologies, regulations, network and actors' expectations) and systematic institutional adaptation throughout the system (Kemp, Shot and Hoogma, 1998; Hoogma, 2002),

Considering a commercial perspective, a niche market can be related to a given place (e.g. geographical location) and/or a specific utilization of a new technology (e.g. application domain), where users present special requirements that are different from mainstream markets. Furthermore, niche markets can be created and (temporally) supported by 'artificial' means (through tax exemptions and financial grants) to protect technological innovations from a harsh selection (by the audience) and competition with established dominant designs (Kemp, Shot and Hoogma, 1998; Van der Laak et al., 2007). Taking into account these ideas different authors (for example, Schot, 1992 and Levinthal, 1998) argue that, firstly, testing and experimenting a new technology in a niche market is a critical stage during the innovation development process for its later introduction in society in a more successful way. Following this course of action, a new technological regime can be established replacing old paradigms fostering the development of radical innovations in detriment of incremental ones (Kemp, Shot and Hoogma, 1998).

From a research point of view, SNM approach concentrates its efforts to understand the trajectories of sustainable technological innovations by analyzing historical cases studies. Based on the analysis of emerging patterns and findings, strategic niche management can also be employed as a tool to formulate future recommendations. For those reasons, Raven (2005) makes clear that the SNM framework can be regarded as a research model and as a policy development tool.

The strategic niche management topic has been widely investigated aiming to understand the key benefits of the technological introduction in niche markets and how the insights collected from these experiments can assist in future diffusion of these innovations (Loorbach and Van Rack, 2007). Studies undertaken by several authors in different sustainable innovations for example, battery powered vehicles (Kemp, Shot and Hoogma, 1998; Hoogma et al., 2002), fuel cell cars (Lane, 2002) and biogas plants (Raven, 2005; Geels and Raven, 2006) demonstrate the use of SNM framework.

Raven (2005) points out that in many studies involving SNM approach, scholars tend to analyze how successful or unsuccessful (failure) a case study is based on the 'three internal niche processes'. The first, ´voicing and shaping expectations´, is related to 'hearing' involved actors (e.g. users, companies, regulators and institutions) and, fundamentally, aligning their expectations towards technology development directions. It might be used to attract new stakeholders and acquire financial support from government authorities. After that, 'building a network' is associated with assembling a pool of actors that will engage in the innovation process, particularly, in its early stages. New stakeholders can join in later stage as well. Finally, 'learning process' is about knowledge share and interaction among actors comprising not only technical (e.g. design and structure); but also, social aspects (for instance, users' preferences and social impacts) concerning the innovation development process.

The following case study was originally published (in Dutch) by Van der Laak (2005) and reviewed in a later publication of the same author (Van der Laak et al., 2007)**.** This particular example was selected due to its richness of ideas to discuss the introduction and use of biofuels in a Dutch province of Boijl (NorthWest).

The SOS (Solar Oil System) company was founded in 2001in Boijl (Netherland). One of its founders had an extensive working experience with Elsebett, German scientist involved with the biofuel niche in Germany. In 2002, SOS successfully lobbed for a tax exemption with the Dutch Government to produce to 3.5 million litres of biofuel (PVO - Pure Vegetable Oil) from natural resources.

From 2002 to 2005, SOS was involved in a series of projects associated with its biofuel technology expertise. To begin with, supported by its successful German experience with biofuels and a recent (government) financial support, SOS managed to gather 400 local farmers willing to participate on a biofuel production. This move also helped to set the foundations of a future firm named ´Noord-Nederlandse´ whose production started in 2005 and was majorly controlled by the involved farmers (51% of stake). Meanwhile, SOS provided technical know-how to the municipality of Venlo, helping it to upgrade the city's road sweepers to run on biofuel, including vehicles' adaptations (comprising engine and pipework) and infrastructure development (e.g. acquiring legal permits for storage tanks and their construction at the client´s site). In 2003, the Solar Oil System acted importing biofuel for McDonald´s delivery trucks. In here, social, environmental and technical issues emerged. People were not used to the stench smell produced by the biofuel burning engines (local population was used to the regular fuel smell). McDonald´s placed stickers on its vehicles noticing them about the biofuel creating a green appeal towards this initiative. In terms of engine's maintenance, dealers were skeptical about the biofuels engines. However, they soon realized that the maintenance required no major mechanical adjustments that affected the vehicles' warranty. In 2004, SOS directly supplied biofuel for other companies from different areas linked to the ´green sector´ such as OMRIN (waste company) and Van Kats (recycling company).

By 2005, Solar Oil System´s network encompassed farmers (fuel producers), Groningen University (research institution), Rabobank (Bank), Venlo, Van Kats, McDonld´s and OMRIN (users of its product or expertise).

To conclude, through time, Solar Oil System was able to bring together a wide range of partners (network) that shared their views in different ventures all linked to the biofuel technology. In each of these social experiments, actors' expectations

were aligned to achieve not only individual but also collective objectives, leading to a steep learning curve and knowledge share (comprising technical, social, environmental, structural and legal issues). Taking into account the 'three internal niche processes' described by Raven, (2005), the introduced case study can be considered a well-managed and successful example of niche management (Van der Laak et al., 2007).

• Transition Management (TM)

Transition management is a comprehensive and complex long-term approach towards the future. The first studies about this topic were conducted in the Netherlands in the early 2000´s by several authors including Rotmans and Kemp (Rotmans, Kemp et al. 2000) (whose contributions are also related to the strategic niche management field), Geels and Verbong (Loorbach and Van Rack, 2007)

In a broad perspective, transition management (TM) is described as a governance approach concerned with the analysis of social issues as part of complex adaptive systems. To begin with, 'systems' comprises several domains that include among others the social structure, culture, behavior, people beliefs, technology, economy, business, institutions (governmental and private) and ecology (Rotmans et al., 2001; Loorbach and Van Rack, 2007)

From a different point of view, Rip and Kemp (1998) point out that social organization can be divided in three levels. The first, *macro* level comprises material infrastructure, politics, global demographics, social values/paradigms, macro economy and the natural environment. Next, the *meso* level deals with the dominant practices and rules (known as 'regimes') associated with private firms and public policy (driven by optimization rather than transformation systems). Finally, the *micro* level (where 'niche' markets are) comprises individual actors, technologies and local approaches. In here, changes with technology through social experiments leading to new practices/techniques might occur, modifying the current status quo.

Across different domains and levels, a wide spectrum of actors from different backgrounds (e.g. governmental bodies, private companies, societal organizations

and knowledge/research institutions) operate. Each one has its own set of goals and, as they push for their interests to be part of the political agenda, debates and negotiations take place. These ‘mutual adjustments’ help to (re)define involved actors’ positions, expectations and perspectives towards a given social problem. (Rotmans et al., 2001; Loorbach and Van Rack, 2007).

Based on the evidences presented, transition management´s goal is to address (and solve) a social problem by changing the landscape through the interaction of relevant actors across different societal levels. Since transitions take a long period of time, future visions work a general ‘framework’ guiding the development of short and long term processes, actions and milestones to achieve the proposed final goal. In that sense, self-organization, co-evolution and co-production appear as direct consequences of an integrated and adaptive learning process that permeates stakeholders’ interaction through the transition course of action. (Rotmans et al., 2001; Loorbach and Van Rack, 2007).

Another key aspect in transition management is the related to the notion of ‘time’. In general, transitions require a long period of time to effectively take place (25-50 years) from its beginning (when changes are subtle and not visible) until stabilization (when driving forces reach equilibrium). Rotmans et al., (2001) explain that a ‘regime’ can impose difficulties or block changes supporting only improvements rather than fostering radical transformations. On the other hand, actors in the micro level (e.g. ‘niches’) such as policy makers, private firms and institutions can act as catalysts for the creation of new (sustainable) technologies and practices. After a period of time (e.g. a couple of years), trying to repeat a number of social experiments (also in different contexts) with these innovations, can help to scaled them up to be adopted in higher social levels (e.g. *meso* and *macro*), establishing new social paradigms and regimes (Rip and Kemp, 1998).

Finally, taking into account the wide spectrum of factors and agents involved in a large scale transition Rotmans et al., (2001) make clear that governments (and related official bodies) play instrumental roles in transition processes. In a general perspective, governments should take the lead managing transitions by engaging with different stakeholders, formulating future visions, inspiring and mobilizing them. Local and regional governments (that are closer to citizens) also play key

roles in societal transformations, stimulating social experiments (through niche formation), business alliances and social discussions about topics of interest. As a result, the 'roles of government in transition management are plural: facilitator-stimulator-controller-director'.

The development of a new energy supply based on low-emissions in Netherlands is an interesting example of an on-going transition management case (Rotmans et al., 2001). Today, the Netherlands relies heavily on fossil fuels. In addition, global economic downturns can directly affect oil production and price impacting on the political arena. On the other hand, overproduction can lead a reduction on this commodity´s price. The commitment to Kyoto protocol aiming to reduce CO_2 emissions can be regarded as a key driver for social change pushing the Dutch government to search for alternative energy sources.

Transition management in the energy sector takes on board a multi-domain and multi-dimension approach considering both quantitative and qualitative aspects to draw a clear objective. Safety and delivery reliability are key requirements. Risks for environment can be measured based on CO_2 emissions levels; thus, a given energy that pollutes less can be considered more efficient and eco-friendly in comparison to fossil fuels (the CO_2 reduction is a top priority for the success of Kyoto protocol). Considering these aspects, the Dutch government supported by its official Energy regulator (ECN) designed three possible future scenarios for future energy supply.

1. Keeping current infrastructure but the final energy supplied is made from other sustainable sources (e.g. wind, solar and biomass). In here, the main changes are basically related to the supply side that also must convert the energy from these sources to provide methane, oil and electricity. Energy types delivered does not change; only energy harvested (from alternative sources). Comments: this is a 'cost-efficient' scenario since overall energy structure is kept; but, it requires a huge amount of biomass to work efficiently.

2. Hydrogen economy. In here, hydrogen is the dominant type of energy supplied to industry, transport and developing areas. To achieve this scenario, it requires a complete change of gas network infrastructure allowing, for example, cars and

public transportation to run on hydrogen. Comments: There is a possibility of having a complete CO_2 free society and the opportunity to create revolutionary related technologies.

3. Electric-based society. Electricity is the dominant energy supplied to all sectors. It also requires a complete transformation of current energy structure including supply network. In this scenario, cars would run on electricity. Comments: It can be a transition from a low-emission to a free CO_2 society; system breakdowns can happen preventing the development of other innovative technologies.

Despite of the technological traits of the proposed scenarios, a transition program must consider other aspects from different domains including economic (e.g. infrastructure, production and logistics), socio-cultural (e.g. users' lifestyle, perceptions, behavior) and environmental (e.g. risk for nature) since they can influence and impact on each other attracting new stakeholders to engage in this long term process.

After proposing three distinct scenarios for future energy development it is not possible to evaluate their viability at this moment. Thus, keeping them open is a reasonable approach since through time some of them might be discarded or combined leading to hybrid routes. Regardless the option, the government plays key strategic roles issuing policies to direct transitions and searching for innovative perspectives.

Currently, the Netherlands can achieve up to 13% of CO_2 reductions for the 2010-2020 period according to ECN only if the government makes an enormous effort (including a massive energy saving approach; use of renewable energies and large scale structural changes). Nevertheless, there is little change on the landscape to modify the current energy structure based on oil, gas and electricity. As a result, two of the proposed scenarios (e.g. hydrogen and electricity); cannot be reached; yet, this does not mean that a transition cannot be made (for future timeframes).

In order to accelerate the process, the Dutch government should conduct a deep research to understand the motivations and interests of the involved stakeholders in local and regional levels. In addition, investments in alternative energy sources can be done. For example, experiments with photovoltaic energy (through the

utilization of wind turbines and the use of biomass (to feed power stations) can offer significant opportunities to learn about different technologies and create innovative solutions.

From a supplier perspective, the transition management should also investigate if the current structure can support changes concerning the energy type used. For example, if the gas network is suitable to deliver hydrogen. Furthermore, if it is possible to estimate future demand for alternative types of energy in order to develop related innovative technologies (e.g. cars running on hydrogen).

The last stage is to acquire and create social support. For instance, finding support for climate change policies; making transparent the reasons for different actors to join the process and experimenting different energy source alternatives. In the private sector, financial barriers must be tackled (e.g. short-term strategies aiming to maximum return of investment rather than long-term approaches).

Finally, from consumers' point of view, the current Dutch energy distribution in is considered efficient, reliable and cheap. Soon, they will be able to select the suppliers that best fit their requirements, contributing for potential technology development and experiments with alternative energy sources (such as solar and photovoltaic).

The previous narrative depicts an example of an increasing concern related to the use of fossil fuels in Netherland and how the government is designing a future-led strategy to tackle it. Using a comprehensive multi-domain and multi-level approach by integrating different stakeholders (e.g. national institutions, the private sector and consumers) and relying on the creation of sustainable scenarios, the Dutch government set ambitious goals for the local energy industry´s future. Despite of supporting and controlling the overall social transition, it remains 'open' to integrate environmental changes as well as technological development and innovations in the process. Thus, realizing the potential of a large scale social transition takes time and hard work; however, commitment of all involved actors become paramount for delivering long term sustainable winning propositions.

3.6.2 Summary of findings in this section

After reviewing different design-led future forecasting approaches employed in both commercial and social projects, they present unique characteristics and dynamics. In this section, their similarities, contrasts and *modus operandi* will be explored and discussed. In addition, a link with the mobile telecom sector will be introduced discussing how a mobile handset manufacturer could benefit from these instruments in their business.

In general, all five approaches, 'Scenarios', 'Roadmap/Technology roadmap', 'Backcasting', 'Strategic Niche Management' and 'Transition Management' are, basically, employed to assist and support a firm or multiple stakeholders to make better informed decisions concerning the future yet to be created and delivered. To do so, a future vision is a key driver to guide the whole process. In addition, to accomplish projects' objectives (regardless their nature), extensive participatory and collaborative approaches (used in both micro and macro levels of social organization) are a common characteristics across these methodologies involving all participants. As a result, information exchange and ideas' generation are essential factors not only to align participants´ expectations; but also, to analyse other potential elements that can deliver an impact on design-led future projects' development. Therefore, 'future visions' (through 'scenarios'), 'decision making', 'participatory process', 'information exchange' and 'ideas generation' are key attributes 'shared' by these five approaches forming the backbone of a well-formulated plan to design for the future.

With respect to the applications of these approaches, there are clear differences among them, particularly taking into account their scope. For example, a firm creating a 'scenario' or a 'technology roadmap' can manage the whole process by itself, relaying (in some extension) on external partners (e.g. individuals or other firms) to cooperate for a short period of time to address its business objectives. On the other hand, a company taking part on complex medium/long term initiatives such as 'backcasting', 'niche market development' or 'social transitions', that encompasses other firms and governmental bodies, will not have the full control of the process. As a result, it will be part of an intricate stakeholders´ network,

discussing and negotiating goals, demands and expectations in order to reach a proposed common goal.

The ‘exception’ among these highly collaborative complex multi-dimension and multi-level approaches might occur during the development of a niche market. In this case, if a company is the main developer/supplier of a specific technology, it will have a strong bargain power over other players (private firms, only); yet, it does not mean that this firm will have management control over the whole system or participants in the value chain. Moreover, the government might act as strategic partner of this company financially supporting the development of this technology.

From a research point of view, these design-led future approaches cover a wide expectrum. For instance, in the micro level, ‘scenarios’ and ‘roadmap/technology roadmap’ are practical and straightaway tools that can be immediately used by any company. In contrast, ‘backcasting’, ‘strategic niche market’ and ‘transitions’ involve the participation of a significant number of stakeholders including the government, in the macro level. As a result, these instruments tend to present a normative characteristic and can be employed as a guideline and/or policy making methodology under government supervision to provide guidance and support to involved stakeholders across different social domains in design-led future projects.

From a practical perspective, despite the fact that each approach can be applied in an independent way; their utilization also can ‘stack’ (e.g. be used in combination). The following examples show how they might work: (1) a company ‘backcasting’ (e.g. running a ‘backcasting’ program) extensively uses ‘scenarios’ as part of its plan to achieve that specific situation in the future; (2) a given firm can employ ‘scenarios’ to envision the creation of future products and ‘technology roadmap’ to support new technologies’ development, aiming to establish a ‘niche market’ for these solutions; (3) in long term social ‘transitions’, a leading company from a ‘niche market’ (relying on ‘scenarios’ and ‘technology roadmap’) can ascend to the mainstream market supported by a ground breaking technology that challenges the current regime, breaking paradigms and establishing a new dominant design.

Based on the previous ideas, despite the fact that each approach presents a unique scope of utilization and purpose, these two attributes (e.g. scope and purpose) seem to be interconnected. Moreover, these five design-led future tools share a

complimentary characteristic, particularly considering that some of them are used in the micro; while others in the meso and macro levels offering several benefits to (private and public) stakeholders.

Taking into account the wireless telecom industry and putting these ideas in the context of traditional handset manufacturers, these firms can benefit from them in different ways. To begin with, as high-technology developing companies, they can use ‘scenarios’ and ‘technology roadmap’ at the same time in their business, managing all related processes. To do so, they can invite field specialists or other firms to take part in the project bringing fresh knowledge. These tools will support companies to envision future solutions´ possibilities (including audience needs, product utilization and value to users) and guide further technology development (comprising research, integration with other technologies and new materials). In a general perspective, these two approaches will help mobile phone companies (including their design teams) to make better informed decisions with respect to future product development.

Considering a wider business scope, handset companies involved in ‘backcasting’, ‘niche market development’ or ‘social transitions’ are, by definition, engaged in in multi-dimension and multi-level projects. Long term ventures employing any of these complex approaches can offer extensive advantages to participants. To begin with, these instruments provide ‘win-win’ gains to stakeholders because they are based on mutual collaboration. For example, a handset manufacturer can receive fresh information from partners about the market landscape (e.g. emerging trends and under development technologies) as well as from government and official bodies (e.g. ethics code for product marketing and regulations for a new wireless broadband standard trials). This intense ideas´ exchange provides a ‘leap of learning’ supporting the mobile phone company to have a comprehensive view of the landscape in order to align its business strengths to take full advantage of these environmental issues. Furthermore, the synergy among all participants (including government, as a financial supporter particularly in ‘niche markets’) can lead to the development of innovative technologies and products that, later, will be available on the mainstream market (and potentially benchmarked by competitors). Examples of successful technologies ‘incorporated’ in the wireless telecom were the digital camera integration on handsets pioneered by Nokia; the utilization of

LCD touchscreen displays on phones (e.g. iPhone) by Apple and the development of LTE standard to improve telecommunications. The Apple case, also can be considered as an remarkable example of a how a firm made a ‘business transition’ from a ‘niche market’ in one sector to another (e.g. computing to mobile telecom), becoming the new dominant player.

Taking into account a more comprehensive perspective, a leading mobile phone company can become a ‘game changer’ during long-term ‘transitions’ processes. Considering the two past examples (e.g. Nokia and Apple), it is possible to say that the wireless industry is evolving fast. Moreover, these two firms can be considered as milestones of a global ‘transition’ from analogical to digital mobile communications. While Nokia was the major player in the past, Apple overcame it with the disruptive iPhone proposition more recently. In this transitional context, governments play important roles supporting and promoting companies, business and related initiatives steering the whole sector towards digitalization.

To conclude, after reviewing these five design-led future forecasting approaches, considering their (shared) characteristics, differences and dynamics, they all serve for different purposes, despite of their clear future-led drivers. While some of the can be employed as a guideline/policy making tools; others are more practical and ‘hands-on’. With respect to mobile phones firms, these tools present a valuable step forward to design for the future. Nevertheless, from a micro (e.g. company) perspective, there is a need for a more holistic model or framework encompassing actions, methods and issues to support them to create innovative future products.

3.6.3 Design-led future forecasting case studies

Evans (2003), explain that in the design industry, competitiveness is attributed to insightful proposals that companies produce to engage with the future of a target market or audience; thus, they tend to not communicate their business procedures. Nevertheless, some design-led companies have disclosed their future forecasting approaches despite of commercial sensitiveness. In these cases, they provide a general view of their activities focusing more in the created/delivered outcomes rather than the processes.

On the other hand, academic researches focus on describing processes and applied methods in details. In addition, their outcomes are regularly published in scientific publications contributing to body of knowledge.

Based on the previous ideas, despite the scarcity and limited number of evidences found in the specialized literature concerning future forecasting, particularly addressing this issue from a design perspective, this section aims to introduce some examples related to both commercial and academic forecasting processes employed in the design field.

• Philips

The following narrative describes a project undertaken by Philips and addressed in different publications by different authors including Lambourne et al. (1997), Marzano (1999) and Evans (2003)

In 1996, The Dutch electronics company, Philips, conducted a large scale project named ‘Vision of the future’ aiming to explore potential ideas for future solutions that could be offered in the market by 2005.

To accomplish this task, an international multidisciplinary team of professionals from Philips including designers from a wide range of backgrounds (e.g. graphic, product and interaction) alongside with external partners and consultants (e.g. anthropologists, sociologists, engineers and trend forecasts) were brought together. The background research process focused on understanding social-cultural trends and technological developments. There was a clear emphasis on ‘people’ rather than ‘technology’ in order to investigate different aspects of consumers’ daily life considering four categories: personal; domestic; public and work environment; and, mobile (‘on-the-go’).

Firstly, this extensive investigation process generated more than 300 different scenarios. Each of them introduced ‘short stories’ that briefly described people (who); their interaction with products and services (how); time (when) and space (where) the action occurs (what) finally, mapping the overall context of use of products/services. Next, these ideas were developed and refined using physical

models and interface simulations. To assist in this task, the project team relied on interaction design approaches to bring these prototypes to life by incorporating organic and natural ways of interface control such as voice, gestures and writing.

In the final stage, these concepts were communicated to a wide spectrum audience (within and outside the company) through short movies displaying how they work in a real life situations. In addition, this approach was used to illustrate that the Philips 'visions of the future' and its products were not just 'science fiction' ideas and artefacts; but, feasible solutions with great potential to tackle actual needs of users in a near future. Finally, the 'Vision of the future' outcomes were featured in exhibitions, videos and website, enhancing their visibility worldwide.

Finally, at the end of this venture, Philips fulfilled four objectives set prior to the beginning of this project: 1) it exhibited the ability and commitment of Philips Design towards the future by creating meaningful market solutions (e.g. products, services and software) that enhance the quality of people's lives; 2) it stimulated the creative thinking and imagination of Philips stakeholders; 3) it investigated emerging market opportunities brought by new technologies, their meanings and contributions regarding social-cultural context and 4) it showed that a simplistic and qualitative approach (in detriment of pure quantitative analytical methods), can bring outstanding benefits to deliver users' experience and satisfaction.

• Samsung/Seymourpowell

The following process was firstly described in the 'Trend Forecasting for Design Futures' conference paper by Martin Evans in 2003.

The South Korean global electronics firm, Samsung, has been using the services of the British design consultancy firm Seymourpowell Foresight (SPF) since 2000. Samsung´s objective is to gain deep knowledge about the European consumer electronics market as well as current design trends (that are different from its home country). Through this process, Samsung can map the differences between different European countries' culture and collect relevant information for future product development for this specific region (Ward, 2002)

Ward (2002) explains that SPF design process focus on examining economical, social, cultural and technological phenomena in order to provide 'action-oriented' visions of the future to inform potential design strategies. In addition, SPF relies on the expertise of a multidisciplinary team of professional covering areas such as sociology, technology, marketing and design to analyse information collected through a great array of approaches (such as statistics, mood boards, ethnography and scenarios) and convert those findings into insights and recommendations for future products.

SPF work for Samsung includes historical analysis of European countries that defines and helps to shape their own visual culture. These aspects associated with recent design trends present a 'snapshot' of the current aesthetics of popular culture as well as relevant inputs about consumer buying habits (Ward, 2002)

Alongside of emerging issues and design trends, Seymourpowell Foresight also investigates Pan-European trends, plotting their trajectories in the landscape. The identification analysis and refinement of these inputs help Samsung to formulate unique design strategies for new product visual language that, according to Ward (2002), deeply contributes for product and brand recognition going beyond just technological functions.

• Apple

The information displayed below was introduced in the book 'Inside Apple: How America´s most admired - and secretive - company really works' by Adam Lashinsky (2012). This publication introduces and discusses the major aspects of Apple´s design process. The findings presented were complemented by insights derived from specialized websites (e.g. business week blog)

First of all, Apple is a full design-led company. Managed by the British designer, Jonathan Ive (Chief Design Officer), the Design studio is at the heart of the firm, dictating its philosophy. From strategy (Mr. Ive reports directly to Steve Jobs, CEO, sitting at the board discussing product design related issues that will support future engineering and marketing efforts directed by the design team vision) up to product development (including hardware and software conception), design is a

key asset for Apple´s successful products such as Macintosh computers, iPhone, iPod and iPad (the last three gadgets accounted for 70% of Apple´s revenue in 2011). From an aesthetical viewpoint, Mies van de Rohe´s 'less is more' mantra steers the creative design process leading to neat, elegant and sleek state of art products that work straight from the box.

When a new project is set, secrecy and discretion are mandatory at Apple. At the bottom line, the 'product start-up' involves organizing key human resources to be assembled in specialized teams. They are allocated in exclusive buildings and offices without contact with other employees working in different ventures (for example, the iPod's development team works in an independent way, reporting directly to its own project manager). However, in specific situations, for instance, during the iPhone development (considered as a high priority), executives allowed its manager to integrate distinctive talents from other divisions (e.g. iPod) to its team. These measures aim to guarantee employees focus on a particular product separating them from the firm's basic structure and, at the bottom line, avoiding 'cannibalizing' its products.

Prototyping is an important step in NPD and it is related to both hardware and software. Based on the ´pixel-perfect-prototype' approach, the design team creates realistic mock ups to have the exactly 'look and feel' of the products. Through the 'pixel-perfect' approach concepts are crafted considering their minimum detail (e.g. pixels) displaying how software (e.g. iOS) actually works concerning all embedded features and user interface. Followed by the '10 to 3 to 1' methodology, designers are expected to create 10 mock ups without any restrictions portraying new features. Next, this number is reduced to three concepts where they spend a considerable amount of time refining them until a decision about one model that presents the strongest potential to become the final product is reached.

When the final design of the product is ready, Apple uses its ANPP (Apple´s New Product Process) to proceed to the next product development phase. Basically, the ANPP is a playbook with guidelines informing about aspects, stages and responsibilities of each function (e.g. person or department) to get the product manufactured. The ANPP was firstly employed in the production of Macintosh computers and it has been emplyed to support the manufacturing of laptops and

mobile devices, ever since. In this stage, two key people managing different teams work in a collaborative way: the Engineer Program Manager (EPM) that coordinates the engineering team (both hardware and software) and the Global Supply Chan Manager (GSM) responsible for sourcing materials, procurement and overseeing production. Despite of working closely at Apple's headquarters (in Cupertino, USA), they often travel to China to oversee manufacturing processes that occur in Chinese factories. They regularly travel back to USA to get the final approval of senior executives concerning 'beta versions' (last fully functioning prototypes) of products before they are ready to be produced.

To follow up product development, regular meetings take place involving a wide range of Apple´s stakeholders. For example, the executive team review meeting happens weekly (on Mondays). Due to the fact that Apple works with a limited line of products, they can be easily reviewed in a regular basis receiving feedback for improvements. In practical terms, it takes approximately two weekly meetings for top executives to check them out and make a final a decision, characterizing a very short decision 'loop', speeding up the whole production.

Different from regular Microsoft's Windows PC´s, Apple has everything 'under its roof'. This metaphor is used to explain a 'new way of vertical integration'. In a broad perspective, Apple has a unique control and integration of its own software (e.g. iOS) and hardware on its products. From an operational point of view, Apple retains its intellectual assets (e.g. technical expertise, creativity and design know how) on its American headquarters, while 'outsources' manufacturing to Chinese factories. The key difference is that Apple has a strict quality control over production and high bargain power to choose the most suitable suppliers. Thus, it virtually controls each production step without (physically) owing the facilities, putting down overall costs (e.g. legal, operational and labour) to a minimum.

Aligned with the previous ideas, Apple's closed approach towards management and product development is the firm's main characteristic. The visual language adopted across its products is consistent in both hardware and software levels. The slick and neat form factor associated with lightweight materials give them a premium look and feel. From software point of view, there is preoccupation to offer a smooth user experience across the different lines of its mobile devices. For

example, Macintosh native OS X was modified to run on the iPhone giving birth to iOS. In addition, the design of icons and user interface (UI) consider each pixel when crafted. Finally, the iPhone is the main product of a standing alone wireless ‘ecosystem’ insides Apple´s product ‘ecosystem’.

Packaging is another key area that Apple spends effort to deliver outstanding user experience. In the packaging room, hundreds of boxes are created, tested and opened to give the designers the opportunity to fully ‘understand’ what customers feel when interacting with these ‘mundane’ objects. This ‘human-centred design’ approach guides the overall process of designing these containers where different materials, ‘arrows’ design (colours, sizes, directions) as well as tapes, tabs (where to pull/open and retrieve the product) and stickers are crafted and thoroughly tested. Apple´s extreme attention and care regarding package design is aligned with its premium price tag strategy and the expectations that customers have when unveiling their new gadgets (just like a shell that protects a shining pearl).

At the last mile, the internal manual named ´Rules of Road’ clearly signposts each step and action to be taken weeks and even months before product released. Apple takes it so seriously, that copies are watermarked and passed to key personnel involved in the process, only. If they commit a strong fail or if the manual is founded with someone not authorized, parties can be made redundant based on the internal Direct Responsible Individual (DRI) policy.

• Design Futures framework

The framework displayed bellow was developed by Martyn Evans and described in his paper ‘Empathizing with the Future: Creating Next-Next Generation Products and Services’, published in the Design Journal, 2011. This publication was selected because it was the only piece of academic publication that addressed the use of design in future-led procedures in a more comprehensive way.

First of all, design must be ‘elevated’ from its established and traditional roles in project development and be applied to support the identification and definition of business objectives. Acting as a strategic instrument assisting in decision-making

processes, design becomes a tool committed to look ahead, exploring and creating the next generation of products.

After that, the researcher points out that there are some barriers that companies must be familiar with during future-led product development processes. First, consumers' opinions are based on historical precedents and on what already exists. Therefore, they present very limited perspectives about the future and cannot explain how it would be. To overcome these limitations, firms must look for new inputs and triggers to feed their creative processes. To do so, a mix of secondary and primary data collection methods can be applied to gather and explore fresh ideas. However, companies must be aware of the complexity, time constrains and financial aspects related to both collection and analysis of these data.

Next, firms must take into account three key factors in order to create the 'next-next' future market solutions: what consumers want and desire in future products; what is strategically and economically possible to produce; and what technologies can be integrated into new products. Solutions that address these issues deliver outstanding benefits for both companies and consumers.

The researcher makes clear that the design futures research process must consider five key aspects (including several approaches to address them: 1) understanding socio-cultural context (using, for example, PEST analysis, personas, ethnography and in-depth interviews); 2) tracking trends and movement in users' behaviour (by monitoring current trends, analysing trends' manifestations, mapping their future trajectories and assessing changes in human behaviour patterns); 3) employing non-design research techniques (for instance, competitors' analysis, SWOT and scenarios); 4) relying on designers' intuition and instinct (based on their own vision of the future, past experience and personal/subliminal synthesis); and 5) gathering experts' opinions and insights (through in-depth interviews, Delphi panels, field specialists and extreme users inputs).

After that, all data collected must be analysed. The inputs are placed together, organized and synthesized in useful information. Subsequently, the transformation of these insights into practical knowledge leads to the formulation of actionable roadmaps, concrete ideas and concepts to be communicated to all stakeholders involved in the process.

The communication process is a crucial step during the design futures research and visual resources are widely used to bring ideas and concepts to life. Sketches; illustrations; 2D and 3D models; prototypes and mock-ups can be used not only to present ‘visions of the future’; but also, to explore, refine, validate, communicate and gain peers’ feedback.

Finally, it is necessary to communicate and educate consumers in order to prepare them to receive the future. Otherwise, all efforts made by companies, designers and other stakeholders will never come true in the shape of a new product.

3.6.4 Summary of findings in this section

The four case studies presented in the last section addressed the design-led future forecasting processes through different points of view. While the first three (e.g. Philips, Samsung/Seymourpowell and Apple) discussed specific and practical applications of design in future-led projects; the last case (e.g. Design Futures Framework) introduced a ‘generic’ academic view about this particular topic.

Considering a different perspective, Apple’s case study focused more on design management related issues; while Philips and Samsung/Seymourpowell cases examined operational uses of design in business. Finally, Evan´s Design Futures Framework (2011) made references to these two domains (e.g. managerial and operational) bridging them considering a strategic point of view. Despite of not being associated with the wireless industry, they present complementary ideas, underlining important aspects that firms should take on board when designing for the futures in the sectors they operate.

Fig. 3.7 - Case studies analysis matrix

In general, the examples highlighted the importance of identifying and acquiring relevant information about a wide array of topics. To begin with, by checking and following the trajectory of distinct environmental phenomena and also several design trends, these movements can work as a trigger leading to the development of new market solutions. Next, with respect to users, even though they present limited views about the future, investigating their daily routines, behaviours and aspirations, can inspire creative ideas and insights about interaction with future products. After that, from a commercial perspective, it is necessary to understand not only external factors; but also, consider internal issues such as what is possible to produce that is aligned with the firm's strategies and future goals taking into account its (physical) structure, human resources (e.g. stakeholders' relationships and teams' managements), expertise (e.g. technical and creative know-how) and constrains (e.g. financial resources and time). At last, engaging with experts can bring valuable contributions when designing for the future since they can provide fresh and unique insights about numberless relevant issues.

To collect these data, a number of research methods are applied considering the source and nature of inputs required. For example, PEST analyses, ethnography, SWOT and Delphi panels are techniques used to investigate trends, users, market and experts, respectively. After that, the information gathered is reviewed and analysed by a multidisciplinary team (including designers, professionals from different backgrounds and experts, within and outside a firm) and transformed into actionable insights that lead to the development of product's concepts, prototypes and scenarios (e.g. hypothetical future situations of product utilization by potential users). These visual resources are used to communicate and collect key stakeholders' feedback about the proposed ideas, since they represent the multidisciplinary team's visions of the future.

Finally, the collection of evidences presented can be classified considering their characteristics and topics addressed. Thus, these inputs can be allocated in one of the following groups: 1) 'Users' inputs'; 2) 'Trends and environmental issues'; 3) 'Business aspects'; 4) 'Experts insights'; and, 5) 'Designer's perspectives'.

3.7 Empathizing with the future: design-led dimensions

Based on the case studies analysis (sections 3.6.3) when engaging in a design-led future project, the design team should identify and acquire relevant information about a number of issues. In addition, it is critical that they apply distinct research methods to explore these factors and generate new possibilities. The chart below displays these dimensions.

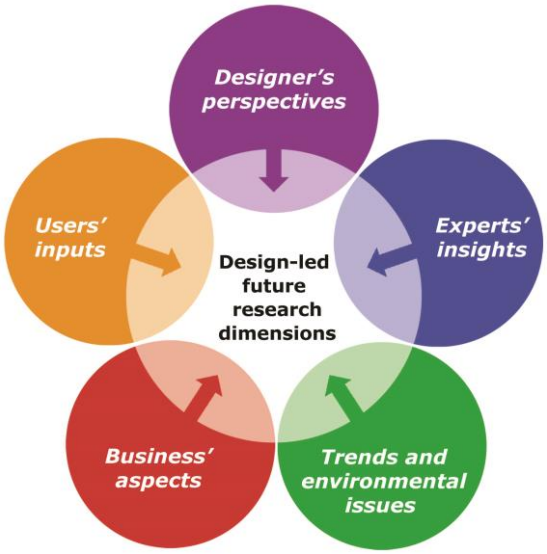


Fig. 3.8 - Design-led dimensions towards the future

• Designer's perspectives

Apart from recognized and established research techniques such as in-depth interviews (to probe/investigate users); PEST analysis (to explore environmental changes and trends) and competitors' analysis (to investigate and evaluate competitors' products and strategies), designers also use a set of informal and non-academic procedures. In certain extension, they rely on their intuition and instincts to conduct projects that engage with the future. Evans (2011) highlights that intuition can be used to break down existing traditional paradigms leading to a creative leap. Aligned with these ideas, Woudhuysen (cited in Evans, 2003) explains that these emotional approaches (e.g. designer's intuition, metaphors and idealistic views) play important roles in the overall design process.

On the other hand, the use of intuition raises some concerns. Due to its lack of rigour, it cannot be precisely quantified, demonstrated or replicated (Evans, 2011).

In addition, Woudhuysen (2007) states that even though intuition plays a pivotal role in design-led projects, the use of formal research techniques can lead to surprising and also counter-intuitive outcomes.

• Users' inputs

Users have been an important source of inspiration and ideas for designers. Therefore, 'understanding the consumer is important for designers in order that they can develop a conscious and subconscious understanding of consumer needs, and translate that understanding into design features' (Cooper and Press, 1995).

Laurel (2003) explains that while market research stands at the back-end of the process and is concerned about advertisement and sales; design research sits at the front-end informing the development of new market solutions from the beginning until the end. Consequently, the difference between these two approaches and their related methods, directly impact on the quality and relevance of information collected. Traditional research methods can be redundant, since users present a limited understanding about the future and they are not able to clearly disclosure what they would like to do or have (Kelley, 2004; Evans 2011). At the same time, conventional market research instruments only reveal what consumers already like, want and need without providing practical future-led insights about the future (Bruce and Cooper, 1997).

As these established tools are not assisting designers to gain a leap of knowledge about different users, Laurel (2003) states that Human centred design research and its several techniques can help designers to have a comprehensive perspective about consumers and the environment, since 'it investigates behind the scenes, looking at individuals, situated contexts, cultures, forms, history and even business models for clues that can inform design.'

• Experts' insights

Experts from different fields and backgrounds are considered another source of significant information that designers should strongly consider when working on

future oriented projects. Their ideas and insights can offer utmost contributions in these ventures. For example, their views can be used to complement previously collected information (from other sources) filling possible gaps in knowledge and also providing fresh, provocative, counter intuitive and contrasting arguments (Evans, 2011).

In addition, Deasy (2003) explains that experts not necessarily come from the market; they can be either specialists or heavy users of a specific product or service. Finally, insights provided by these professionals regarding when, how and in what extent future events will take place are useful resources employed by companies to assist planning their business; forecasting activities and decision making processes (Clarke and Gupta, 1996; Woudhuysen, 2007)

• Trends and environmental issues

External and environmental phenomena such as economic factors, social cultural changes, technological developments and trends in design also should be taken into consideration when designing for the future. Makridakis (1998) points out that using past data (e.g. statistical records) to understand patterns of changes can assist in projecting further developments of these events in future time frames.

Moreover, it is necessary to identify current and emerging issues in the landscape by analysing distinct sources of information. For example, academic (e.g. journals and conference proceedings), non-academic (e.g. magazines and newspapers) and also specialized publications (e.g. industry and trend reports) provide paramount information about these manifestations (Evans, 2011).

Finally, new fast moving events and trends coming from unexpected sources (such as different industries and business areas) impose considerable challenges. Thus, they must be constantly monitored and their effects evaluated considering the potential impacts on business and the time scale required to respond them (Ansoff, 1980).

• Business aspects

When designing for the future (for example, the next generation of products), several business and commercial aspects should be taken on board throughout the design process.

Apart from dealing with constrains that can be related to time (to market) and financial resources, Weiss (2002) highlights that companies should be aware of other factors. Firstly, firms should understand the key drivers and motivations for people to buy; consume and interact with artefacts (desirability). Next, what technologies can be incorporated into products under development (feasibility). Finally, what is strategically viable to produce that is aligned with the company's objectives and competitive position in the market (viability). While the first topic (e.g. desirability) shares a close relationship with 'Users' inputs' (previously described); the last two (e.g. feasibility and viability) are related to strategic and technical issues.

At last, a constant evaluation and analysis of market competitors, including their strategies, products and position helps a company to direct its business approaches and efforts to specific directions in order to take advantage of opportunities, avoiding potential threats and minimizing risks.

3.7.1 Summary of findings in this section

Ranging from external and 'uncontrolled' issues (e.g. environmental aspects; users' requirements; competitors' approaches and products) up to internal and 'controlled' factors (e.g. strategies, know-how and financial resources), the dimensions previously presented (Section 3.7) cover a broad spectrum of elements that should be strongly considered when carrying out a project engaged with future timeframes.

Firstly, by scanning the environment taking into account environmental, social, economic and technological factors as well as design trends, the multidisciplinary research team can have a comprehensive view of the market landscape. Next, researching and investigating users can provide useful information about their

requirements, behaviours and attitudes towards a given product or service. After that, exploring competitors' approaches, products and market position allows the research team to have a clear idea about their business strategies and possible directions. Subsequently, by engaging with experts, fresh and updated information about a number of issues can be collected complementing past data gathered. Finally, based on these insights, the research team can create innovative strategies that are better aligned with the firm's *ethos* and goals.

In conclusion, the extensive range of factors that needs to be taken on board reveals the complexity and magnitude of a well-planned design-led future oriented project. Thus, lacking or superficially addressing those aspects leads to deficient decisions, impacting first in the design research process and later, in the project's final outcomes.

3.8 Design research towards the future: a multidisciplinary tool box

Since design is considered a multifaceted discipline, it incorporates and employs a number of methods originally applied in other fields. Lunenfeld (2003) explains that design research use tools ranging from social sciences up to marketing and business when necessary. In addition, design research is committed to find out something new and unexplored rather than finding what is already known.

The following chart is illustrative rather than exhaustive and introduces some of the most used formal techniques employed in design research towards the future.

Fig. 3.9 - Formal design future's research tools

3.8.1 Users' data collection methods

• Contextual Enquiry

In a general, contextual enquiry works as a combination of an 'in-depth interview' and 'observation'. In fact, contextual enquiry is a type of interview conducted in the place (context) where a specific product is used. The benefits brought by this approach for design research are numberless. Firstly, it supports the collection of detailed information *in loco*. After that, it fosters open discussions around the researched topic. Next, the observation part brings deep levels of design insights about users' interaction with products. At last, their needs, behaviours, attitudes and constrains can be checked, evaluated and clarified instantaneously (Deasy, 2003; Don and Petrick, 2003; Ireland; 2003).

On the other hand, this method presents some limitations. External factors (e.g. phone calls) can be a source of interruption or distraction during the research process (Ireland; 2003).

• Users' survey

Survey is a primary data collection method used to gather descriptive information about general market issues, demographics, consumers' attitudes and market potential for new products (Kotler, 2008). To be effective, it must be applied to a large sample of consumers that represent that specific target segment (Silverman, 2006). The amount of inputs collect from each respondent varies according to the aim of the survey. Usually, it is used to test previous hypothesis and its findings are consolidated in statistical data (Silverman, 2006; McDaniel and Gates, 2007; Kotler, 2008)

Despite its flexibility (surveys can be applied through different channels such as mail, telephone and online), it presents some constrains. For instance, respondents can give answers to please the researcher; they might do not feel comfortable with the topic or they cannot be sure about the answer. Online surveys offer flexibility and convenience for respondents regarding time and place to complete the task. Yet, this approach is very impersonal and does not allow researchers to evaluate

respondents' emotions and attitudes towards the investigated topic (Kotler, 2008). Last but not the least, other drawbacks can be caused by interviewer's influence or measurement errors (McDaniel and Gates, 2007).

• In-depth interviews

In-depth interview is a primary data collection method employed for learning how a person feels and thinks about a specific topic (Best, 2006; Ireland (2003). This instrument is concerned with the quality rather than the quantity of information gathered. 'Quality' in this context is associated with respondents' richness of experiences, transparency and honesty of insights provided (Malhotra and Birks, 2003). Therefore, the use of exploratory questions (e.g. 'what' and 'why') helps the researcher to explore the investigated subject (Deasy, 2003).

In addition, through the direct interaction with respondents, researchers can see, hear and collect personal information regarding their needs, dreams, desires and frustrations (Don and Petrick, 2003; Shedroff, 2003).

On the other hand, in-depth interviews also present some limitations. Apart from (possible) interviewer's influence on the process (Ireland, 2003); respondents might feel judged and 'pushed' to speak what the interviewer 'wants to listen' (Shedroff, 2003). Finally, since the analysis of the information collected through this method is laborious, biased interpretations of facts can occur (Malhotra and Birks, 2003).

• Ethnography

Deriving originally from social sciences, this method is applied to observe, learn and sequentially map the lives, behaviours, beliefs and preferences of a group of people taking into account their interaction with artefacts within a context or environment (Borja de Mozota, 2003; Raymond, 2010; Plowman, 2003; Ireland, 2003). Furthermore, it can obtain information when people are not willing or do not know how to elicit answers (Kotler, 2008). Ethnography brings useful benefits

for the design process, since designers can develop a critical thinking approach about human interaction that leads potential insights and ideas (Plowman, 2003).

The advent and easy access of more sophisticated devices such as digital cameras (for taking pictures and recording movies), laptops and even mobile phones help researchers to collect, edit and share their findings in a fast and convenient way (Ireland, 2003).

However, since it relies heavily on observation, ethnography is not recommended for fast paced developing projects. In addition, this qualitative data collection tool is difficult to benchmark in order to check the quality of the research conducted or the amount of data collected (Ireland, 2003).

• Focus groups

Focus groups engage a small group of target consumers in a discussion about a specific issue (Best, 2006; Ireland, 2003). These meetings are facilitated by a moderator that follows a script to address the researched topic, aiming to generate ideas and expand general understanding without the need of reaching an audience consensus (Ireland, 2003). At the same time, consumers' reactions and behaviours can be observed and analysed (Best, 2006).

Since this instrument is used to collect opinions of different people interacting at the same time, it presents some limitations. First of all, focus groups are not recommended for sensitive and private issues (Ireland, 2003). Next, respondents can be influenced by peers during the interview process. Finally, respondents might not be honest and open in front of other people (Kotler, 2008).

• Usability tests

In general, usability tests aim to check products or services and how users interact with them (Purpura, 2003). Usually, these evaluations are performed in the early stages of the product development, either in a full controlled (e.g. laboratory) (Purpura, 2003) or a real-life environment (e.g. user's home) for a given period of

time in order to provide useful feedback about these under development concepts (Ireland, 2003; Design Council, 2007). Moreover, usability tests bring numerous insights for the design process. By exploring the experiences that users have with these prototypes, designers can evaluate various aspects of the proposed solutions. By the end of this extensive process, they can have a clear idea about the winning concepts (Purpura, 2003).

3.8.2 Market & business data collection methods

• SWOT analysis

'SWOT' stands for Strength, Weaknesses, Opportunities and Threats. While the first two factors are associated with a firm's capabilities (e.g. internal factors) that can be controlled and managed; the other two aspects deal with market issues (e.g. external factors) that are beyond a company's control (Kotler, 2008).

SWOT is an analysis method applied to scan the market conditions and confront them with the company's internal assets in order to 'match' them. When these events are, somehow, aligned with the firm's resources, it generates valuable business opportunities. Conversely, when this corporation do not have know-how (for instance, in a particular area) to take advantage of these landscape phenomena, they become threats. (Ansoff, 1980; Kotler, 2008). To conclude, the use of SWOT analysis can assist firms to monitor, evaluate and develop efficient strategies to promptly respond to changes in the external environment (Ansoff, 1980, Van Assen et al., 2009)

• Competitive analysis

According to Best (2006), competitive analysis can be achieved through the use of matrices with the purpose of checking a firm and its competitors positions in the market. The contribution of this tool is twofold: it assists companies to identify the relationship between its products/services and those offered by other players as well as to envision possible market gaps and opportunities.

Different competitive analysis matrices have been used to cover a variety of issues including brand position, value proposition, product and service portfolio and customers' perspectives (Kotler, 2008). For example, both the Boston Consulting Group (BCG) matrix and the General Electric (GE) grid focus on portfolio performance analysis despite of following different approaches. On the other hand, Ansoff's (1988) product/market grid aims to explore distinct strategies for product development (from current solutions up to new products) taking into account the nature of markets where a company aims to compete.

3.8.3 Experts' data collection methods

• Experts' interviews

Experts' interviews are a primary and qualitative data collection method used to assist in the diagnostics of a research problem. Malhotra and Birks (2003) declare that researchers do not have to follow a formal structured questionnaire; however, it is paramount to make a list of key topics to be covered during these meetings.

Don and Petrick (2003) state that through experts' insights, designers can quickly find out and learn key issues about a specific topic that, usually, are 'taken for granted'. In addition, the professionals approached can be specialists in a given field/industry or present distinct backgrounds. Deasy (2003) points out that by contacting experts from the same area, researchers are able to have a multifaceted view of the investigated subject. In contrast, experts from different backgrounds and areas of expertise present a unique set of ideas and a particular frame of reference that challenges the traditional mindset and *status quo* (Rhea, 2003).

This approach also presents some limitations. They can be related to a specific type of knowledge or expertise that a given professional do not possess and/or constrains to locate and access a particular individual (Malhotra and Birks, 2003)

• Delphi panel

Named after the ancient Greek god/oracle Delphi, who offered visions and advises about the future, the Delphi panel relies on a group of experts to generate future oriented insights about a topic (Clarke and Gupta, 1996; Woudhuysen, 2007)

This popular and inexpensive tool has been used to forecast and make predictions regarding different time horizons (from short to long term) in different industries. In addition, through this long-range qualitative forecasting technique, researchers can quickly and efficiently elicit responses from a group of specialists bringing knowledge, authority and insights about an investigated issue and, at the same time, promoting learning among panel members (Clarke and Gupta, 1996). The high quality insights generated through this experts' panel supports forecasting and decision making processes in both public and private sectors (Clarke and Gupta, 1996; Woudhuysen, 2007).

Conversely, panellists can deliberately promote desired outcomes, influencing future decisions by arguing that the group reached a consensus about the topic under investigation (Clarke and Gupta, 1996)

3.8.4 Trends and environmental issues data collection methods

• PEST analysis

According to Kotler (2008), PEST analysis is a tool used to review and monitor political, economic, social and technological aspects of the macro environment. Basically, variations and changes occurring in the landscape in association with other related phenomena can deliver a direct impact on market and business relationships. Therefore, this straightforward and simple method plays a strategic role and 'can be used as an early warning system for companies to be prepared and plan ahead future actions' (Best, 2006).

• Trend scan

The process of scanning the environment, tracking trends and other relevant issues that might impact on future-led projects is done using different tools and sources of information.

For example, designers and design teams can commission specialised firms to deliver trend reports that Brunini (2011) refers as ‘strategic documents that track down the behaviour and evolution of notable shifts in society, culture, aesthetics, technology, environment, consumers. Trend reports go beyond what is happening now and always present patterns suggesting directions to future projections’.

Apart from acquiring already compiled and digested data/information about trends, designers can look themselves for these signs. According to Raymond (2010), they can search through printed material (e.g. books, magazines and newspapers); live media channels (e.g. radio and television); online (e.g. specialized websites, blogs and social media services); exhibitions and specialist trade fairs; and, last but not the least, looking for similar design patterns and visual language (e.g. shapes and materials) through objects and artefacts from different sectors such as medical equipments and automotive industry.

All these approaches aim to assist in the task of finding where the ‘first symptoms of a trend are likely to emerge’ (Raymond, 2010).

3.8.5 Data consolidation and synthesis methods

The following two techniques, Personas and Scenarios, are not placed together with other tools previously described (fig. 3.9). The reason behind this approach is related to the fact that these two particular tools are not used to collect information, but to synthesize and consolidate data gathered through other methods.

• Personas

Personas are a straightforward method applied to build up profiles based on real users/consumers’ information through visual and textual descriptions of these this

audience (Ireland, 2003). Don and Petrick (2003) explain that personas are created in collaborative brainstorming sections comprising stakeholders and a number of professionals from different fields such as design, marketing and engineering.

Personas are not an end, but a means to indentify users' personal goals and needs; therefore, inspiring and guiding designers during the research process. In addition, the collection of profiles created through this method can be strategically aligned with corporative business objectives and technical resources in order to establish priorities of technological features embedded in new developed products (Don and Petrick; 2003).

• Scenarios

Best (2006) states that 'scenarios create a context in which to imagine consumers using potential products and services.' In addition, Rhea (2003) explains that the scenario building technique creates a script to address experiences that users will find in the future, taking into account aspects such as people (who), time (when), space (where), reasons (why) and context (how).

This instrument can be applied to describe what future products can do for users (e.g. process and features); how these products will look like (e.g. materials and size) and how they will fit into users' lifestyle (Rhea, 2003). Furthermore, users' behaviours and emotions can be plotted considering a wide spectrum of people (e.g. family) or just only one target (e.g. individual) (Shedroff, 2003).

Scenarios are created during brainstorming sections. Through these small written, oral and visual stories, designers are forced to look at things considering the point of view of users, putting aside any other biased perspective (Rollestone cited in Best, 2006). Thus, they must follow their own logic, rationale and their proposed future narratives must be realistic and true (Raymond, 2010).

3.8.6 Summary of findings in this section

The wide range of formal research instruments discussed in the last section can be divided in two main groups according to their purposes and utilization: data collection or data synthesis methods.

As important as exploring their contributions to design-led processes towards the future, it is to identify and understand their dynamics, strengths and weaknesses. Since different tools are employed together rather than being used alone, they can uncover different details about the investigated topics; overcome limitations that a given tool might present and give more credibility to the overall process.

For example, a detailed survey can be employed to check users' attitude towards a specific mobile technology. The findings can be integrated into statics informing about users' perceptions concerning the investigated topic. Also, they can be used as platform for creating a focus group targeting specific consumers segments to discuss certain issues about wireless products. On the other hands, if detailed and personal data are required, researchers can conduct in-depth interviews or evaluate users' behaviours *in loco* (e.g. checking how they perform a give task with their phones) through a context enquiry. In addition, ethnography can be employed when there is a need to check users' attitudes with handsets without influencing their responses.

From a commercial perspective, a thorough assessment of competitors strategies (for instance, mobile ecosystem approaches) and products (e.g. handset portfolio) combined with a SWOT analysis can assist traditional handset firms to evaluate the market landscape in order to identify new opportunities and avoid potential treats.

Next, the use of PEST analysis for the identification an examination of current and emerging environmental phenomena within and outside the wireless sector (e.g. a new technology or a particular resource) provide useful information to wireless firms. Associated with secondary research sources (such as trend and specialized industry reports), they can offer a broad perspective about market issues that can trigger the development of future mobile equipment and services.

By engaging with experts from different fields and backgrounds, manufactures can gain substantial benefits. These high calibre professionals are the ultimate source of updated information covering a wide range of topics. In addition, their unique know-how can be used to complement or challenge past acquired data from other types of sources. When working together with other experts (in a Delphi panel), their analytical skills and insights can be determinant for the development and adoption of new strategies in order to achieve business goals.

At last, with respect to data synthesis tools, the use of both personas and scenarios offer great support for analysis and consolidation of inputs collected. Persona is an instrument that assists the research team to map and define groups of users according to different factors, for instance, economical power, current life stage, handsets' usage patterns and attitudes towards new technology. Scenarios is a comprehensive technique that not only encompasses the description of potential users (who); but also, the overall situation(s) where a potential product (where, when, how and why) is used. The idea behind this particular method is to create a future context where a wide range of issues that might influence users' interaction with a product (e.g. a new mobile handset) can be mapped and exanimated.

3.9. Conclusions

Throughout this chapter, design was addressed and thoroughly discussed in order to identify and describe its distinct roles and contributions for future forecasting activities.

Firstly, the origins of the word 'design' as well as its fundamental uses (related to philosophy, research approaches and methods) were introduced and discussed. The comprehensive range of design applications indicates that this discipline is committed with the future by understanding current situations/issues in order to develop solutions to address them.

Next, a wide range of design-led future forecasting approaches were reviewed and analysed. Ranging from micro and macro levels, these distinct tools covered both 'hands-on' and policy making methodologies underlining their contributions to support companies to design for the future.

After that, a relationship between design and forecasting related approaches was introduced. Supported by industrial evidences (based on future-led case studies examination), the different functions and contributions of design and designers for future forecasting processes were presented and highlighted.

Through the analysis of case studies analysis, five dimensions named ‘Designer’s perspectives’; ‘Users’ inputs’; ‘Business aspects’; ‘Trends and environmental issues’ and ‘Experts’ insights’ where identified as key areas that firms working on future-led design projects should carefully investigate. Moreover, a number of approaches and research methods employed to address these numberless factors (e.g. users, trends, experts and business issues) were presented and classified accordingly, alongside with tools used to analyse data to propose directions for future solutions’ development.

Last but not the least, by understanding the characteristics of the several elements presented in each dimension and employing appropriate research approaches and methods to address them, the multidisciplinary research team is able to conduct in a rigorous and efficient way a design-led (research) process to create, shape and deliver the future yet to come.

4 Methodology

4.1 Introduction

While the first two parts of this report (e.g. Introduction and Literature Review) is presented and discussed several topics that this research addresses (e.g. changes in the mobile telecom landscape; users' adoption and experience drivers regarding wireless technologies and the extensive applications and contributions of design for future forecasting), this chapter is dedicated to describe the methodology used throughout the course of this PhD research

Basically, it is divided in two major sections. Firstly, an overview of different research methodologies is introduced. Ranging from generic up to specific design related approaches, they are discussed in details followed by the selected research strategy. In the second part, the methodology used in this study is presented highlighting the relationships between selected methods and research objectives. In addition, this section also addresses both data collection (e.g. literature review, case studies and experts' interviews) and data analysis tools (e.g. Ground Theory) employed through this research.

4.2 Research in the design field

Gray and Malins (2004) describe research as an organized investigation process that, initially, is supported by three key questions: 'what' (research proposition and research question); 'why' (the need of the research considering the context where it is applied) and 'how' (methodology and methods used to explore relevant issues). All these dimensions lead to a final step named 'so what' that, basically, is related to the contributions that a study brings to a given field and can be widely disseminated.

When conducted in the design domain, Cross (1999) argues that the main purpose of the design research is to produce, articulate and convey design knowledge. Aligned with these ideas, Cooper and Press (2004) point out that 'the overall aim

of design research is to develop an accessible, robust body of knowledge that enhances our understanding of design process, applications, methods and contexts'.

Based on the exposed facts, this PhD research aims to contribute to the body of knowledge by producing a design-led future forecasting model for mobile communications industry. In order to achieve this goal, this study investigates the character of design research and also the process of future forecasting applied in the design field. In addition, by exploring key different dimensions and a number of design and non-design research tools, the researcher can identify where these factors and techniques sit in the different stages of the process. Ultimately, this study intends to bridge design expertise and future forecasting approaches taking into account major issues from the wireless communications industry with the purpose of creating the intended framework.

4.3 Research methodology

In a general perspective, Silverman (2006) declares that methodology refers to the selection of appropriate research approaches (models and types), cases to study (issue or problem) and methods (of data collection and data analysis) applied throughout several research stages (from planning to execution). Based on these ideas, the following sections address the research milestones: research approaches (section 4.3.1); selected research strategies (section 4.3.2); methodologies applied in design research (section 4.3.3); selected research methodology (section 4.3.4) and selected methods (comprising data collection and data analysis tools) used in this study (section 4.4)

4.3.1 Background of research approaches

In this section, distinct research approaches ranging from generic to more specific strategies used in the realm of design will be briefly reviewed. After that, the line of research selected for this study will be presented in details.

• Generic research approaches

There are various approaches to design an academic research. One established criterion deals with the purpose or nature of the investigation process that directly impacts on the type of study conducted. An ‘exploratory’ research focuses on a topic that little understanding or evidences have been provided; therefore, ideas and hypotheses for future studies can be generated. In a ‘descriptive’ research, a bold and accurate information background about the research topic is presented, highlighting its main characteristics. At last, an ‘explanatory’ research looks for an explanation for a given situation, exploring different aspects in order to identify associations between patterns, drivers and the investigated phenomenon. Therefore, this approach is more comprehensive (in comparison to the other two) and deal with topics that already reached maturity (Robson, 2002; Yin, 2009).

Another research approach considers the relationship between the character of the study and the employed research methods. To begin with, a quantitative research stresses the use of numeric and statistical values to deliver an outcome. It relies on structured and fixed procedures (for example, surveys) to evaluate variables (or propositions) extracted from developed theories. On the other hand, a qualitative research explores the use of communication and language. In this approach, researchers use less rigid tools (e.g. open-ended interviews) aiming to understand processes’ dynamics and the meanings that individuals or target groups give to a particular issue (Creswell, 1994; Creswell, 2009; Bryman and Teevan, 2005). Apart from these divergent approaches there is a ‘third route’ that, basically, combines both qualitative and quantitative techniques (Creswell, 1994; Creswell, 2009; Spicer, 2011).

Considering a different dimension, a research can be classified as either inductive or deductive. In an inductive research, observations and patterns that emerge from data previously collected lead to the creation of a theory that explains a specific phenomenon. In opposition, in a deductive research, a theory is used as a guideline for the development of questions and hypotheses that then are subjected to empirical assessment in order to validate the proposed theory (Bryman and Teevan, 2005; Henn, Weinstein and Foard, 2006). While the former works from specific issues towards generalisation (‘research-then-theory strategy’); the latter

pursues an inverted course of action (‘theory-then-research strategy’) (Henn, Weinstein and Foard, 2006). Last but not the least, Spicer (2011) explains that an inductive process is linked to qualitative research; while the deductive approach is related to quantitative research.

• Design related research approaches

Taking into account strategies applied specifically in the field of design, Frayling (1993) points out that a research conduct in the Art and Design can be categorized in three different dimensions: firstly, in the research ‘into design’, situates Design (as a discipline) and its numerous related aspects and factors in the heart (as a core subject/theme) of the investigation process. Next, in the research ‘through design’, Design is related to both the means by which a study is conducted and also the way its outcomes are communicated (basically related to methods and processes). Last but not the least, in the research ‘for design’, a visual, tangible and embodied artefact (e.g. object) is the final outcome of an extensive investigation process undertaken to create it.

Considering a different point of view, Cross (1999) explores the *design knowledge* that people, processes and products present. Based on these elements, the author proposes a design research classification to describe and categorize them. Firstly, the design ‘epistemology’ investigates the ‘designerly’ ways of knowing (e.g. human ability of how people design). Next, the design ‘praxiology’ deals with design practices (e.g. methodology, strategies and methods). Finally, the design ‘phenomenology’ explores the embodied design attributes of products (e.g. form, materials and finishing).

4.3.2 Selected research approaches

First of all, this study is classified as an ‘exploratory’ research. Despite the fact that (future) forecasting processes have been widely discussed in several fields, there is little or a limited number of publications that address this particular issue taking into account a design perspective. Moreover, those that do, focus more on

highlighting the final outcomes rather than presenting detailed aspects about the processes themselves. Thus, due to the lack of substantial and accurate evidences about this topic (e.g. future forecasting) taking into account a design-led point of view and the original character of this PhD research, it cannot be considered 'descriptive' neither 'explanatory'.

This research relies on the strengths of qualitative research methods. To begin with, the literature review provided access to widespread and relevant information about different topics (e.g. wireless industry landscape, design discipline and its roles in forecasting process). Next, the reviewed case studies offered a holistic perspective about the diverse contributions and roles of design concerning future-led procedures. After that, the experts' interviews were employed to acquire fresh and updated information about the investigated topics as well as to asses several model drafts produced along the process. Subsequently, the students' workshops helped the researcher to examine the practicalities of the created framework. Overall, the combination of secondary and primary research tools offered detailed insights about the topics under investigation. Finally, the use of the Grounded Theory as an analysis method assisted in the process of understanding, exploring and linking ideas to develop the intended design-led future forecasting model for mobile communications that this study aims to deliver. (Further details about the selected research methods will be provided later in this chapter).

In a different dimension, this PhD study is considered inductive due to its unique attributes. By employing distinct qualitative methods (e.g. literature review, case studies, experts' interviews and Grounded Theory), this research reflects not only on the nature of these instruments (e.g. secondary and primary methods); but also, on the meaning and relevance of the insights that emerged from the investigation processes to deliver its final outcome (e.g. design-led future forecasting model for mobile communications). Moreover, since it does not aim to evaluate or use a particular theory as a guideline to produce the intended framework, it cannot be considered deductive.

Finally, this research investigates Design and its several roles in future forecasting activities in the context of the wireless industry supported exclusively by a design-led research methodology comprising different techniques not only to explore and

understand those issues; but also, to communicate its final outcomes (e.g. design-led future forecasting model). Therefore, this study is conducted ‘through design’ and also can be classified as a ‘praxiology’ course of investigation.

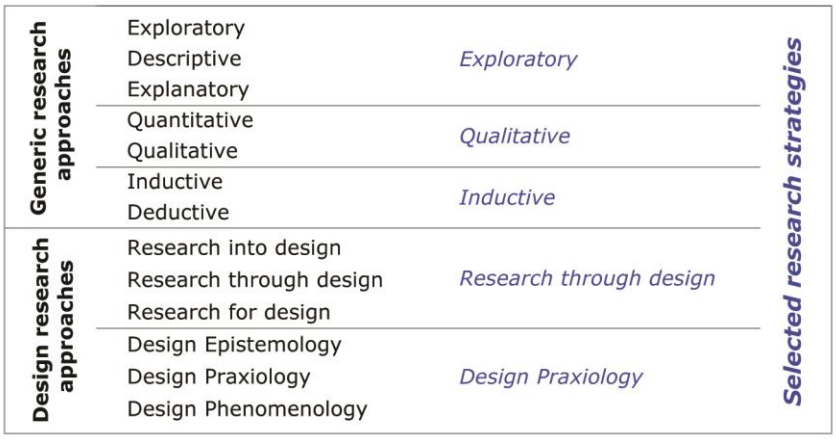


Fig. 4.1 - Selected research approaches for this PhD study.

4.3.3 Research methodologies applied in Design

Considering a more generic perspective, after carefully reviewing the ‘Design Studies’ (academic design publication) annual award winner papers, Cross (1999) states that best practices in design research exhibit a set of unique characteristics.

Table 4.1 - Key features of best practices in design research (Based on Cross, 1999)

Purposive	Based on the identification of an issue or problem.
Inquisitive	Seeking to acquire new knowledge.
Informed	Condutected from a awarenesses of previous, related research.
Methodical	Planned and carried out in a disciplined manner.
Communicable	Generating and reporting results which are testable and accessible by others.

Despite the fact that these attributes (see chart above) can also be found in high standard research conducted in other disciplines, Cross (1999) reinforces the idea that a study conducted in the design domain is an interdisciplinary, disciplined and organized course of action whose outcomes must inform and also support future inquiries in a ‘re-usable’ way.

Blessing and Chakrabarti (2009) point out that ‘a methodology for design research should guide the selection and application of suitable approach and appropriate methods, and encourage reflection on the approach and methods used’. Based on these ideas, the authors propose a comprehensive methodology named Design Research Methodology (DRM) developed to guide and support studies conducted exclusively in the design field.

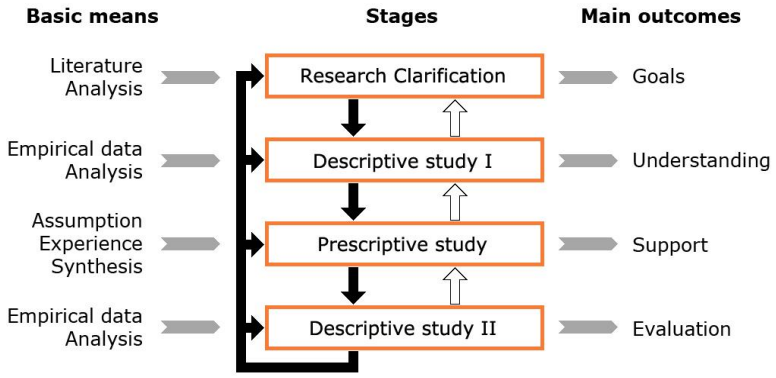


Fig. 4.2 - DRM, Design Research Methodology
(Blessing et al., 1995; Blessing and Chakrabarti, 2009).

During the *Research clarification*, the researcher looks for preliminary indications and evidences that support his first hypothesis. For instance, literature review is applied to collect information that is subsequently analysed to formulate a clear and realistic research goal.

In the next stage, *Descriptive Study I*, the goal is to have a deep understanding about the key factors associated with the main researched subject. To accomplish this task, the researcher uses different instruments for example, observations and interviews to unveil new, unclear or hidden insights. After gathering and analysing data from different sources, he can create a comprehensive description of the current panorama.

After that, the researcher proceeds to the *Prescriptive study* phase. In here, he further elaborates and corrects his first description by addressing the most relevant factors in order to improve the current situation. Based on his thoughtful analysis and experience, the researcher develops a support to deliver his desired future scenario and advances for a preliminary evaluation to check if the created tool works as intended.

In the last stage, *Descriptive study II*, a deep valuation is conducted to assess if the support is useful to address properly the target situation and if other factors (e.g. implications and limitations) related to the support concur for its usefulness.

4.3.4 Selected research methodology

After carefully examining the previous design research methodologies described by Cross (1999) and Blessing and Chakrabarti (2009), a relationship between them can be established. Based on this theoretical link, a rationale supporting the selected research methodology for this PhD study will be introduced followed by a research methodology framework.

First of all, after conducting a background research a key issue was identified: the scarcity of publications (e.g. academic studies and industrial reports) addressing the use of Design in future forecasting processes particularly in the context of the mobile telecom sector. *Theoretical relationship (dimensions): Purposive (Cross, 1999) + Research clarification (Blessing and Chakrabart , 2009).*

Based on these facts, preliminary hypotheses, research aim and objectives were formulated in order to set the appropriate research direction and scope.

After that, a more specific literature was thoroughly reviewed comprising books; academic and industrial publications; related PhD thesis and specialised websites. Furthermore, future forecasting approaches and design related case studies were analysed to explore the roles of design in future-led projects. At last, interviews with experts from different backgrounds were conducted to provide a holistic perspective about the use of design in future forecasting activities; how design has been used in the wireless sector and other relevant topics related to this industry. *Theoretical relationship (dimensions): Inquisitive + Informed (Cross, 1999) + Research study I (Blessing and Chakrabarti, 2009).*

Next, the inputs previously collected were analysed using qualitative tools such as the Grounded Theory supported by professional data analysis software (NVIVO).

Based on the data analysis, a comprehensive design-led future forecasting model was developed. *Theoretical relationship (dimensions): Communicable (Cross, 1999) + Prescriptive study (Blessing and Chakrabarti, 2009).*

Subsequently, the created framework was assessed by a number of stakeholders (e.g. experts with solid experience in the design working in the wireless telecom sector and also design students from different design backgrounds). *Theoretical relationship (dimensions): Communicable (Cross, 1999) + Descriptive study II (Blessing and Chakrabarti, 2009).*

After conducting the whole investigation in a disciplined manner and following a structured methodology, the research outcomes were communicated to its main beneficiaries and a broader audience. *Theoretical relationship (dimensions): Methodical + Communicable (Cross, 1999).*

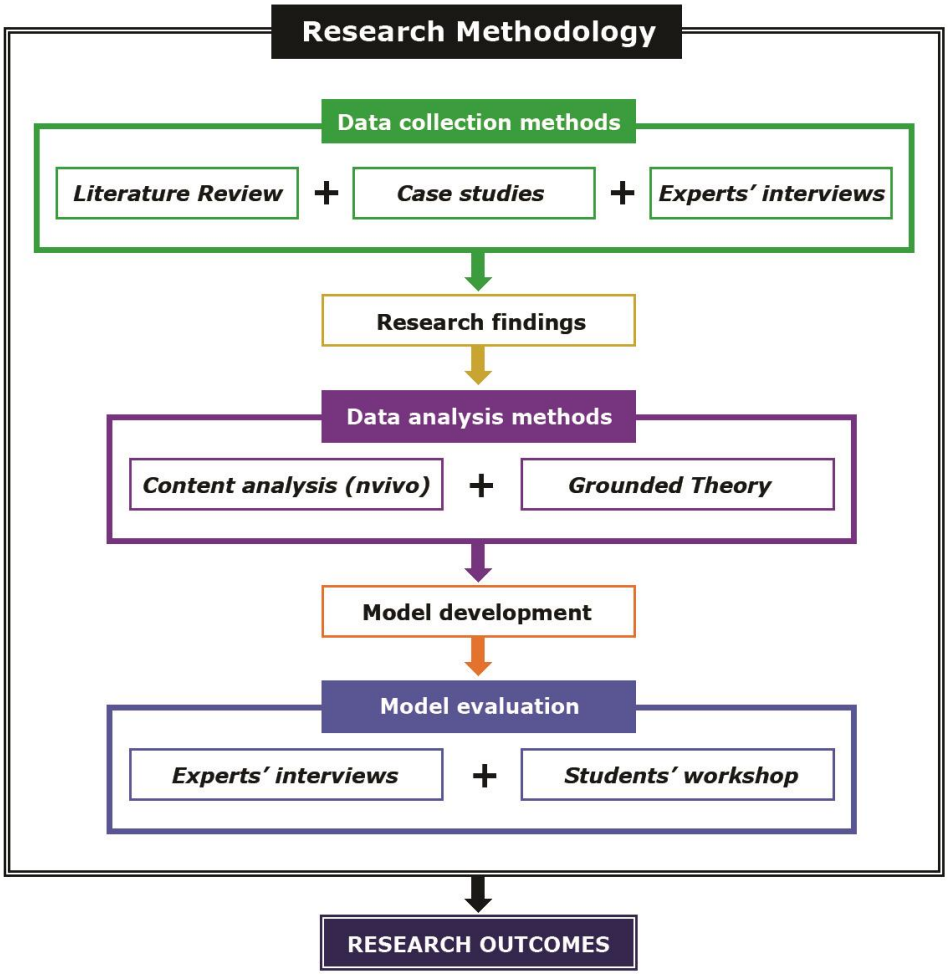


Fig.4.3 - Research methodology framework

4.4 Research methods

Robson (2002) states that methods are specific techniques used to collect relevant information and analyse data previously gathered. In this section, the selected research methods applied in this study are discussed. Before introducing them, a brief overview of the research objectives will be displayed.

4.4.1. Relationship between research objectives and methods

As it was mentioned earlier in Chapter 1, section 1.9, this research comprises a set of six objectives. Creswell (1994) states that research objectives work as signposts that restate and clarify the research aim.

Taking into account theses research milestones, it is possible to draw a connection between them and the proposed research methodology (see Fig. 4.3), particularly concerning its stages and applied methods. Even though the process seems to be straightforward and linear; in practice, some of these steps are addressed almost in a simultaneous way. The following diagram portrays these relationships.

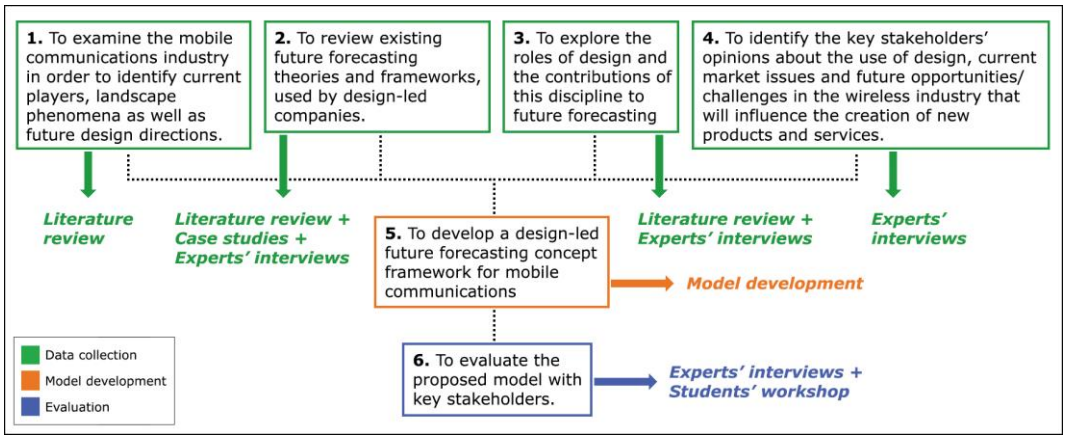


Fig.4.4 - Relationship between objectives and research methods

After presenting how the different objectives sit within the research methodology, the next section, will explore and give further details about the different research methods employed throughout this study.

4.4.2 Research methods: data collection instruments

• Literature review

The 'literature review is a written appraisal of what is already known; existing knowledge on a topic' (Jesson, Matheson and Lacey, 2011). In addition, literature review can work as a trigger or stimulus for research in several ways. According to Corbin and Strauss (2008), the background information collected can assist the researcher to keep up with the examined field; investigate unexplored areas or discover a topic that needs further development. Finally, technical literature can provide descriptive data with little interpretation that stimulates critical questions and analysis.

Overall, the literature review was the foundation of this entire research process. It helped the researcher to gain solid background knowledge about distinct areas that this study investigates such as Design (including its applications, design research process and tools); Future forecasting (comprising its main stages, key factors, the roles of designers in this processes and the use of non-design research methods) and finally, the wireless sector (concerning industry structure, handsets, services, trends and users' experience drivers). The chart bellow summarizers the main issues covered through the comprehensive literature review.

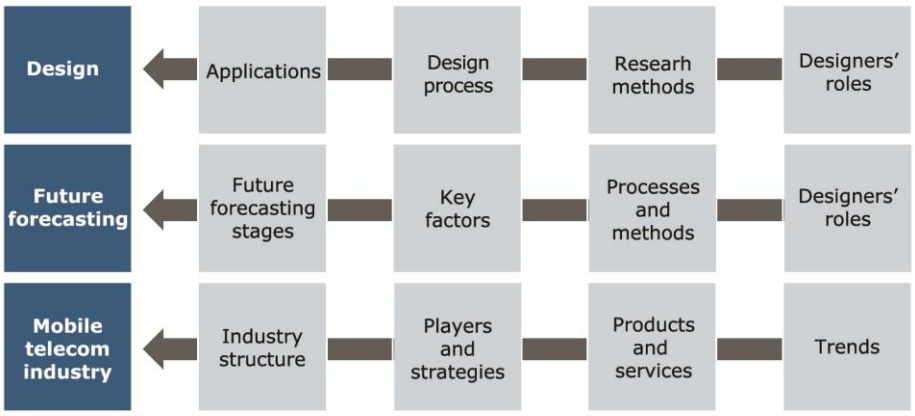


Fig. 4.5 - Main topics covered through literature review

The process of data collection considered a wide range of sources such as books; academic journals; conference papers; trends and industrial reports. In addition,

information displayed in online newspapers, specialized websites and corporative portals provided fresh and updated insights.

With respect to Design, publications from authors and institutions such as Mozota (2003), Best (2006), Cooper and Press (1995), Laurel (2003) and Design Council (2007) offered significant insights about this discipline including its numberless applications, key stages of design processes, research methods and designers' responsibilities.

Next, the ideas presented in studies undertaken by Evans (2011) and Woudhuysen (2007) and combined with industrial perspectives introduced by Marzano (1999) provided extensive knowledge about design-led future forecasting processes, key factors, associated methods and the roles of designers in these processes.

Finally, the mobile telecom industry encompasses a broad scope of issues. Views from different authors such as Steinbock (2003), Peppard and Rylander (2006), Mickalowski et al. (2008), Funk, (2009), Chang (2009) and Holzer and Ondrus (2011) about this sector (e.g. structure, players, products, services and users' adoption drivers towards wireless technology) combined with publications about trends (e.g. Trendwatching reports and Popcorn, 1992), specialized IT research companies websites (e.g. Gartner Research) and digital versions of established newspapers (e.g. BusinessWeek) offered valuable and up to date information about several issues related to the wireless industry.

• Case Studies

The main purpose of a case study is to examine real-life phenomenon (such as contemporary events) considering related aspects and contextual circumstances in order to 'sharp' thinking and enlight decision making, by understanding 'why' and 'how' different actions and steps were taken and outcomes, produced (Lee, 1999; Schramm cited in Yin, 2009; Yin, 2009).

According to Breslim and Buchanan (2008), the case studies method have been widely employed across different areas/disciplines to explore the space between theory and practice and, particularly in design, it has been used in an efficient way.

However, designers are not used to write and employ case studies as part of the design education and research development processes. Furthermore, Svengren (2003) reports that the case study method has been used mainly as a descriptive approach in design management

In the design domain, the vast majority of design case studies are published in the form of 'business case studies', which means that the principles underlining the design processes are regarded as corporative intelligence. Thus, the information related to processes, methods and concepts/products development are not shared with the public (Breslim and Buchanan, 2008). These evidences are aligned with the ideas introduced by Evans (2003) about the limited amount of publications addressing the use of design to support future forecasting processes due too commercial sensitiveness's. In addition, the case studies disclosed to the public focus more on the end results rather than the processes.

This study examined four case studies concerning the use of design in future-led procedures. While the first three (Apple, Philips and Samsung/Seymourpowell) presented an industrial perspective; the last, introduced an academic approach based on a study conducted by Evans (2011). Through the analysis of these case studies, the researcher was able to identify and explore several applications and roles of design and designers for future forecasting including design process steps; methods (for data collection and analysis); key factors (e.g. users' perspectives; environmental events; market issues and experts' opinions); value proposition (through the development of concepts and prototypes) and; managerial aspects (towards the rational use of design in business).

• Experts' interviews

Kolb (2008) points out that 'an expert interview is conducted to gather factual information about a problem from someone with a specific product, consumer or industry knowledge'. This primary data collection instrument is usually applied in the early stages of the research process, aiming to clarify and produce useful information about the investigated issue (Smith, 1972; Kolb, 2008).

The experts' interviews were used in two different stages of this research. Firstly, to explore a wide range of issues and later, to access the proposed model that this study aims to deliver. In this chapter, particularly in this section, the key aspects related to the use of this method to gather relevant information about the topics investigated will be presented. Later, in Chapter 7, sections 7.4.1; 7.4.2; 7.5.1 and 7.5.2 the applications and outcomes of the experts' in-depth interviews concerning model valuation will be introduced and discussed in details.

Primarily, experts' interviews were used in an exploratory way mainly to address several issues included in objectives 3 and 4 (see figure 4.4). During the interview processes, ten professionals from different backgrounds (e.g. design managers, researchers, consultants and academics) were approached. A myriad of issues identified through the literature review were examined in these meetings. These topics included: the wireless communications sector (comprising players; business strategies; products and services; environmental trends; market opportunities and challenges); the contributions of design for handset manufacturers' business and forecasting procedures (as a strategic asset; processes and research methods) and the designers' roles during the investigation and analysis of different types of data (e.g. users' requirements; landscape trends and experts' opinions) to propose new value propositions for future products.

To collect experts' perspectives and insights, semi-structured in-depth interviews were conducted. This particular approach is characterized by a fair level of flexibility since it combines aspects of both structured and unstructured interview techniques. When conducting interviews using a semi-structured approach, the researcher follows a 'pre-planned' list of questions (a feature of the structured interview approach). However, he has more freedom to probe the interviewee (in the same way as in the unstructured interview process) by addressing not only the topics under investigation; but also, their contours (Preece, Rogers and Sharp, 2002; Bryman, 2012).

The following charts display the profiles of the professionals approached for interviews (Table 4.2) and the relationship between their expertises and topics addressed/data collected through these processes (Table 4.3).

Table 4.2 - Chart exhibiting the profiles of the experts interviewed.

Proficiency	Interviewee profile	Remarks
Design director	• Founder and director of his own design consultancy company. • Design director of an international design consultancy firm. • Holds a PhD degree in design from a world class British University.	• Interviewee (1) • Face-to-face interview
Head of user experience	• 10 years of working experiences as interaction and UX designer. • Former creative director of a major British television channel. • Head of user experience at British design agency.	• Interviewee (2) • Face-to-face interview
Senior lecturer	• Senior Lecturer (Information systems) of a leading British University • Holds a PhD degree founded by a major British telecom company. • Worked in several projects supported by wireless companies.	• Interviewee (3) • Face-to-face interview
Design manager	• Over 10 years of working experience with different lines of consumer electronics products • Design manager for European market of a global electronic firm. • Coordinates a multidisciplinary team of professionals (including designers) from different areas of expertise.	• Interviewee (4) • Face-to-face interview
Vice president of brand experience	• Over 10 years of working experience with mobile communications. • Works across different departments to create consistent product and brand experience through numberless consumers' touch points. • Coordinates multidisciplinary teams (including designers)	• Interviewee (5) • Face-to-face interview
Head of research	• Head of research of a global mobile telecommunications company. • Solid design research experience (qualitative and quantitative tools) • Work alongside with distinct research departments and multidisciplinary teams.	• Interviewee (6) • Face-to-face interview
Head of research	• More than 10 years of working experience with design research. • Head of research and associate director of a world class British design consultancy. • Coordinates a multidisciplinary group of professionals, including designers working mainly with qualitative research methods.	• Interviewee (7) • Face-to-face interview
Head of product marketing	• More than 15 years of working experience in the automotive sector. • Head of product marketing team of a British luxurious car brand. • Holds a PhD degree in design from a world class British University.	• Interviewee (8) • E-mail interview
Strategic planner	• Planner of a British design agency working primarily with consumer electronics companies/clients. • Solid working experience with trends, design research and UX. • Holds a PhD degree in design from a world class British University.	• Interviewee (9) • Face-to-face interview
Independent Consultant	• Former VP of a global leading mobile telecom consortium. • Solid experience consulting for different firms/sectors worldwide. • Holds a PhD degree in psychology from a leading British University.	• Interviewee (10) • Face-to-face interview

Table 4.3 - Main topics covered through the experts' exploratory interviews.

Expertise/ topics addressed	Interviewee number 1	2	3	4	5	6	7	8	9	10
Design										
Process	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NPD	✓	✓	✓	✓	✓	✓		✓		✓
Strategy	✓	✓		✓	✓	✓		✓	✓	✓
Creating the future		✓			✓	✓	✓		✓	✓
Multidisciplinary teams	✓	✓		✓	✓	✓	✓		✓	
Design management	✓			✓						
Design research process	✓	✓	✓	✓	✓	✓	✓		✓	✓
Design research methods										
Trends				✓		✓	✓	✓	✓	
Users	✓		✓	✓		✓	✓	✓	✓	✓
Experts				✓		✓	✓		✓	
Wireless industry										
Players			✓	✓	✓	✓			✓	✓
Strategies				✓	✓	✓				✓
Products			✓	✓	✓	✓				✓
Services			✓	✓	✓	✓				✓
Trends			✓	✓					✓	
Opportunities			✓	✓	✓	✓			✓	✓
Challenges			✓	✓	✓	✓			✓	✓
User experience										
Wireless products, services			✓	✓	✓	✓			✓	✓
General	✓	✓								
Trends (general)	✓			✓	✓	✓	✓	✓	✓	
Innovation	✓	✓		✓	✓	✓				✓
Technology		✓	✓						✓	✓

• Students' Workshop

In a later stage of this study, two workshops were conducted with design students from different backgrounds and expertise levels (combining Masters and PhD students) aiming to evaluate in an empirical and practical ways several aspects of the model developed. Basically, the students recruited by the researcher were all from Brunel University.

In these workshops, participants were divided in groups to take part in a practical task whose briefing was: '*you are part of a design team of a traditional mobile phone manufacturer and by using the model as an inspirational platform among other resources, design a future wireless phone/solution considering a 5 years'*

time frame). After completing the proposed activity in the first workshop, the two groups of participants were interviewed separately. These group interviews helped the researcher to understand and explore different aspects of the proposed model (such as usability; relevance; information appropriateness's as well as support for participants' interaction, discussions and decision making) based on participants' feedback about their experiences with the model (for further details, see Chapter 7, sections 7.6.1 and 7.6.2).

With respect to the second workshop group activity, the researcher used majorly observations to gather inputs followed by a quick group interview/chat (to ratify any previous collected information). This second workshop helped the researcher to investigate and check how the developed framework supported and influenced group decision making process (for further details, see Chapter 7, sections 7.6.4 and 7.6.5).

4.4.3 Research methods: data analysis instruments

As it was mentioned early, considering the nature of this research, it relies only on qualitative research methods. While in the last section data collection tools were presented; in this part, the selected analysis instruments will be introduced.

Basically, to examine the insights acquired through the interviews, the Grounded Theory was selected as the main analysis framework. To support some steps described in this theory (e.g. coding and clustering data), the researcher also found useful the use of professional data analysis software NVIVO to assist in this task.

The Grounded Theory is an established technique whose objective is to discover or produce a theory that explains a specific phenomenon based on systematically data analysis (Glaser and Strauss, 1967). At the heart of this analytic tool is the process of 'coding'. Corbin and Strauss (1990) define 'coding' as procedure of breaking down data, conceptualizing and rearranging it together in a different way. To conclude, the Grounded Theory was employed in this study because of its appropriateness for qualitative analysis since it allows the researcher to explore a large amount of variables about the topic under investigation by breaking data into

specific themes; checking for potential patterns, similarities and differences; and finally, drawing relationships among these inputs.

In the case of this research, the insights gathered through several interviews were analysed following similar approach described in a study that relates Grounded Theory and Japanese fashion designers conducted by Au, Taylor and Newton (2003). In this academic publication, the authors used a four-step process (e.g. data sorting, open coding, constant comparative analysis and theoretical coding rooted in the Grounded Theory principles to proceed with data analysis.

• Data sorting

Firstly, the data collected from previously conducted interviews were transcribed into a document/file using word processing software (e.g. Microsoft Word) to provide the basis for the analysis.

Next, the transcriptions were carefully examined allowing the researcher to become familiar with both the responses *per se* and the context where they were presented. In addition, special attention was made to distinguish interviewers' tone of voice, particularly regarding the use of language/words to describe a given phenomenon, situation or concept.

Finally, after reviewing the interviews' transcriptions, the most relevant passages (incidents) were highlighted (in the transcription file) and separated to be coded.

So it's been, er... the design has always been right at the centre of that and the **role of design has really been about understanding people and what they want, and to see you know what they want emotionally for their handset.** You know things you need it to portray and

Fig. 4.6 - Fragment showing a highlighted incident (from exploratory experts' interview)

• Open coding

Corbin and Strauss (2008) explain that the 'open coding' process is related to 'breaking data apart and delineating concepts to stand for blocks of raw data'. As the incidents were separated, in this particular stage, they were formally coded.

Basically, 'coding' stands for naming each piece of abstraction individually in order to describe them in the most precise way. To accomplish this task, words related to the topics under investigation derived from the context of narratives or from the questions made to the interviewees were used as labels.

During this process each incident was reviewed and coded. After all abstractions were coded they were clustered into groups according to themes/topics that they addressed and/or described.

Fig.4.7 - Examples of data fragments and their respective codes
(from exploratory experts' interview)

• Constant comparative analysis

In the first moment, coding and clustering abstractions were straightforward tasks. Nevertheless, as the amount of codes and categories emerged from the analysis, these activities became highly complex and time-consuming. In fact, these steps complemented each other since the last was the end result of the first.

Taking into account the ideas and meanings that each abstraction conveyed, every new incident was carefully compared to previous abstractions before being coded.

Those that were conceptually similar received the same code. Corbin and Strauss (2008) illustrates the importance of the comparative analysis since the abstractions named under the same code add value to the general properties of that particular label, elaborating and making it unique.

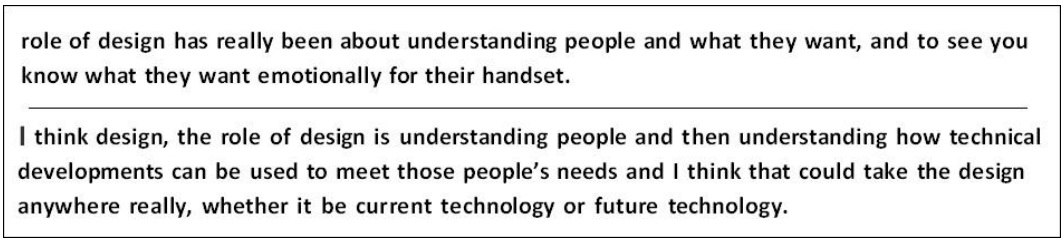


Fig. 4.8 - Examples of incidents under the same code: 'Design/understanding users' (from exploratory experts' interview)

Aligned with the previous ideas, Au, Taylor and Newton (2003) state that through the constant comparative analysis, codes are refined to better describe data in a more accurate way. As a result, codes are often sorted, place or combined into a new category.

Finally, the steps highlighted before, outline the foundations of the entire data analysis carried out in this research. The meticulous activity of comparing codes (one to another and also through different categories) continued until all of them were exclusively arranged into categories covering all the discovered themes.

• Theoretical coding

By the end of this extensive qualitative analysis (conducted based on the findings that emerged from the experts' exploratory interviews), seven major theoretical clusters named 'Design', 'Research', 'Wireless Industry (business)', 'Users', 'Trends' (in wireless industry), 'Technology' and 'Innovation' were discovered. While some of them comprise several categories (for example, 'Research'); others present few codes, only (e.g. 'Innovation').

In addition, the most crucial aspect of the theoretical coding process was related to how these codes were structured, positioned and their relationships, established. Finally, through this procedure, the insights derived from the interviews were

summarised and re-arranged assisting the researcher to have a comprehensive view of the data in order to develop the intended design-led future forecasting framework for mobile communications.

In the next page, an example of how incidents were grouped under the major theoretical cluster named ‘Wireless industry (business)’ is presented. All the steps related to the analysis of the insights derived from the experts’ interviews as well as the related final theoretical clusters generated will be introduced and described in the next chapter (see Chapter 5, Findings and Analysis for details).

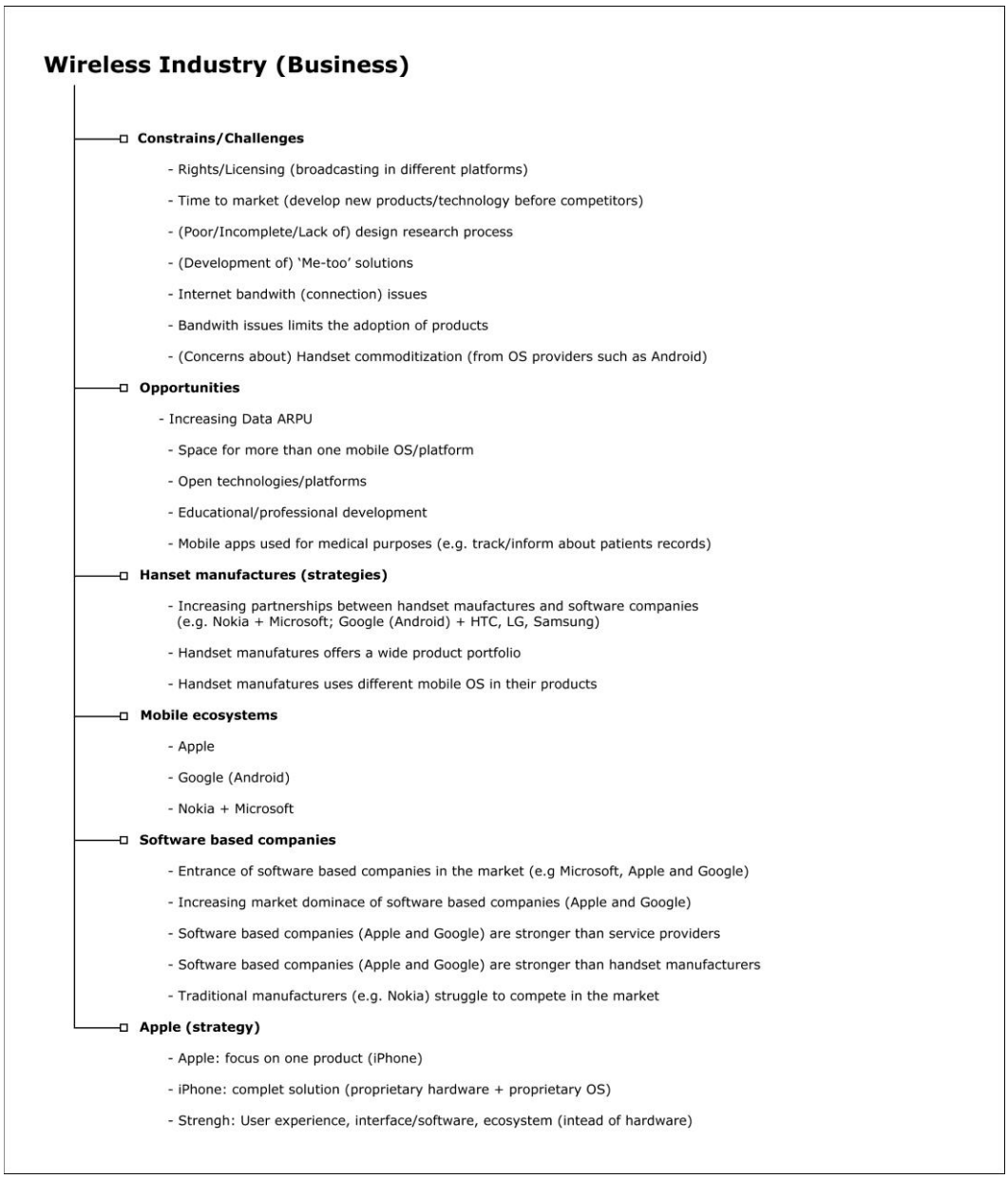


Fig. 4.9 - Example of theoretical coding: Wireless Industry (Business)

4.5 Reliability and validity

Taking into account the several factors that a researcher should consider when designing and conducting any type of research (e.g. qualitative or quantitative), reliability and validity are among the most important aspects. Regarding the qualitative nature of this study, Creswell (1994) explains that it is imperative to address the concepts of reliability and validity.

Despite the fact that it is almost impossible to effectively guarantee reliability and validity of any research process due to the unpredictability of anticipating all potential challenges and difficult circumstances, the researcher should take into account these issues and select rigorous approaches to maximize reliability and validity results. Handley (2001) argues that strict study protocols can be employed as a strategy to reduce and minimize validity and reliability threats. Therefore, this study displays its own set of protocols comprising: (1) a clear research aim; (2) a set of research objectives; (3) a comprehensive research plan eliciting methods for data collection and analysis; and, (4) fieldwork encompassing interviews, audio records, personal notes, data transcripts and their relationships.

Moisander and Valtonen (2006) highlight that in a non-quantitative research; reliability can be fulfilled by making the research process transparent, which means informing and describing the selected research strategy and data analysis methods in details. Concerning this study, an overview of the adopted research strategy is introduced in a chart in section 4.3.4, displaying key milestones and methods employed in each phase. After that, the relationships between research objectives and the methods used to address them are highlighted in section 4.4.1. Next, the selected data collection tools (e.g. literature review, case studies and in-depth interviews) are presented in section 4.4.2 underlining their contributions to this study. Finally, the selected data analysis method (e.g. Grounded Theory) and its applications are introduced and discussed in section 4.4.3.

With respect to validity in qualitative research, it can be enhanced by employing the triangulation technique. Creswell (1994) points out that triangulation is an attempt of finding convergence among different sources of information; different methods of data collection or different investigators. According to Denzin and Lincon (1994), there are four types of triangulation: data triangulation, that

indicates the use of a variety of data sources; investigator triangulation, that is related to the 'use of several different researchers and evaluators'; theory triangulation, that employs distinct perspectives to examine/interpret a single set of data and methodological triangulation, that recommends the use of distinct research methods to study a single problem. Since this study investigates the roles of design to support future forecasting processes in the wireless communications, it employs distinctive research methods such as literature review, case studies and experts' interviews to collect data about this topic. Moreover, Denzin and Lincon (1994) reports that the use of different methods implies an attempt to acquire a comprehensive and in-depth understanding of the phenomenon investigated.

Considering a different perspective, Richardson and St. Pierre (2005) use the metaphor of 'crystallisation' to extend the concept of triangulation. The authors explain that the triangle is a rigid and two-dimension geometric shape; whereas, a crystal 'combines symmetry and substance with an infinite variety of shapes, substances, transmutations multidimensionalities and angles of approach. Crystals, grow, change and are altered, but they are not amorphous. Crystals are prisms that reflect externalities and refract within themselves, creating different colours, patterns, and arrays casting off in different directions.' With respect to qualitative research, the distinctiveness of each method employed in this study is directly related to the nature of data required (e.g. secondary and primary); therefore, 'shaping' the findings produced. To conclude, just like a crystal, the use of multiple research methods offers multifaceted perspectives and nuances about the investigated topic that, in the case of this particular study, deals with the uses and contributions of design to support future forecasting processes in the mobile telecom industry.

4.6 Conclusions

This study relies exclusively on qualitative research approaches to investigate three main areas: design; future forecasting and the mobile telecommunications sector. In order to develop the intended design-led future forecasting model for mobile communications (aim of this study), three instruments were employed to

gather relevant information about the previously mentioned subjects followed by a data analysis tool used to scrutinize the inputs collected.

As a secondary research method, the literature review of specialized information sources offered valuable insights about a wide range of topics. The collection of these widespread evidences provided a holistic view about the current wireless landscape; the applications and uses of design and how this discipline can assist in future forecasting activities. Moreover, the literature review set the foundations of the entire research process.

Next, four case studies were examined in order to understand the contributions of design and designers for future-led processes. From the analysis of the collected inputs, the researcher was able to discover and identify a broad spectrum of uses and applications of this discipline ranging from strategic up to operational functions, informing and supporting the whole design process towards the future.

After that, a series of in-depth interviews with experts from different backgrounds including industrialists and academics were conducted. Through these meetings data previously collected (through literature review) were checked, discussed and clarified. Furthermore, new and up to date insights about the mobile telecom landscape; the distinct applications of design in this particular industry and how it supports future forecasting processes were gathered, helping the researcher to have a more comprehensive perspective about these issues.

After all information was brought together, a qualitative analysis was conducted supported by the Grounded Theory. Through this method, data collected from the interviews were ‘broken’, coded and grouped taking into account the main ideas conveyed or the situations that they describe. By the end of the process, all the abstractions were clustered and the information was re-structured. Ultimately, the insights presented across the different theoretical coding charts played important roles during the model development process (See Chapter 7, Model development and evaluation for further details).

5 Findings and analysis

5.1 Introduction

The chapter five introduces the key insights collected from the experts' interviews as well as the milestones related to data analysis process. Basically, it is divided in two parts. The first section deals with the main findings derived from the series of in-depth experts' interviews conducted. The ideas are presented and discussed supported by passages from these meetings. In the next section, the insights are consolidated and organized in groups (e.g. theoretical clusters). Through this process, information is restructured and new, meaningful relationships can be drawn from data. Finally, these links are further discussed and analysed.

5.2 Primary research main findings and discussion

In the following sections, the key insights collected through the exploratory experts' interviews will be introduced (supported by quotations and examples), contextualized and explained. Due to confidentiality reasons, the interviewees will be referenced by codes. The codes used throughout this particular chapter are the same codes displayed in the Chapter four (Methodology, section 4.4.2) to identify the professionals approached.

Table 5.1 - Summary of experts' profiles and their codes

Interviewee's proficiency/position	**Remarks/codes**
Design director	Interviewee (1)
Head of user experience	Interviewee (2)
Senior lecturer	Interviewee (3)
Design manager	Interviewee (4)
Vice president of brand experience	Interviewee (5)
Head of research	Interviewee (6)
Head of research	Interviewee (7)
Head of product marketing	Interviewee (8)
Strategic planner	Interviewee (9)
Independent consultant	Interviewee (10)

5.3 The wireless industry: current landscape

5.3.1 New entrants: software based companies

The advent of the internet in the wireless communications introduced substantial changes in this industry. For example, a major phenomenon is related to the entrance of new players particularly from other industries (e.g. computing) in the mobile telecommunications field. *'Software-based companies are getting into the telecommunication increasing the market in the mobile area and they are succeeding now* (Interviewee 4). Large scale and global firms such as Microsoft, Apple and Google are already competing in this new business sector in a very successful way, particularly the last two companies.

There are several factors that explain the successful 'migration' of these firms to the wireless sector. Firstly, Apple launched the iPhone (mobile handset) running an exclusive operating system named 'iOS'. This complete product set a new standard competition standard, raising the bar in the whole sector. Moreover, this company competes in the market with only one product (e.g. iPhone). At last, the device's hardware technological features combined with its mobile operating system (OS) and unique interface offers outstanding competitive advantages for Apple (Interviewee 4; Interviewee 5).

Conversely, Google and Microsoft pursued a different strategy (in comparison to Apple). They focused on developing their proprietary mobile operating system (OS) Android and Windows mobile, respectively. Aiming to gain market share, they promote their software through partnerships with different manufacturers (Interviewee 4; Interviewee 5). This strategy proved to be efficient as it soon became a widespread business approach bridging traditional handset firms and new entrants (e.g. software firms).

5.3.2 Partnerships between manufacturers and software based firms

From a manufacturer's point of view, the alliance with software based companies brings opportunities and also challenges. For example, Microsoft established an exclusive partnership with the Finish firm, Nokia. The major benefit that Nokia

receives through this venture is related to Microsoft's solid expertise in terms of software and interface development (Interviewee 5).

In addition, a single phone maker can have multiple partnerships with different software based companies. Since manufacturers tend to work with an extended product portfolio aiming to address different market segments, the advantage of using multiple mobile OS is that they can offer more options to consumers (e.g. different devices running distinct software) making their products more appealing. In addition, by employing this strategy (e.g. multiple mobile OS), these firms do not become constrained by one mobile platform (Interviewee 4).

In the case of Nokia, this company uses Microsoft software named as 'Windows mobile' in their high end products (e.g. smartphones); while low cost and middle range devices run different platforms (such as Symbian and Meego). As a result, Nokia carefully plans ahead its portfolio to avoid that new solutions cannibalise their old products (Interviewee 5; Interview 6).

Overall, the adoption of different mobile operating systems (OS) strategy across a portfolio of products is a common strategy used by traditional handset companies. This approach helps manufacturers to avoid being linked to only one platform, preventing the commoditization of their products (Interviewee 10).

5.3.3 Mobile ecosystems

Since partnerships involving traditional manufactures (such as Nokia, Samsung, Motorola, LG and HTC) and software based firms (e.g. Microsoft and Google) became a standard business approach, the panorama of the wireless sector changed. The profound integration between these two types of company (those that create handsets and their counterparts that develop operating systems) drove competition to a new level. Therefore, market competition is not only based on hardware performance or intuitive software interface; but also, on an exclusive ecosystem of services. The current industry scenario can be briefly summarized as follow: *'Apple has created an ecosystem with its apps and everything that links to that and you have Android which is the emerging second ecosystem which is*

actually growing substantially faster than Apple and so Nokia going into strategic partnership with Microsoft is about creating a third eco system' (Interviewee 5).

Apple's iPhone is a complete product that runs its own operating system (e.g. iOS), fully supported by Apple's exclusive services (e.g. iTunes and App Store). The combination of hardware, software and related services gave birth to the first mobile ecosystem. After that, Google's Android is an open platform that has been gaining *momentum* since it has been adopted by an increasing number of handset manufacturers. This mobile platform is supported by Google's proprietary service, Android Market (recently renamed to 'Google Play'). As a result, devices running Android OS are part of the Android ecosystem. Finally, the partnership between Nokia and Microsoft established the third mobile ecosystem. The new devices created after these global firms' alliance benefit from Nokia's hardware know-how and Microsoft's software expertise and services.

5.3.4 New industry order: software based companies' dominance

As software based companies' presence in the market grows; so is their influence. For example, the strategy adopted by Google to promote its mobile software (e.g. Android) highlights its increasing dominance. More than never, manufacturers rely on third party platforms (particularly, Android); thus, they become more dependent of software firms. Since mobile phone firms compete to create better hardware (and not software), Google 'comfortably' takes advantage of its huge bargain power to carefully select the most 'convenient' phone maker to launch upgraded versions of its Android OS (Interviewee 4).

From a different perspective, the influence of the new entrants, particularly Apple and Google, also affects their relationship with service providers. In the current scenario, software firms have enough power to negotiate better deals with carriers, taking away a big revenue sum from them (interview 4; Interview 9).

Based on these evidences, it is clear that the influence and power of these firms (e.g. software based companies) have been radically changing the structure and the nature of competition in the wireless telecom sector that once was dominated

by the commercial relationships established between traditional manufacturers and network providers.

5.3.5 New industry paradigm: from hardware to software

The expansion and dominance of software based companies (e.g. Apple, Google and Microsoft) in the mobile telecom industry pushes mobile operating system to play unprecedented roles. More than never, the software (that is responsible for a substantial amount of the device's functionalities associated with other design elements) becomes a key factor granting a particular handset a strong market competitive advantage. *'... An awful lot of whether a company succeeds now is about its interface and its usability, and the emotional experience and user style'* (Interviewee 10). Therefore, it is the 'look and feel' of the device (also comprising hardware aspects) that delivers a high standard user experience leading to an outstanding product performance in the market.

Reinforcing the ideas presented, the strategy implemented by Apple is a clear example of how computing companies are successfully thriving in the wireless business. After the emergence of the internet in the mobile telecom sector, while traditional manufacturers (for example, Nokia and Samsung) were still relying on technology and hardware development expertise; Apple (originally, a computing firm) wisely used its software and interface know-how to deliver a new product proposition (through the iPhone and its mobile ecosystem), engaging users into the digital world (Interviewee 5). According to Interviewee 4, *'Apple is creating better software out of a beautiful box'*. Consequently, after the entrance of software firms in the market, traditional manufactures lost *momentum* due to their lack of vision to understand that handset user experience was quickly shifting from the 'box' (hardware) to mobile operating system (software).

5.3.6 Opportunities across the mobile telecommunications industry

As partnerships involving handset manufacturers firms and software companies proliferate supporting the expansion of mobile ecosystems, each related platform

offers unique and exclusive value to users. For example, while Apple (through the iPhone) targets high-end consumer segments; other manufacturers (aligned with different software companies) can offer more tailored options (such as low and mid-range solutins) to fulfil different audiences' requirements. Therefore, there is enough market space for more than one mobile platform/ecosystem (interviewee 3; Interviewee 9).

Regarding user experience, emerging open technologies and mobile operating systems (for instance, Android) will push the bar in terms of handset interaction. In the future, users will be able to shape and customize their phones not only in physical ways; but also, in terms of software to attend their needs (Interviewee 9). Functionality will achieve a new dimension (in here, in a very personal level) and possibly, handsets will deliver much more than remote communication.

Finally, as time passes by, the frontiers between the analogue and digital world will shrink. More than never, users spend more time browsing the internet through their handsets resulting in a dramatic data traffic expansion. Thus, the ARPU (Average Revenue per User), terminology used by service providers to measure profit based on internet usage through mobile phones, will increase. '*…[Mobile] data will increase dramatically for the next few years because of devices can make it happen and contents can make it happen'* (Interviewee 4). A major reason behind this phenomenon is the thorough optimization of mobile devices, enabling users to access numberless online services from social media up to exclusive mobile 'apps' from their choice of ecosystem in an easier and convenient way.

5.3.7 Challenges in the mobile telecommunications industry

The wireless industry is recognized by its fast pace and fierce competition; thus, a precise 'time to market' is a key aspect for players in this sector to stay ahead of competition. The pressure for developing new products and quick market release is incessant and, frequently, manufacturers do not have enough time to fully test them. It means that critical steps of the design process are not properly taken (e.g. background development, prototyping or users' evaluation) (Interviewee 3). For instance, when a given competitor launches a device displaying a new feature or

resource, a company tries to use the same or similar technology to produce a new handset to compete in the market. This situation can be summarized as follow: *'…products take a while to be developed; it means that you are always behind the curve and when somebody else comes with a new feature, you have to put that thing on. Them, the product becomes messy, has too much stuff on'* (Interviewee 2). These evidences present a common scenario where a number of newly created products lack of deep consumer appeal, presenting fuzzy interface; consequently, becoming just another 'me-too' solution.

Concerning strategic alliances, although partnerships between manufacturers and computing companies such as Google and Microsoft (through the use of their mobile platforms, Android and Windows mobile, respectively) bring business advantages for handset companies; they also impose some limitations and threats to them. Different from Apple that produces its own hardware and proprietary software (e.g. iPhone and iOS); traditional handset firms face a potential commoditization of their products since they compete only on hardware basis without intervening on the software to add 'extra' value to the devices themselves (interviewee 10). As a result, mobile handset companies should work closely with their partners to develop innovative solutions based on the combination of hardware and software to create ultimate customer value and attractive business propositions to involved stakeholders.

Despite the fact that a number of mobile internet protocols (e.g. 3G and LTE) have been developed through the years; the wireless internet connection is still considered a major concern in the mobile telecom sector. Firms operating in this business, either manufacturers or software based firms (e.g. Apple, Google and Microsoft) have to cope with this particular issue (Interviewee 3). Since devices are sold through network providers, internet connection issues (e.g. strength and coverage of the signal provided) can prevent users to access specific features or services and, in the worst case scenario, preventing them to buy a given product. Therefore, they are not sold on their merits (Interviewee 9). Given the urgency of this matter, it is imperative that carriers tackle this situation to offer a better mobile internet experience to consumers.

Finally, the legal rights for 'wireless' media broadcasting are factors that also impose limitations regarding user experience. The rights for broadcasting (live streaming or not) depend on the nature of the platform and the selected channel (Interviewee 2). For example, due to licensing frameworks an individual can listen a music track or watch a streaming movie through a laptop but will not be able to access the same content through a handset. Consequently, users will not have the same experience level when using different devices to access the same media content.

5.4 Trends in the wireless sector

5.4.1 LTE (Long Term Evolution)

One of the major technological trends in wireless industry is the expansion and adoption of a new mobile internet protocol named 'LTE'. Basically, LTE stands for 'Long Term Evolution' and it is the newest wireless internet standard for mobile phones offering high speed connection. Since new handsets are capable of connecting the World Wide Web through this particular technology, it has been regarded as key feature that will drive and shape users' future online experience (Interviewee 4, Interviewee 9).

5.4.2 Social media and social broadcasting

As the internet becomes more ubiquitous, social network services will continue to expand in a way far beyond than just connecting people. For example, social media services such as Facebook have been used to engage people into informal learning processes (interviewee 3). This particular phenomenon is known as '*social broadcast'* (Interviewee 2). Through links displayed/offered in specific community pages or personal profiles in this platform, users and their peers have the opportunity to access relevant and updated information about areas of their interest, increasing their knowledge in these fields.

5.4.3 NFC (Near Field Communications)

On a different dimension, technologies that enable the exchange of personal data (e.g. files and documents) in an easy way have been regarded as a synonym of ultimate convenience. Near Field Communications (NFC) is a specific wireless standard that aims to deliver this type of 'convenience'. Among its several applications, NFC will allow users to make payments through their mobile phones (Interviewee 3, Interviewee 9). Referred as '*payment technology'* or '*mobile wallet'*, this feature when integrated into handsets can replace credit/debit cards and is expected to make a 'revolution' on how people pay their bills and make financial transactions.

5.4.4 Convergence

Last but not the least, a number of features has been systematically integrated in mobile phones through the years. This phenomenon named 'convergence' started long time ago and is expanding ever since. As it advances, *'... there will probably be a period of this integration getting a lot better and smoother than it is now, and I have noticed it improving all the time'* (Interviewee 10). Based on these evidences, in the future, mobile communications will be even more ubiquitous, connecting people seamlessly, playing distinct and more important roles.

5.5 Design

5.5.1 Strategic roles, applications and contributions

Design is a complex discipline that integrates features, processes and perspectives of different areas whose scope of applications range from a being a 'way of thinking' up to supporting product develop. Considering a strategic point of view, design delivers paramount contributions playing pivotal roles not only defining; but also, assisting in the implementation of corporative strategies (Interviewee 10). Furthermore, when this discipline is fully integrated becoming part of a firm's culture, it permeates through its structure touching in every single business area (Interviewee 5). As a result, Design presents a holistic character supporting a wide

spectrum of corporative activities including being *'... a core component of the products appeal to the customers, through the central element of the product emergence process to customer facing activities and materials'* (Interviewee 8).

To achieve business objectives in an efficient way, it is necessary to carefully select the most suitable design approaches. Since corporations are unique, they require tailored methodologies comprising a set of different tools to define and deliver their strategies (Interviewee 1). These methods must reflect the company's peculiarities (e.g. stakeholders' requirements, budget and targets). In addition, the selected plan/course of action (including milestones and design tools) should also consider possible constrains (for instance, limited timeframes) to achieve best and realistic results.

One of the most recognised uses of design is related to its outstanding capability of addressing and solving problems (Interviewee 2; Interviewee 8; Interviewee 10). This discipline is applied to deal with a wide range of subjects, for example, product related issues (such as mobile phone interface) and also those associated with a particular market segment (e.g. specific requirements). Thus, the strength of design lies on the combination of flexibility and holistic approaches to tackle a plethora of situations supported by a solid human-centred factor.

5.5.2 Designers: social translators and visionaries of the future

Designers are considered '*...inherent translators of social need.*' They are trained in a number of expertises, in particular, to engage and understand people. As a result, they are emphatic to identify people's concerns, struggles and difficulties working to make their lives easier in the future (Interviewee 3; Interviewee 6).

In addition, since these professionals are qualified to scan the environment and analyse data considering multiple angles, they present an outstanding ability of visualizing new possibilities. Designers are extremely versatile and capable of translating information into something tangible such as a new product. When working in multidisciplinary teams alongside with professionals from different backgrounds, they are able to communicate in deep details how their ideas 'work'.

Through discussions and brainstorming sections they can generate rich insights and innovative ideas for future solutions (Interviewee 9; Interviewee 10).

Since design is committed with future timeframes, more than never, this discipline becomes a critical asset in the mobile telecom sector: *'... Design is about looking ahead and looking to the future; what handsets can deliver in the future'.* Supported by design thinking and a creative mindset designers not only envision new possibilities; but also, create the next generation of wireless solutions *'...they create the future by what they do'* (Interviewee 2; Interviewee 10)

5.6 Design Research

5.6.1 Applications, approaches and contributions

Overall, design research covers a wide scope of activities supporting different stages of the design process ranging from prototyping and communication efforts up to market proposition development (Interviewee 1). Therefore, the holistic and multifaceted character of design research provides utmost support to tangible (e.g. product development) and intangible (e.g. marketing strategies) business activities.

One of the key stages of the design process comprises searching and collecting relevant information about a topic under investigation. To conduct these activities, both qualitative and quantitative research methods are employed. Due to their characteristics these approaches offer different benefits *'...with qualitative research you get insights, you get inspiration, you get ideas, you observe, you immerse yourself in real scenarios; with quantitative information, you get data which is really static, it is not dynamic, you can't shape it…'* Despite the fact that the strengths of the design research are related to the combination of these two complimentary approaches, designers share a preference to work with qualitative rather than quantitative information. The reason behind this choice is associated with the fact that qualitative insights are about discovery. Therefore, they can manipulate soft data bridging different parts, discovering associations, patterns and similarities helping them to have a fresh perspective of the investigated topic (Interviewee 4; Interviewee 7).

Concerning future timeframes, the research stage is a fundamental; however complex and time-consuming part of the design process. Among different factors, a crucial element when conducting a future-led design project is to engage with professionals that are creative and 'visionary': *'...you can't research the future unless you are with somebody who can imagine the future*' (Interviewee 6). Thus, future-led research relies on a conjoined effort of a group of people that must be aware of 'what is going on' in society. They should be following news, reading magazines, being part of popular culture by walking around, discovering new trends, experiencing new things and carefully watching how different phenomena and trends evolve through time (Interviewee 9). Finally, more important than just gathering information, these professionals must make an effort to track possible directions that distinct events can take, since these phenomena can unveil valuable opportunities for the development of new market solutions.

5.6.2 Researching about users and related methods

Researching about users is a critical activity during the design process. In general, to investigate users (including their requirements and aspirations), it is necessary to gradually check and analyse their behaviours and understand what makes their life easier, better and convenient (Interviewee 6).

Concerning design research conducted in the wireless sector, placing users (and their needs) in the centre of the investigation process (a process known as 'Human Centred Design') help researchers to identify the key factors that shape handset experience. *'...Look at people usage patterns on products and services and look at the experience as a whole to understand what's currently influencing people's expectations and of an experience...'* (Interviewee 3; Interviewee 6). Taking into account that experience lies on the intersection between the device's features and the contracted services, by using this systematic approach (e.g. Human Centred Design), researchers and designers are able to discover a wide range of complex issues related not only to physical (e.g. interaction); but also, the emotional (e.g. needs) drivers that influence the users' handset experience.

The Human Centred Design (HCD) hall of methods comprises distinct types of research techniques. In a general perspective, the most practical tools to collect information about users are: observing them; taking pictures to register their behaviours and actions; and talking with them (Interviewee 1). Even though these approaches seem to be fairly simple and straightforward, they can be used in very sophisticated ways depending on the person or group of people investigated and also the context/situation where the inputs are collected.

For example, users' observation can take place either indoors and outdoors. It also can be done once (e.g. one-off attempt) or through a long period of time to check a particular issue. Frequently, global companies operating in the mobile telecom sector have specific facilities reproducing daily life environments where they invite selected users to spend a whole day while a research team check, identify and analyse their behaviours/interaction with mobile devices (Interviewee 4). In a different perspective, observations can also be conducted through a long period of time considering a massive sample of consumers (known as 'longitudinal studies') *'…to observe different aspects of sort mobile technology use to make an idea of how people are using technology'* (Interviewee 3). Although time-consuming, these approaches present a complimentary character offering fresh and up to date insights about how users deal with wireless technologies and adapt them to match/address their personal needs.

Another established technique that has been used in the design research domain is ethnography. The *modus operandi* of this method can be defined as *'…when you spend time with users in their real environment, analysing their everyday life without putting them under any test or any task or you don't give instructions'* (Interviewee 7). Based on this statement, ethnography is a non-intrusive research tool that aims to collected insights from an external point of view. When applied in the mobile telecommunications industry, ethnography covers a wide range of situations. For example, to observe users when they interact with their gadgets in different situations including public transportation; when they are walking on the streets; at home; at work and even at school (Interviewee 4). Since mobile communications become part of people daily life, this method emerges as one of the foremost research tools to explore how people use their phones to perform a myriad of tasks in different environments without interference from researchers.

Consequently, insights collected represent real behaviours and feelings of users towards their devices.

5.6.3 Researching about trends and related methods

As part of research efforts, scanning the environment for phenomena that can deliver impacts on businesses is also an essential part of the design process. Following these events (e.g. political, economical social and technological issues) demands time since its paramount to understand their nature and 'predict' possible directions that they might take in order to prepare suitable actions to tackle them (Interviewee 9). With respect to the wireless landscape, tracking trends requires effort and robust analytical skills to explore these incidents from different angles. More than never, as the mobile telecom industry integrates features and resources from other business sectors, it is also necessary to investigate the situation on those areas *'...you have to look at probably other industries than your own and see where those things might come crashing into your industry'* (Interviewee 6). Finally, gathering evidences about these distinct issues assist the research team to have a 'big picture' of the market landscape. However, it is essential to take an active approach and use the information about trends wisely to inform briefings and strategies for future solutions, staying ahead of competitors (Interviewee 7).

Since exploring and gathering insights about trends become instrumental to support the creation of innovative solutions, firms have been investing a great amount of time and resources to develop this expertise. In general, companies can either set up an in-house team or commission third party agencies to supply them with updated information about these landscape events. When investigating trends, the research team should be aware of discontinuities patterns and also anomalies happening in different social spheres (Interviewee 7). Since trend research is a continuous process, data collected through different sources of information must be organized (for example, using verbal and visual databases), regularly checked and promptly updated taking into account new information or event: *'...whether it is a spreadsheet or whether it is a proper database it will just be ticking over and them when things, if things evolve or if they become irrelevant, you can delete them…'* (Interviewee 9).

At last, an efficient trends' database allows researchers not only to keep track of several phenomena (on-going and also emerging issues); but also, to project these events in future timeframes (Interviewee 9). As a result, based on these 'visions', companies can develop future scenarios where these issues work as inspirational platforms leading to the creation of products and services.

5.6.4 Experts' perspectives and insights

In a broad perspective, experts from different backgrounds (including academics industrialists) are regarded as an utmost source of up to date information across different sectors. Engaging with these professionals bring outstanding benefits to design research process. More than just gathering fresh data, researchers can gain a leap of knowledge developing new insights based on these experts' ideas that, otherwise they could not have access, if they consider only inputs gathered from consumers (Interviewee 7).

Apart from providing specific information, experts also play important strategic roles. For example, they can identify and advise about current trends in the market. More than never, companies operating the wireless sector invite experts to assist their in-house design research teams in the task of analysing these landscape phenomena and how they might evolve in the future: *'for external, we use future forecasting companies, experts and professors and internally, design use relevant head of departments to joy the workshop every quarter to define trends and work with future trends'* (Interviewee 4).

In addition, the use of multidisciplinary teams including professionals and experts from different departments within a firm contributes to rich discussions and ideas generation to create 'roadmaps' for future products. Together, they analyse data and provide assistance to build future scenarios that lead to innovative solutions (Interviewee 4).

Finally, experts' insights have been considered critical inputs in which companies in the wireless sector are relying more to make strategic decisions (Interviewee 5; Interviewee 6). Benchmarking with those professionals provide valuable insights

about a broad range of issues such as distinctive product design outlook as well as knowledge about user's experience to support future decision making processes.

5.6.5 Data consolidation methods: scenarios and personas

The development of 'personas' (e.g. profiles of potential consumers or market segments) is a crucial step used to define future directions to be taken in the next stages of the design process. The use this established data consolidation technique, help researchers to have an overview of potential consumers for future products (Interviewee 10). Therefore, the richer these descriptions are; the more accuracy the design research team has to develop insights about tailored future solutions to address the characteristics of each 'persona' created.

In a different perspective, another method used to visualize possible situations of new product utilization is called 'scenario'. This technique has been regarded as the foremost instrument to define future strategies (Interviewee 4). Different from 'personas', 'scenarios' focus on describing in rich details the context of utilization of a given product or service. Through these 'visions' of the future, it is possible to plot a myriad of characteristics related to the artefact under development considering 'how', 'where', 'when' and 'by whom' this product will be used; the integration with other products/technologies and value proposition/unique selling points (USP).

Finally, *'persona building and scenario building, those are incredibly important, and they are incredibly in communicating the ideas as well…'* (Interviewee 6). Taking into account the distinct nature of these two methods, 'personas' and 'scenarios' complement each other assisting the design research team to analyse and consolidate data in an efficient way, integrating insights and defining the most promising directions for new product development.

5.7 Users

5.7.1 Market segments' drivers

In a broad perspective, distinct customers' segments present unique requirements that can be fulfilled by different types of devices (Interviewee 4). Based on these ideas, handset manufactures develop an extensive product portfolio ranging from low to high end solutions, incorporating standards and state of art technological resources to address these specific audience needs. Moreover, the market segment considered more inclined to adopt new wireless products/technologies is known as *'pioneer'; 'tech-follower'* (Interviewee 4). Basically, this group is composed by young, open-minded and technology driven consumers, eager to try new products and services as soon as possible; consequently, influencing their peers, setting behaviours and starting new consumer trends.

5.7.2 Experience and interaction drivers

Since mobile phones have been integrating and combining several technological features, more than never, users have access to several communication channels to reach their peers. The internet was a major driver for the creation of innovative services that opened a horizon of possibilities in wireless communications. From regular and established services such as phone calls and 'text messages' (e.g. Short Message Services, SMS) up to Voip (e.g. Voice over internet protocol), passing by social media services and mobile applications *'…if they (users) think about connecting to somebody, there are actually seven or eight ways of they might do that'* (Interviewee 6).

With respect to handset experience, it becomes more intuitive and organic through time. While in the past, scrolling through several menus by pressing a physical button was a landmark of mobile phone utilization; today, large, high resolution touch sensitive displays presenting colourful icons that can be dragged and moved anywhere on the screen dominates interaction on these devices. Moreover, current mobile phone experience is also heavily associated with software. More than never, applications (or 'apps') play key roles regarding interface interaction since they allow users to customise their gadgets (Interviewee 10). Moreover, users

have more flexibility to adapt their devices including related wireless technologies to match/address their personal requirements (Interviewee 9). As a result, these tiny pieces of software enable them to go one step further, pushing the bar in terms of user experience. Therefore, they are able to not only perform tasks in a more convenient way; but also, to find new usages for their mobile phones.

With respect to internet usage on handsets, *'…people will expect to have the same internet experience to their mobile as they do with their laptops and fixed PCs you know, expect the speed of access to be the same…'* (Interviewee 3). As recent mobile internet protocols (e.g. LTE) expand and devices become more optimized particularly in terms of software to cope with emerging technologies, limitations related to the wireless internet will progressively be reduced, improving overall handset online experience.

5.8 Technology

Technology has been regarded as one of the major aspects concerning both new product development and customer experience. In the first case, it is a key factor that drives the design, creation and production of new mobile phones and related features (such as innovative materials; new hardware and integrated software resources). From a different perspective, end users are the biggest beneficiaries of these progressive improvements: *'…new technologies make things easier to do than they were a couple of year ago'* (Interviewee 2). In addition, as people use mobile technologies in a more organic and natural way, they adapt their devices to their needs and find innovative uses for resources that were not envisioned or considered by handset manufacturers during the design process.

5.9 Innovation

Innovation becomes one of the most challenging topics in the current corporative agenda when designing new market solutions and trying to achieve success in the fast pace wireless industry. However, the process of innovation involves a fair amount of risk that few companies are prepared to take for different reasons (e.g.

financial, structural or strategic). *'When you talk about innovation; you talk about risk. You cannot create a truly innovative product, a new idea, a new business model or an innovative service without concerning the element 'risk' involved…'* (Interviewee 1).

In addition, associated with these concerns (e.g. risk, uncertainty and possibility of failure in a new venture), other factors also concur for making real innovation extremely difficult to achieve. For example, finding a clear opportunity and the right 'time to market' to launch a strategy or product to address this market gap requires more than just perception and a skilled business mind to be successful (Interviewee 2). In fact, what happens in the real corporative world is that *'the great innovations, sometimes, occur because somebody 'buys in' the plan, supporting the role process despite the risk involved* (Interviewee 1). Based on these evidences, it is possible to say that probably a senior executive, CEO with strong decision making powers (such as Steve Jobs) or a skilled design champion are the most likely people to support the idea of a new project assuming the responsibility despite of the risk involved to execute the proposed plan.

5.10 Findings consolidation and further analysis

Throughout the last section, highlights from the exploratory experts' interviews were displayed and examined. This segment is fully dedicated to scrutinize even further the insights derived from the previously conducted primary research, breaking down and reorganizing the data collected.

As it was explained before in the Methodology chapter (Chapter four), data collected were analysed based on the principles of Grounded Theory. During this procedure, all insights were brought together, coded, compared and clustered according to the topic they conveyed. Thus, the information was summarized and re-arranged in order to make sense. This process not only helped the researcher to organize data; but also to, acquire fresh and different perspectives about these inputs, discovering new and meaningful relationships among them.

In the following pages, the final outcomes derived from the analysis process will be presented, comprising seven major clusters: ‘Wireless Industry (business)’; ‘Trends (in wireless industry)’; ‘Design’; ‘Research’; ‘Users’; ‘Technology’ and ‘Innovation’.

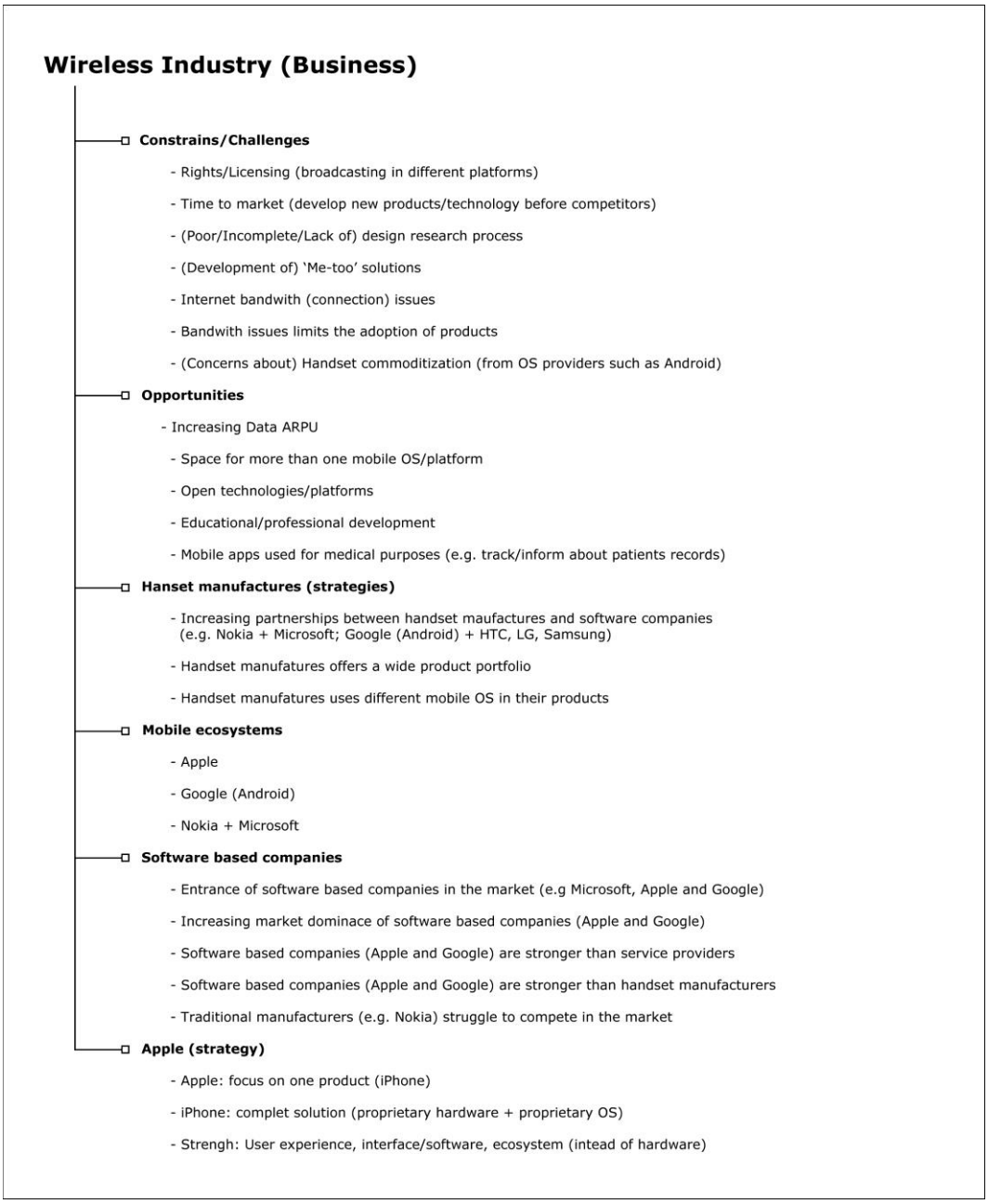


Fig. 5.1 – Major theoretical cluster – Wireless industry (Business)

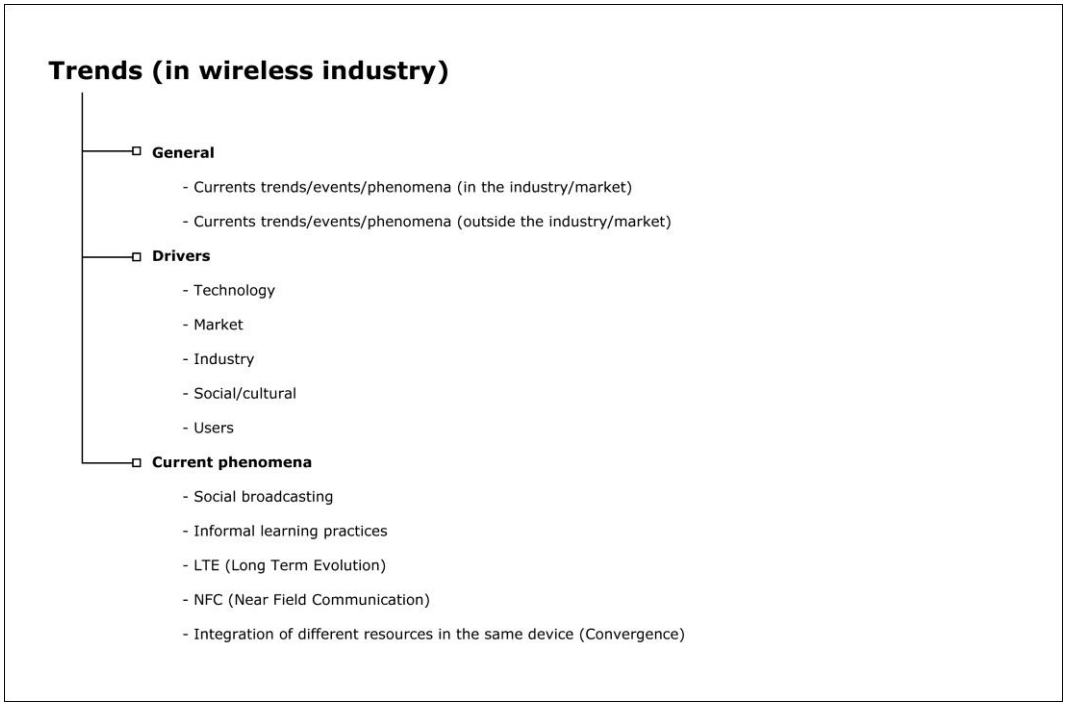


Fig. 5.2 – Major theoretical cluster – Trends (in wireless industry)

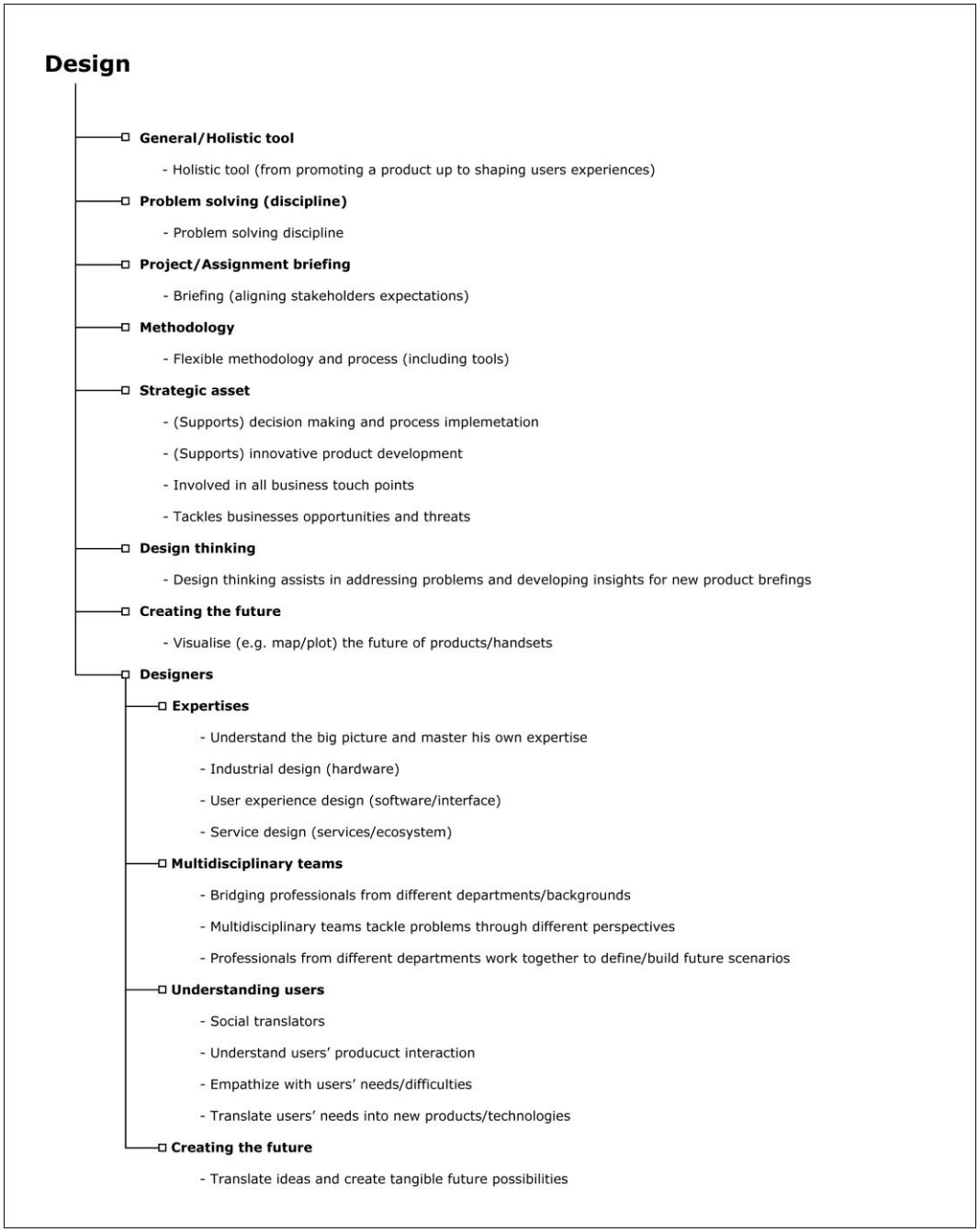


Fig. 5.3 - Major theoretical cluster - Design

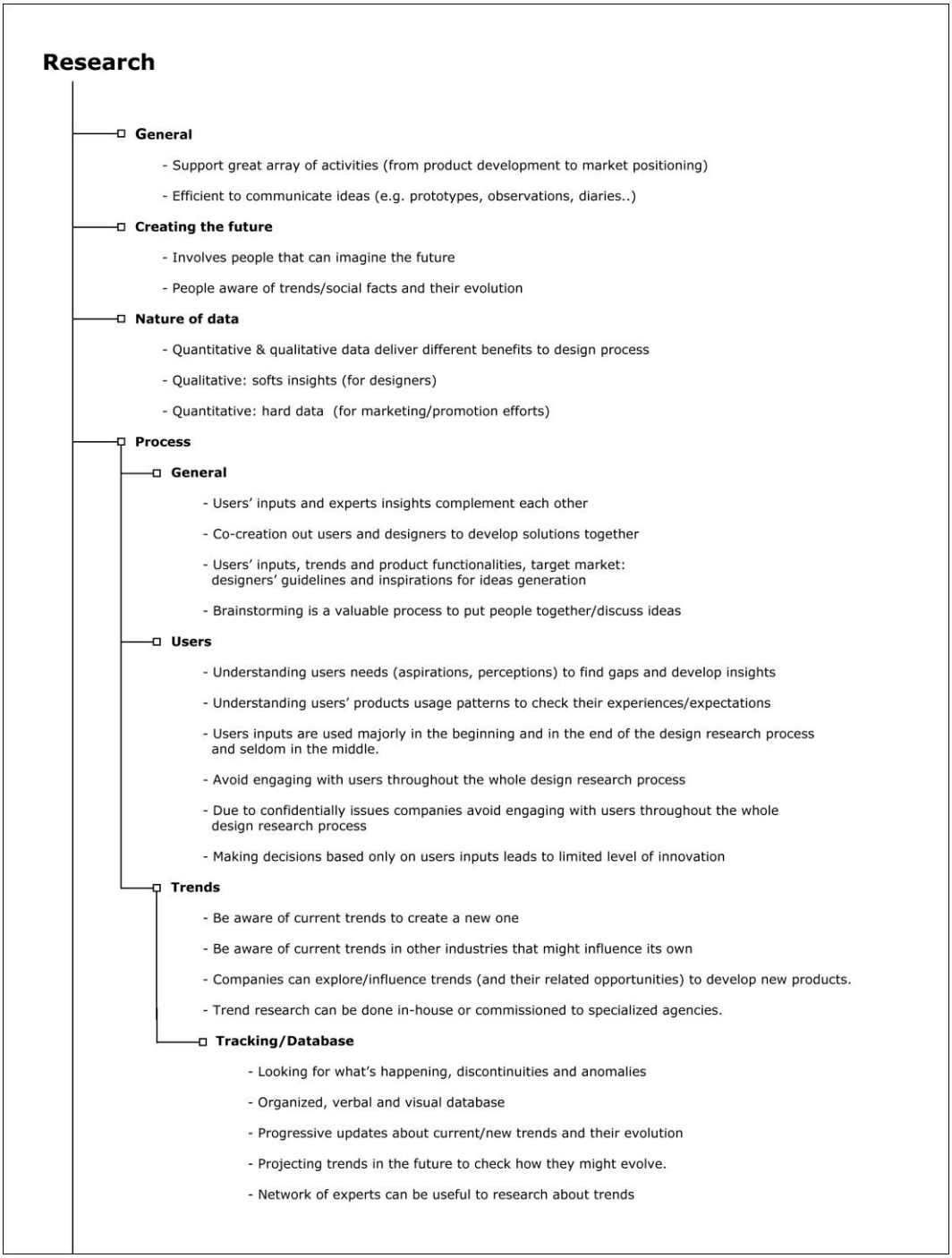


Fig. 5.4 Major theoretical cluster - Research (Top - Part 1)

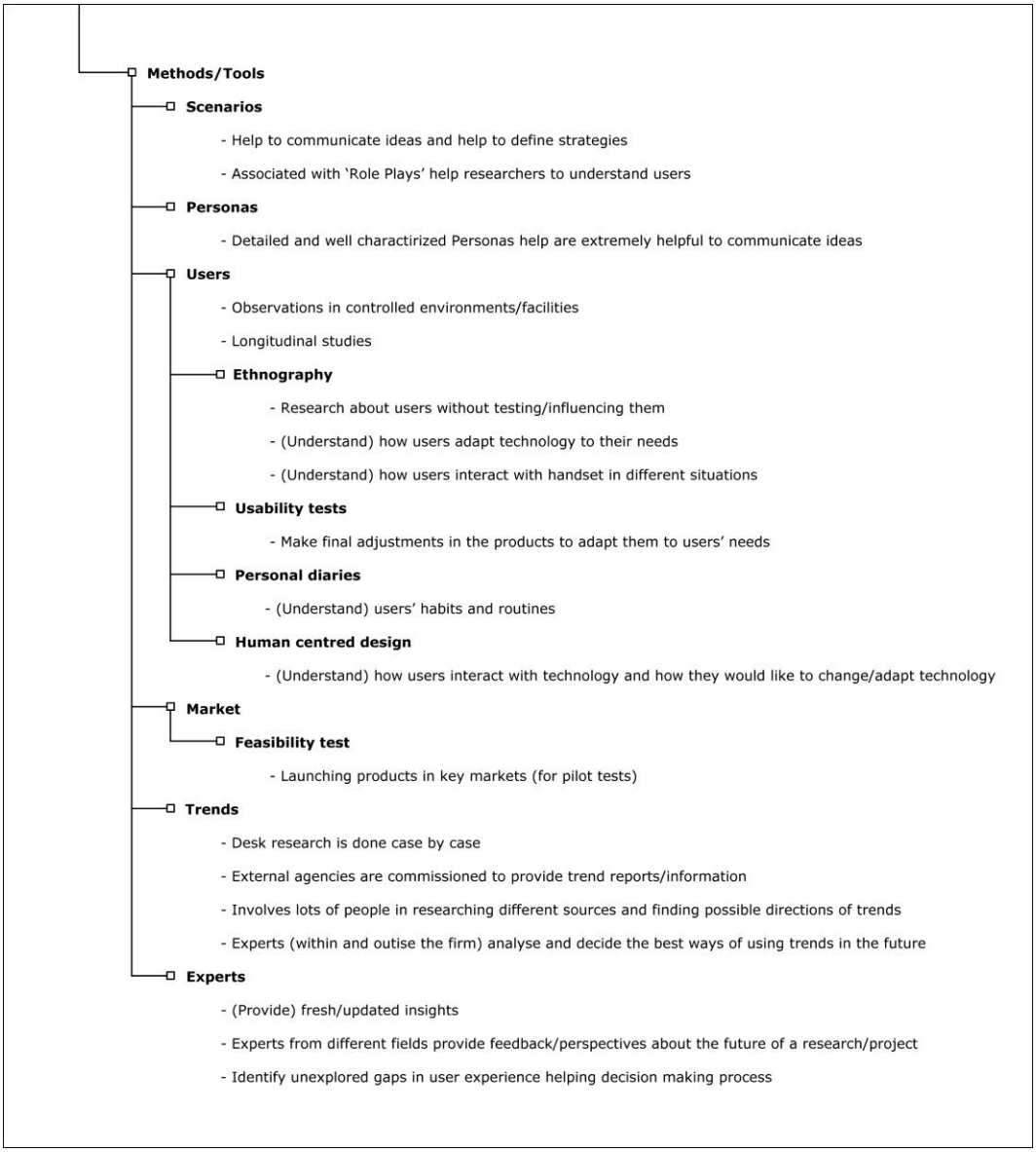


Fig. 5.5 Major theoretical cluster - Research (Bottom - Part 2)

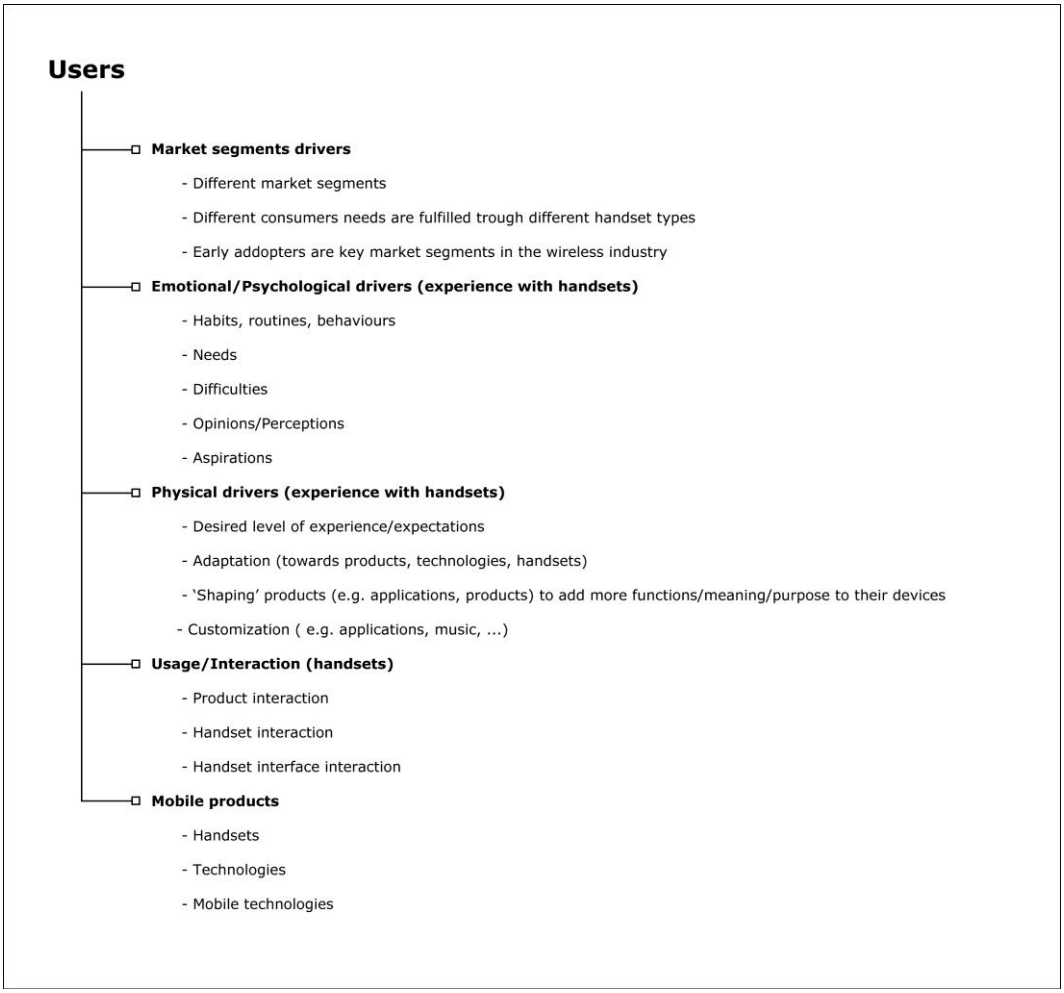


Fig. 5.6 - Major theoretical cluster – Users

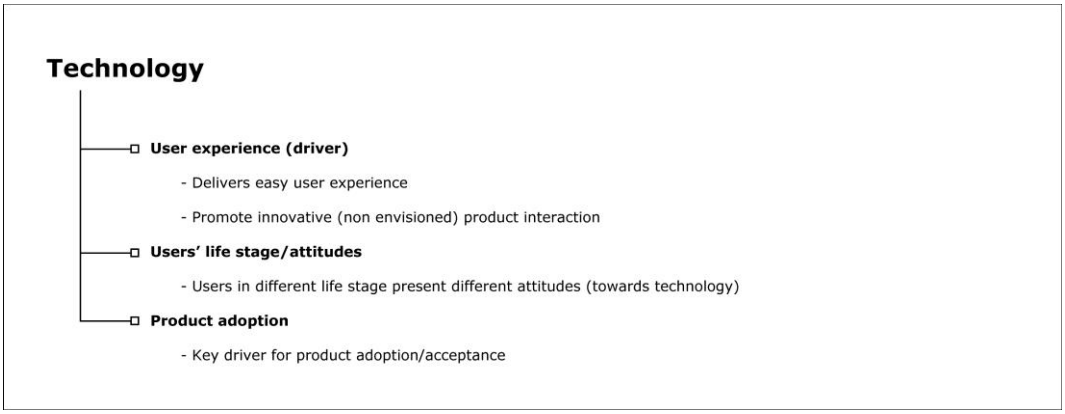


Fig. 5.7 – Major theoretical cluster – Technology

Fig. 5.8 - Major theoretical cluster – Innovation

The introduced seven theoretical clusters display the already synthetized and organized main ideas resulting from the experts' interviews analysis. Each group encompass a series of codes and sub-codes that were labelled using direct and brief words or key expressions taking into account the theme or context in which abstractions are related to.

Due to theoretical reasons, despite the fact that every cluster, codes and sub-codes were created and named in an independent way to keep its exclusivity, somehow, they share some relationships.

5.10.1 Building data relationship: network of insights

Since abstractions derive from a given context, they are also connected to other related topics. As it was mentioned before, through the analysis process supported by the Grounded Theory, they were allocated in different clusters, codes or sub codes for theoretical reasons. However, even though organized and restructured in this manner, information can be linked in different levels. The following sections will introduce two types of data relationship: within and across different clusters.

5.10.2 Relationships within the same theoretical cluster

The first type of relationship occurs inside of a cluster (‘intra-cluster’) connecting the ideas of different codes (and sub codes) to each other. For example, inside the Cluster ‘Research’ (figures 5.4 - top and 5.5 – bottom), among different codes, there is a first level code named ‘Methods and tools’. This particular code, is also divided in other six second level sub-codes (e.g. ‘Scenarios’; ‘Personas’; ‘Users’; ‘Market’; ‘Trends’ and ‘Experts’). Finally, inside the sub-code ‘Users’, there are there four third-level sub-codes named ‘Ethnography’; ‘Usability tests’; ‘Personal diaries’ and ‘Human Centred Design’.

Based on the previous example, the ideas presented in the sub-code ‘Ethnography’ describe the *modus operandi* of that particular tool and why it is employed in the context of mobile telecommunications. Moreover, alongside with other research methods, it is used to gather information about users. Next, the sub-code ‘Users’ encompasses several related research techniques and, alongside with other areas (such as ‘Trends’ and ‘Market’), requires different and specific methods to be investigated. Finally, ‘Methods and tools’ code comprises a collection of different approaches used to collect inputs about a wide range of issues and it is also one key area that ‘Research’ (cluster) involves. The following chart displays the relationships of data inside the theoretical code ‘Research’.

Table 5.2 – Examples of categories/relationships within the same cluster (‘intra-cluster’)

Category	*Cluster*	*1st level (code)*	*2nd level (sub code)*	*3rd level (sub code)*
Label (name)	Research	Methods and Tools	Users	Ethnography
Relationship	*One key area that ‘Research’ comprises*	*One key topic where different tools are used to collect data*	*One method of data collection about users*	

5.10.3 Relationships between different theoretical clusters

Apart from the relationships that occur inside the same cluster (‘intra-cluster’), it is also possible to establish links and associations between the abstractions across different groups (‘extra-cluster’).

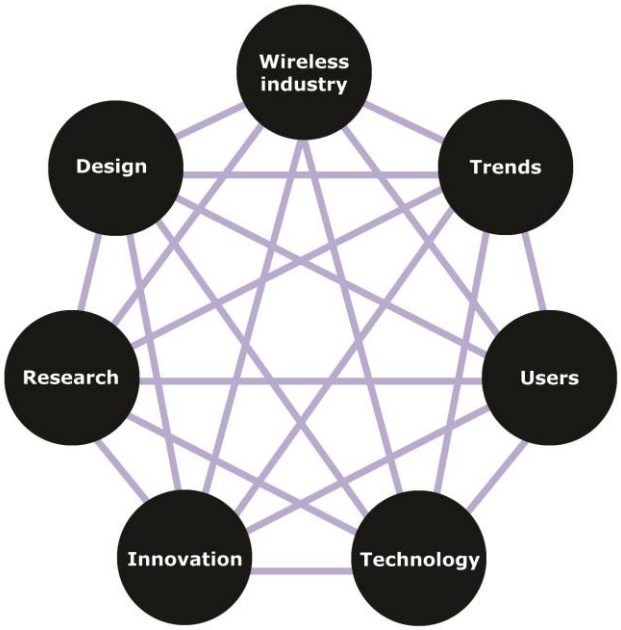


Fig. 5.9 – Relationships across different clusters (‘extra-cluster’)

For example, there is a link between ‘Design’ and ‘Users’. Design plays pivotal roles as a process also and as a holistic tool supporting designers to empathize with users’ difficulties and aspirations regarding their experience and interaction with mobile handsets. By understanding and exploring their unique requirements (alongside other social issues), designers are able to ‘translate’ these soft inputs to create the next generation of products/services to address the audience needs.

Next, a relationship between the clusters ‘Research’ and ‘Trends’ can be clearly identified. In order to scan the landscape and acquire valuable insights about key phenomena from the wireless industry and other sectors, it is necessary to employ specific research tools to examine these events. For example, trend research can be conducted by an ‘in-house’ team (within a firm) or it can be commissioned to a specialized research agency. Either way, it involves tracking and progressively checking how these events evolve through time. Experts also play important roles advising companies about major landscape issues based on their knowledge in a

specific field. Finally, the main purpose of these processes is to inform companies about environmental events and determine how they can be used to support the development of future handsets and services.

After that, clusters ‘Trends’ and ‘Technology’ also share an intimate connection, particularly in the mobile telecom sector. In a general perspective, mobile phones have been incorporating a myriad of resources from different industries (including computing and entertainment). Some of them were successfully introduced by a given company in a specific device. As time passes by, other firms also integrated these features in their wireless products, becoming a widespread handset standard. Examples of new technologies recently integrated by handset companies in their products are: NFC (Near Field Communications) that allow users to exchange files between devices and LTE (Long Term Evolution), a fast wireless protocol that aims to improve users’ mobile internet experience.

Last but not the least, since its establishment, the wireless industry is recognized by introducing innovative products, services, standards and business models. Thus, it is possible to point out a link between ‘Wireless Industry’ and ‘Innovation’. A clear example of how an innovative product imposed dramatic changes in this sector was the introduction of Apple’s iPhone in the market. This device not only presented hardware (e.g. touch screen); but also, software (e.g. mobile operating system, iOS) innovations. Moreover, this handset was supported by unique and exclusive services (e.g. App Store and iTunes). The combination of these factors gave birth to the first mobile ecosystem, (in this case, characterized as a ‘closed platform’, due to the restricted nature of the handset and its related services). Thus, the successful implementation of this business strategy (e.g. mobile ecosystem) by Apple was also later copied and adopted by other players (e.g. new entrants such as Google and also traditional firms for example, Nokia) in this industry.

5.11 Conclusions

The extensive collection of findings derived from the exploratory interviews with experts from different backgrounds, provided a comprehensive perspective about several elements that compose the current wireless industry landscape.

Based on the insights that emerged from the experts' narratives, it is possible to say that the mobile telecom industry is a highly intricate and complex sector. Moreover, firms operating in this business face daily challenges to compete in a sustainable way. Among several factors to be considered during the development of new products, design appears as an important asset for companies competing in this industry, particularly handset manufactures.

Among the several strengths of Design discipline, flexibility and wide spectrum of applications can be highlighted, providing valuable support for traditional handset firms. As a mindset, it permeates through several departments of a manufacturer touching in every single part of the business. When employed as a strategic tool, this discipline provides paramount support for decision making processes. As a research methodology, it comprises both data collection and analysis instruments addressing different issues such as competitors' strategies and products; experts' insights; users' needs and landscape trends. Finally, design is associated with the development of innovative wireless technologies and products that go beyond customers' expectations.

Last but not the least, from an academic research perspective, the analysis of the experts' insights using the Grounded Theory principles offered new possibilities for this study. The rearrangement of data in different clusters led to the discovery of relevant links and associations among different abstractions within and across different groups. Through these several theoretical connections, data gained new and relevant meanings assisting in a later stage of this study, the development of the design-led future forecasting model for mobile communications (aim of this research).

6 Discussion

6.1 Introduction

This Chapter is dedicated to explore and discuss the wide spectrum of findings introduced throughout this report, particularly focusing on the insights gathered via primary research (see Chapter five). Basically, it is divided in four main segments. In the first part, an overview of the changes in the mobile telecom landscape is introduced, highlighting the on-going transformations driven by the advent of the internet in this industry. Next, the situation of traditional handset manufacturers in the current wireless market is examined. After that, the extensive contributions of design for business are presented and discussed. Finally, the last section addresses the roles that design play and how it can strategically support traditional mobile phone firms to engage with the future, creating and delivering the next generation of wireless solutions.

6.2 Shifts in the wireless telecom landscape

6.2.1 The entrance of software firms and industry integration

The advent of the internet in the mobile telecommunications was a critical factor that led to radical changes in the entire sector, delivering impact on different areas including business models, players, services and value proposition.

Unexpectedly, it was Apple, a company originally from a different industry (e.g. computing) that envisioned potential opportunities brought by the progressive integration of internet in the wireless sector. Apple's move into this completely new business area where it did not have any previous experience could be considered audacious, at least. However, it was the combination of several factors including the company's extensive computing know-how and the progressive digitalisation of the wireless industry that supported this firm to create a unique product to address these unexploited opportunities: the iPhone. Introducing a 'complete product', featuring a combination of mobile handset and computer

functionalities; full touchscreen interface, proprietary operating system and exclusive related services (e.g. iTunes and App Store), the iPhone, soon, became a remarkable market success.

Not long after the iPhone's triumphant market debut, Google, another computing firm, also entered the wireless sector. Its strategy was based on the development of its own open source mobile software, Android. Since Google did not produce any hardware (e.g. mobile phones), it established partnerships with a wide range of manufacturers to distribute this new operating system through their handsets.

Within a year, two major global computing players, Apple and Google, supported by different strategies launched innovative solutions (e.g. iPhone and Android) to compete in the wireless sector, taking advantage of the mobile internet revolution.

From that moment, it was clear that it was a matter of time for these two business sectors' boundaries, computing and mobile communications become blurred.

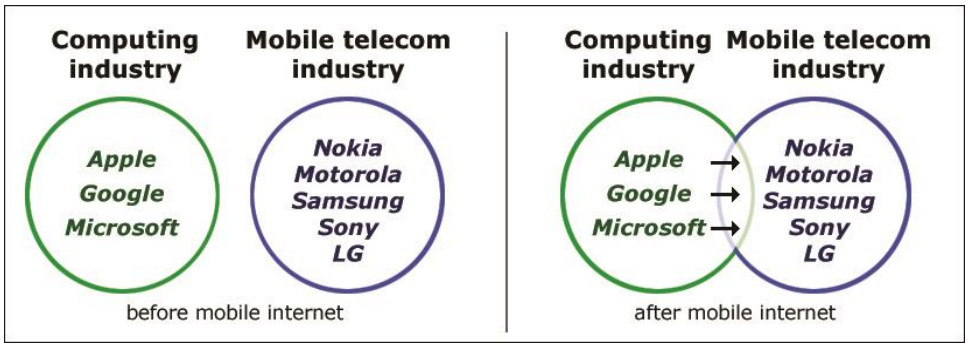


Fig. 6.1 - Before (left) and after (right) the entrance of computing firms in the wireless telecom sector supported by the expansion of the mobile internet.

6.2.2 Industry leadership shift: from manufacturers to software firms

To understand the reasons behind the outstanding success of software based firms in the mobile telecom industry and the decline of traditional manufactures, it is necessary to explore some key factors that led to these events.

To begin with, the business propositions brought by Apple to the wireless sector were completely different from those approaches employed by established mobile phones companies. Interviewee 5 briefly compared them: *'I think that Nokia was a technology company first and foremost making hardware… we came from a*

world of devices that allow people to make calls and send text messages… Apple, on the other hand was a computer company that whose world was about an empty box that people filled up with stuff that they wanted to do….'

During the 'Pre-mobile internet Era', market competition was based on hardware development capabilities including the aesthetical elements of mobile handsets. Nokia was the dominant player and sales leader, offering a wide portfolio of products running Symbian, a standard and commoditized mobile OS also used by other manufacturers such as Sony and Motorola.

After the integration of the mobile internet and the progressive digitalization of telecommunications, computing firms such as Apple, started gaining *momentum* in the wireless industry inaugurating the 'smartphone Era'. Supported by ground breaking solutions, Apple, through its iPhone, enabled users to achieve a level beyond in terms of handset interaction by accessing internet based content in unprecedented ways.

The simple and fundamental understanding that the wireless telecommunication was becoming 'similar' to the computing sector (due to the progressive expansion of the internet) was the key factor for the triumph of software based firms. In a short period of time, these companies dominated the wireless landscape by setting new trends and steering the directions of whole industry.

On the other hand, for established companies (e.g. Nokia), the steep fall was not only a direct consequence of ground breaking approaches (e.g. business strategies and innovative products) implemented by the new entrants; but also, the lack of vision to address long term and emerging trends such as the internet, that has been transforming the entire sector, since long time ago.

6.2.3 Partnerships between manufacturers and software firms

As software based firms consolidated its position, tradition handset manufactures took a plunge with respect to market competition. In order to still remain relevant and competitive, these firms had to readapt to the new 'rules of the game'.

While Apple achieved almost immediate success with iPhone's market release; it took some time for Google to establish itself and find space in the wireless sector. The company's strategy to distribute its mobile operating system (e.g. Android) through a series of alliances and partnerships with handset manufactures started to flourish when Android gained *momentum* and also scalability through a massive market distribution.

In reality, partnerships between software based firms and traditional mobile phone manufacturers became a common strategy. Several handsets companies have been using this approach for different purposes. However, the major reason is related to the fact that manufacturers' strengths are based on product development; thus, they tend to rely on third party mobile operating system to run their handsets.

Among the several partnerships linking handset manufactures and software based firms, the Nokia-Microsoft is one to be highlighted. The entrance of companies from the computing sector (particularly Apple and Google) in the mobile telecom, impacted on Nokia's business performance leading to speedy decline. In this turbulent context, Microsoft envisioned a clear opportunity: proposing a strategic alliance to Nokia. Since the software firm was already operating in a discreet way in this market through its Windows Mobile OS with marginal presence, a joint-venture could be beneficial for both companies. Interviewee 4 explained that this manoeuvre could be considered 'the last breath' for the Finnish firm: *'... I think that it was only through the partnership with Microsoft, it was the only way that Nokia could make it'.*

This partnership intended to bring together Nokia's solid hardware and product development expertise and Microsoft's software and interface development know-how. This alliance aimed to drive Nokia back on steady market competition and, at the same time, help Microsoft to gain wireless market share by embedding Windows Mobile OS exclusively on Nokia's handsets' products.

Fig. 6.2 –Nokia phones running Microsoft's Windows mobile OS (Lumia Series)

Since all major computing firms started operating in the wireless sector following different strategies, these companies soon developed their 'areas of influence' that stretched beyond the mobile phone itself, comprising also intangible assets.

6.2.4 Mobile ecosystem: a 'lock-in' business approach

The partnerships and strategic alliances involving both software based companies and handset manufacturers can be considered the precedents of current 'mobile ecosystems'. Characterized by an intricate and complex network of relationships comprising several actors (see Chapter 2, section 2.3.1 for further information), a mobile ecosystem relies on, impacts and influences its business community (e.g. corporations and consumers).

Interviewee 5 presented a snapshot of current wireless landscape concerning the ecosystem business approach: *'Apple has created an ecosystem with its apps and everything that links to that and you have Android which is the emerging second ecosystem which is actually growing substantially faster than Apple and so Nokia going into strategic partnership with Microsoft is about to create a third ecosystem.'*

The three previously mentioned mobile ecosystems present some similarities and differences. In practical terms, they comprise hardware (e.g. mobile phones); software (e.g. mobile operating system) and related services. As a result, all these three core elements work as foundations of this unique business approach.

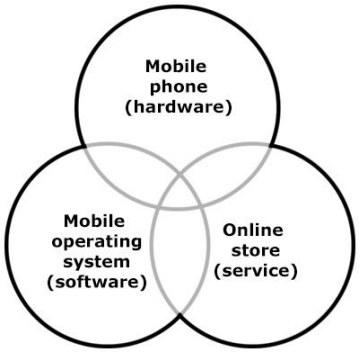


Fig. 6.3 – Core elements of a mobile ecosystem

Apple produces the iPhone (hardware) running its mobile operating system (iOS) that is associated with proprietary services, iTunes and App Store. Pursuing a different strategy, Google developed the Android (mobile platform) that has been distributed in numberless handsets manufactured by different companies (such as Samsung, LG, HTC…) and is linked to its own online service (e.g. Play Store). Finally, while Nokia offers a comprehensive range of solutions (hardware), Microsoft embeds its Windows mobile OS (software) in Nokia's high end mobile phones and progressively rolls out Nokia's originally online service, OVI.

Concerning the differences among these ecosystems (apart from the uniqueness of solutions developed such as mobile phones, mobile OS and services), they are, basically, related to the strategies employed by the firms ahead of these clusters. For instance, Apple has complete control over the development of the iPhone, iOS and proprietary services (e.g. iTunes and App Store). Therefore, it has a closed approach toward its mobile ecosystem.

Next, while Google is responsible for developing/updating Android and managing the Play Store (whose contents are mostly created by independent developers); handsets running Android are developed by its several partners (e.g. Samsung, HTC and Sony), characterizing an open mobile ecosystem. With respect to the Nokia-Microsoft ecosystem, it works in the same fashion. In here, Nokia produces the hardware; whereas Microsoft develops the Windows mobile OS and together, they run an exclusive online service offering 'apps' for their products.

Table 1 – Characteristics of the current mobile ecosystems

Mobile ecosystem	Hardware manufacturer	Software manufcturer	Service provider	Ecosystem type	Business approach
Apple	Apple (iPhone)	Apple (iOS)	Apple (iTunes; App Store)	Closed	Quasi-vertical integration
Google	Samsung, LG, HTC, Sony...	Google (Android)	Google (Play Store)	Open	Partnerships
Nokia Microsoft	Nokia (Lumia Series)	Microsoft (Windows mobile)	Nokia (former OVI)	Open	Partnership

Based on the evidences presented, it is possible to say that Apple follows a *quasi*-vertical integration approach towards its wireless business (the iPhone uses third party spare parts and the App Store contents are mostly developed by independent developers). This specific business approach (e.g. vertical integration) was very popular during the 'Pre-internet mobile Era' when market competition was based on hardware development, being employed by several traditional handset firms such as Nokia.

On the other hand, due to the nature of their ecosystems, both Google and Nokia-Microsoft clearly depends on third party firms to create 'complementary' wireless solutions (either hardware or software) to support their mobile ecosystems (also content for their related proprietary services are mostly created by third party developers). These two ecosystems highlight the growing interdependence among different players in the value chain, contributing to a high market fragmentation.

Last but not the least, since mobile ecosystems are independent; users' experience also becomes 'exclusive'. Depending on handset model (and manufacturer), it is embedded with a specific mobile OS that is linked to a proprietary online service. For example, a given user that purchases an iPhone will have his mobile phone experience 'locked-in' to a specific mobile ecosystem (in that case, iOS). Thus, he will have access to contents offered in the iTunes and App Store, only.

6.2.5 Increasing dominance of software based companies

From one perspective, mobile ecosystems become an established 'channel' for traditional manufacturers to remain competitive in the wireless market. However, these firms have to cope with unprecedented business pressures that are directly related to the fact that they are 'locked' in this system: the increasing power of software based companies.

More than never, traditional manufactures present a growing dependence of computing firms' software solutions. As a result, they become 'hostages' of the increasing commercial power of these companies. This becomes evident when an upgraded version of a given mobile OS, for example Android (Google) is ready to be launched in the market. As interviewee 4 explained, *'they [software based companies] are just single companies and manufacturers, like us, are many that they become powerful and choose the manufacturers that they want in order to introduce their new operating system (OS)'.* In many cases, the release of new (or upgraded) software is done by integrating this platform into an exclusive handset model. As this flagship product becomes a 'reference point' for consumers aiming to buy a mobile phone, it has the potential to generate an increase in sales (and also revenue) for the selected manufacturer of that particular device.

As software firms' bargain power increases; traditional manufactures have been struggling to reach reasonable agreements with them in order to be selected to design the device that will introduce the next version of a mobile OS. That's the main reason behind handset manufactures' preoccupation with respect to software based companies.

6.2.6 Shifts in end-user value: from hardware to software

As it was mentioned before (section 6.2.2), market competition was hardware-led, particularly before the advent of the internet in mobile telecommunications. At that time, Symbian was the most popular and commoditized mobile platform and traditional handset manufacturers ruled this sector supported by solid product development expertise. Apart from the devices' functionalities, form factor and style were key drivers for product adoption. Several players such as Nokia, Sony

and Motorola created unique design solutions taking into account the aesthetical elements of mobile phones.

Fig. 6.4 – Different handset models portraying innovative form factor.
From left to right: Nokia (candy bar); Sony Ericsson (slide) and Motorola (clamshell).

The integration of the internet in the mobile telecom brought deeply modifications in this sector. The 'migration' of software firms to this industry supported by their solid computing know-how followed by the establishment of mobile ecosystems (a landmark approach of the current period), more than never, helped to turn the balance in favour of software.

Taking into account the progressive digitalization of the wireless telecom industry, user experience becomes heavily associated with mobile software. Today, handset interaction drivers are mostly related to interface, software resources, navigation flow and applications that can be acquired from a proprietary online service. In this context, Apple's iOS and Google's Android are good examples of established mobile platforms (and digital 'gateways') that facilitate and shape user experience in these 'pocket-sized' devices.

Fig. 6.5 – Left: Apple's iOS interface (handset and App Store, respectively), Right: Google's Android interface (handset and Play Store, respectively).

Based on these ideas, it is possible to say that current handsets (hardware) became just a 'bridge' connecting users to the digital world. Mobile operating system (software), more than never, plays significant roles not only controlling handsets' functions; but also, enabling users to access a plethora of internet based content.

Through time, there was a radical change in the type and nature of value delivered to end-users. In the beginning of the wireless telecommunications, handsets' sales were based on their technological resources and aesthetical (style/form) factors (hardware); while after the emergence of the internet, mobile OS (software) and related ecosystems became the ultimate driver for delivering and shaping handset user experience.

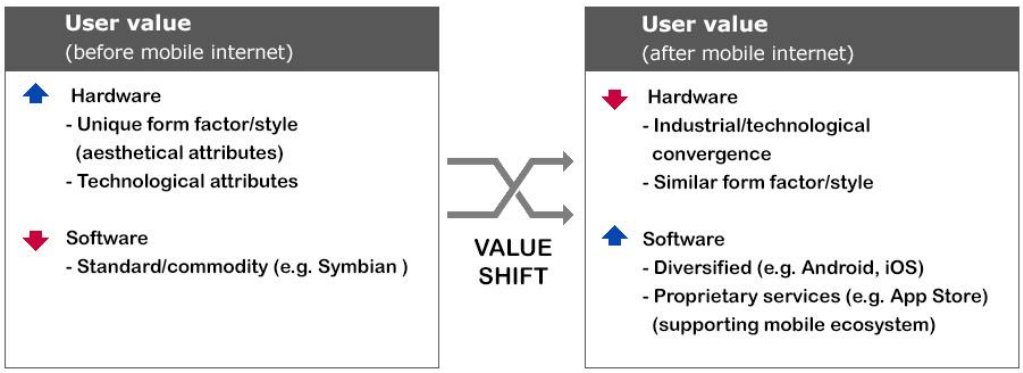


Fig. 6.6 – Major shifts concerning end-user value in the wireless sector

6.3 Current market situation for traditional handset manufactures

Nowadays, traditional mobile phone firms are not able to stand alone competing in the market as it happened in the beginning of the wireless industry. In fact, the modifications brought by the progressive internet integration and the entrance of software based firms in this sector, limited their power in the current telecom value chain.

Arguably, the digitalization of telecommunications was one of the key factors that promoted the fragmentation of the wireless sector. In the current scenario, handset manufacturers remain the only part of the value chain that still produces end-user physical value (e.g. mobile phones). All other players operating in this business sector including software companies; applications/content developers and services providers are, basically, creating 'intangible' value (e.g. software and services).

As a result, considering the complexity of today's mobile telecom value chain, traditional manufactures have been employing a wide range of strategies to thrive in this difficult environment, in order to discover new business opportunities and avoid threats/pitfalls along the way.

6.3.1 Software related approaches: multiple mobile OS strategy

As it was mentioned before, traditional mobile phone companies are subjected to the power of software firms, remaining 'locked-in' to a mobile ecosystem in order to remain competitive in the current 'digital' wireless industry.

Traditional manufactures' concerns towards mobile operating system exist since the early days of wireless communications. In the past, Symbian was the leading platform used by several mobile phone firms. Its widespread utilization led to a massive handset commoditization across the whole wireless telecom industry. Today, traditional manufacturers' heavy dependence of third party platforms can be regarded as a 'critical technical issue', particularly taking into account the expansion of open source platforms (e.g. Android). In practical terms, being part of a given mobile ecosystem (for example, Android), means very limited room for phone makers to manoeuvre in the market.

To tackle these issues, traditional mobile phone companies have been employing a unique strategy. Interviewee 4 explained this approach: *'[We work with] many operating system; so, we are not restricted as well. Samsung and HTC, they all have same strategy because with multiple OS is easier to bring the products more [appealing].'*

In reality, this strategy can bring several benefits for handset manufacturers. To begin with, the use of multiple software platforms can assist to prevent overall commoditization of their products. Next, this approach can help decreasing the dependence of phone makers towards a specific mobile OS and; consequently, the ecosystem that it is related to. Finally, by using different software across their product portfolio, handset companies can offer a wider selection of solutions (e.g. low, mid-range and high end devices) to address different market segments.

The following pictures depict the use of this approach by two different mobile phone companies (e.g. LG and HTC) in different lines of products. It is important to emphasize that the use of Windows mobile OS by different manufacturers were very common before Microsoft established an exclusive partnership with Nokia.

Fig. 6.7 – LG (left) and HTC (right) are examples of firms that have been using different mobile OS (e.g. Windows mobile and Android) across their product portfolio.

6.3.2 Software related approaches: mobile OS overlay

Apart from using a multiple mobile OS strategy in their products to offer better solutions to a growing consumer demand, traditional handset manufactures have bee also implementing another software related approach.

Open source platforms such as Android are extreme flexible. Taking into account the examples displayed in the last section (6.3.1), it can be considered highly adaptable to fit different handset models produced by several manufactures. In addition, the examples also highlighted the level of scalability of this platform.

From a software engineering perspective, open sources platforms (e.g. Android), also allow customisation, in a certain extension. In order to take advantage of this opportunity, traditional handset manufacturers have been developing 'their own version' of this software. Since they cannot intervene in the architecture of the platform, customization works at the 'cosmetic level' (e.g. aesthetic). Basically, mobile phone firms are creating a proprietary 'overlay' and applying their own visual language (e.g. design of menus, navigation and icons) on the top of the original software. For example, firms such as Samsung and HTC offer exclusive proprietary user's interface (e.g. 'TouchWiz' and 'Sense', respectively) running on top of Google's Android platform embedded in their handsets.

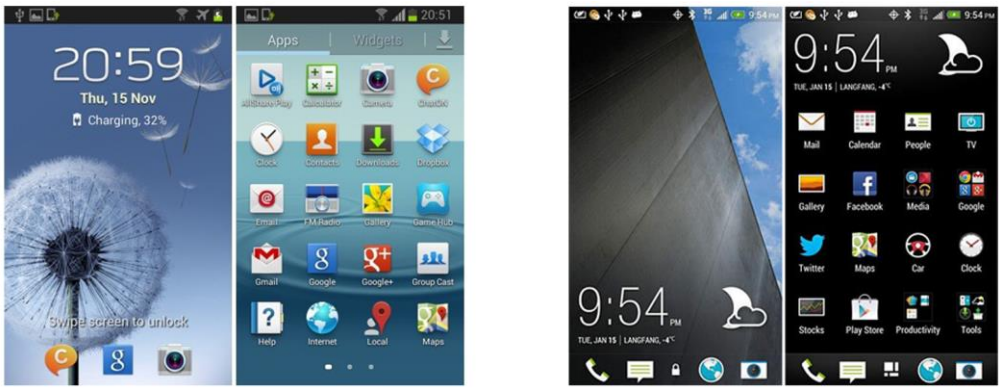


Fig. 6.8 – Android UI customization: Samsung Touchwiz (left) and HTC Sense (right).

This specific approach not only helps traditional manufactures to avoid (in some extension) commoditization of their products by the same software; but also, it offers a clear opportunity for product differentiation. Furthermore, this approach can also be considered as a way of offering extra value for consumers. Finally,

since a significant part of handset interaction/experience is related to software, interviewee 10 explains that *'... an awful lot of whether a company succeeds now is about interface and its usability and the emotional experience and user style.'*

6.3.3 Hardware related approaches: industry and tech convergence

Apart from the different software related strategies, traditional manufactures also implement hardware-led approaches in order to make their mobile phones more appealing to consumers and sustain competitiveness.

Interviewee 4 stated that *'...we started to change small elements since we cannot change all the operating system structure because is owned by Google (Android) and Microsoft (Windows Mobile).'*

These evidences reinforce the ideas that mobile phone companies are prevented to make deep modifications in the mobile software (since they are provided by third part firms). On the other hand, relying on their core business competences (e.g. product development), traditional manufacturers have freedom to explore the hardware part bringing innovate functions/resources to their solutions. The following diagrams displays examples of physical features (e.g. technologies) introduced in current devices.

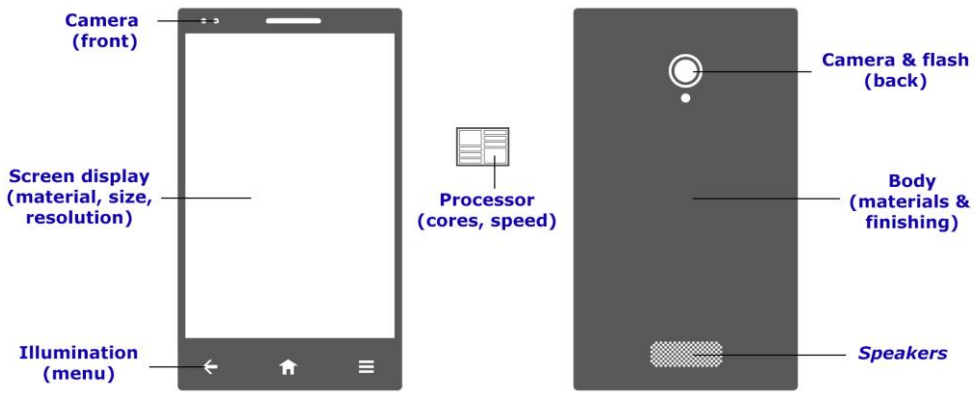


Fig. 6.9 - Manufacturers have been integrating numerous technologies in handsets.

With respect to digital images and video recording, Nokia launched the Nokia 1020 phone dedicated for taking pictures. Its rear camera achieves 41 megapixel

combined with state of art xenon flash. Conversely, HTC One Max portrays 2.1 megapixel high resolution (HD) front camera for 'selfie' pictures and video calls.

Regarding screen features, the Sony Xperia Z Ultra offers a huge 6.4 inches full HD (high definition) display; while, Samsung Galaxy S4 presents a 1920 x 1080 resolution super AMOLED (high density pixels per inch & 'extra' bright) display.

In terms of sound technology, the HTC One offers duo stereo speakers embedded with Beats Studio audio technology. In addition, the device's sturdy 'unibody' ('no separate parts put together') made of aluminium grants the phone a premium outlook and light weight.

Finally, controlling all handset functions, the LG G2 portrays a powerful quadcore (four cores), 2.26 GHz processor. This feature make LG's device faster than many laptop computers available in the market.

The previous examples highlighted different areas (e.g. processors, screen display, materials and cameras) where traditional manufactures have been investing to offer outstanding user's value through hardware differentiation. In addition, it also highlights not only the impact; but also, the extension of this on-going long term trend named 'convergence' (see Chapter 2, section 2.3.1) that is characterized by the integration of a number of technologies (also from other industries such as computing and entertainment) in one single device (in here, a mobile phone).

6.3.4 Business strategies: mixing hardware and software approaches

In the last sections, a number of software and hardware strategies implemented by traditional manufactures were introduced and discussed. In the current wireless sector, the use of approaches related to these two different, but complimentary areas becomes a *sine qua non* condition to retain competitiveness.

Taking into account the fact that traditional mobile phone companies are inserted in the context of one or more mobile ecosystem, it is possible to say that from a hardware perspective, these firms have been pushing the innovation bar through the continuous development of revolutionary materials and the integration of new technological resources. On the other hand, from a software point of view, the use

of multiple open sources mobile OS (e.g. Android and Windows mobile) and the possibility to interfere on the aesthetical part of the software, customizing and creating proprietary overlays, help manufactures to deliver differentiation in an area where they have limited expertise.

The combination of hardware and software strategies associated with a planned and well managed product portfolio helps to create a wide range of solutions to address the requirements of a broad audience, increasing manufacturers' market competitiveness and avoiding operational risks.

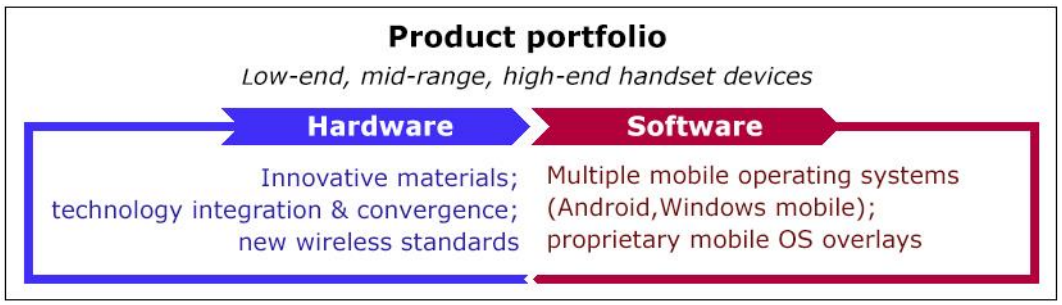


Fig. 6.10 – Traditional manufacturers' competitive strategies combines both hardware and software elements

6.3.5. Opportunities in the current wireless sector

As it was mentioned before, the entrance of software based companies and the establishment of mobile ecosystems as a major business approach bridging these firms to traditional manufactures led to an increase in the number of players in telecom chain driving the market to a high fragmentation.

In the current landscape, firms have been in a constant effort to offer innovative value propositions through their products to attract new consumers. Since each ecosystem has its particular characteristics (including benefits and disadvantages), consumers have a wide range of options to choose from. Based on these ideas, Interviewee 9 argued that *'…there is definitely space for more than one platform'*. Therefore, traditional manufactures using multiple mobile OS will benefit from this strategy to compete in a more sustainable way.

With respect to wireless standards, since the internet became an established communication channel in the telecom sector, new protocols have been developed

to cope with the soaring audience demand to access the World Wide Web. The LTE (Long Term Evolution) (described in Chapter 2, section 2.3.1) is regarded by specialist as a key technology to improve internet connection and overall user experience with handset devices. In addition, another wireless standard with a great market potential, particularly from a financial point of view, is called NFC (Near Field Communication) (see Chapter 2, section 2.3.1 for further description). NFC aims to be used as a 'replacement' for physical payments. Since it transfers data in short range, it can be used as a 'mobile wallet' enabling wireless payments (for example, for train tickets and low value goods) on demand. Finally, both LTE and NFC technologies have been progressively introduced in a broad range of mobile phones.

At last, mobile handsets, more than never, integrate a variety of resources and technologies even from other industries allowing users to perform a number of different tasks at the same time. Aiming to develop a solution with great potential to become the next icon in mobile communications, manufacturers focus on a specific segment to introduce these products. Interviewee 4 explained that *'...the main consumer is what we call 'pioneer'; 'tech-follower'; those who want to have a technology early. Those will be the main driver'.*

The specialised literature addressing product adoption, refer to this specific group of consumers as 'innovators' (Roger, 1962). Basically, it comprises young people presenting high social status, substantial financial resources and a cosmopolitan mind set sharing deep interest in innovative products/services. Considered 'risks takers', they are willing to try new technologies before anyone else. Next, they are regarded as 'leaders', setting behaviours, giving opinions and influencing their community. Finally, 'innovators' represents only 2.5% of all consumers adopting straightaway a new product of services (Roger, 1962, 1983).

These evidences can explain the reasons behind traditional manufacturers' heavy investments in carefully understanding the key drivers associated with adoption and utilization of mobile handsets in order to create new solutions, particularly, targeting young consumers. The rationale supporting the strategies towards this specific segment is simple: if their products are immediately accepted/adopted by innovators; potentially, they will achieve success in the short-middle term future.

6.4 Applications, roles and contributions of design for business

Since design is regarded as a holistic discipline, it can be associated with a wide range of utilizations from ‘processes’ to ‘outcomes’ supporting companies across different sectors. After reviewing the cases studies introduced on Chapter three, (section 3.6.3) the findings presented can provide indications of potential uses and benefits of design for business. Applications

• Design as a strategic business asset

The case studies provided extensive evidences informing about how distinct firms have been using design to support strategic future-led approaches across different levels of their business.

To begin with, Apple puts design in the heart of its *business philosophy* touching different domains of the company. The Chief Design Officer (CDO), Jonathan Ive, not only manages the design team creative process towards product development; but also, sits at the board of directors (with senior executives) to discuss future applications of design for business. Basically, Mr. Ive bridges the strategic and operational sectors of the firm though design. Another key strategic use of design is related to the implementation of a unique *business model* (e.g. quasi vertical integration) that enables the firm to control and oversee all production stages, at the same time that its safeguards intellectual and creative expertise, outsourcing labour and manufacturing processes from foreigner factories (in China).

From another perspective, Philips tried to *predict the future* through its ‘visions of the future’ project. Taking a strategic step forward, Philips not only looked ahead at time and tried to anticipate potential users´ daily needs; but also, positioned itself as a company with a *long-term vision* capable of proposing and designing solutions for situations/problems yet to come.

Taking into account the previous ideas, a study conducted by Evans (2011) made clear that firms should employ design in a more strategic way to devise *goal-oriented actions* supporting decision making process. Furthermore, the author reflects and discusses about the relationship between *production feasibility and*

consumers´ desire. Companies designing for the future should find an optimum balance between these two complementary (internal and external) factors to create and deliver superior value propositions to all involved stakeholders.

• Design as an tool to develop, manage and support business processes

From a different point of view, design also can be related to a variety of 'process oriented' roles. For example, this discipline can be linked to with human resources and multidisciplinary teams (management); research approaches and investigation methods; and corporative decision making processes.

To begin with, Apple designed a *teamwork management system* that reflects its systematic closed approach towards its business. Employees are allocated to work on specific projects (from the beginning to the end) without the possibility of engaging with any other product or venture at the same time. Moreover, Apple relies heavily on its internal workforce without inviting any external personnel or consultants to its design process. As a result, it keeps its teams focused, avoiding disclosing any strategic information to third parties and retaining it secrecy.

Other formats and uses of *multidisciplinary teams* can be found across different companies engaged in design-led assignments. Philips 'combined' its internal design team with a wide range of external experts from different background (e.g. anthropologists, sociologists, engineers and trend forecasts) to conduct its long-term ´visions of the future' project. The mix of different types of professionals brought a valuable assistance during data collection and analyses that resulted in 300 different scenarios of future products' utilization. Using a similar approach, the British consultancy Seymourpowell also employed specialists (from different areas such as technology, marketing and sociology) to help Samsung map and track design trends across Europe to support the development of future solutions for this regional market. In conclusion, 'building' multidisciplinary teams do not follow a precise or strict 'guideline'; their compositions are directly related to the nature and objectives of the project that they are involved with.

From a research perspective, a broad spectrum of *investigation approaches and tools* have been used by design-led companies comprising both design and non-

design related instruments. For example, Seymourpowell employs a combination of qualitative (e.g. ethnography and mood boards) and quantitative (e.g. statistics) methods to collect information in order to help Samsung understand the main design trends of the European market. Conversely, Philips relied extensively on 'scenarios' (hypothetical contexts of products utilization by a target audience) to consolidate data during its ´Vision of the future' project to create concepts of potential future solutions. Finally, on its publication, Evans (2011) highlights the importance of using non-design techniques (e.g. SWOT and competitor analyses) to aid firms mapping the landscape to design for the future. Based on the previous ideas, it is possible to say that through the combination of *qualitative and quantitative tools; design and non-design research instruments*, firms are able to gather and analyse different types of inputs transforming them into actionable insights to feed their design processes.

Another important element of any design process is to take on board stakeholders´ opinions to promote and support *better informed decisions*. From strategic top level to operational mid-range levels, constructive *feedback* can be regarded as an essential step to exchange ideas and find consensus among peers. Apple designed a system where senior executives are involved in NPD process. This participatory approach allows them to review under development products (e.g. prototypes) before manufacturing in order make any necessary modifications before market release. At last, acquiring key *stakeholders' 'buy-in'* is an important step to roll out initiatives and make sure that they are aligned with business objectives.

• Design as a comprehensive tool to support solutions' development

The more 'tangible' applications of design for business are related to physical and functional outputs. In this context, design shares a close relationship with product development (encompassing hardware and software), also contributing to shape users' experience with these artefacts.

During the course of any design process, a potential future solution 'preview' can be achieved through the creation of (real) graphic representations of that particular product. Evans (2011) states that ´visual resources´ comprising *sketches, models*

(2D and 3D) and prototypes can be considered ´visions of the future' and should be used to explicate, check and improve ideas taking into account peers´ opinions and feedback.

The importance and practicalities of prototypes were also verified in the Philips case study. The 'vision of the future' project was based on the development of working prototypes to display the benefits of future solutions to a broad range of stakeholders. To do so, Philips integrated software technologies and *unique user interface* functionalities enabling the audience to *manipulate and interact* with them using organic commands (such as voice and gestures).

In a similar way, Apple's 'pixel-perfect-prototype' approach is a good example of how committed this firm is to design state-of-art future products. By *integrating hardware (e.g. materials) and software (e.g. operating system)* these working prototypes are crafted to showcase all possible functions and be reviewed by top level stakeholders before they are ready for manufacturing. The software part receives extra attention, hence the adaption of Apple´s desktop computer OS to run on mobile devices (rebranded as 'iOS'). Responsible for delivering *unique user experience*, the operating system interface is carefully created in 'pixel-sized details' to be consistent across all Apple's products line.

The final frontier of design for business is to deliver a 'promise' in the shape of a 'solution' to consumers. The importance of designing a product goes beyond its functionalities and reaches a distinctive form factor (from a branding perspective). Samsung uses Seymourpowell intelligence to gather information about European design trends to create an exclusive visual language for its future solutions. Using 'similar' approach, Apple´s products are quite distinctive and easy to identify due to the use of lightweight materials and clean design to deliver a unique form factor.

Based on the wide range of evidences presented and discussed, it is possible to say that the design can be used in a very comprehensive way supporting different areas of business. From 'intangible' and to 'material and physical' applications this discipline plays a broad range of roles delivering contributions for companies to design for the future. The following chart summarizes is applications.

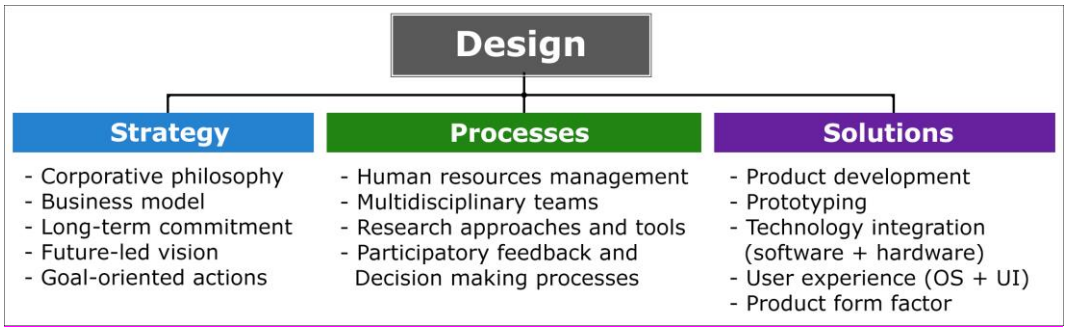


Fig. 6.11 - Areas where design can deliver contributions to business

6.5 Designing for the future in the wireless sector

6.5.1 Key domains

With the purpose of designing for the future in the wireless sector, mobile phone firms should have a deep understanding about four key areas in order to identify potential market opportunities and avoid possible treats to their businesses.

• Wireless industry

To begin with, traditional manufactures should have a clear view about the current market landscape considering their position and their competitors' situation in the wireless value chain.

With respect to internal capabilities, these companies should constantly review their business models taking into account their mission (e.g. value proposition); vision (e.g. drivers to the future); strategies (e.g. processes and methods); products and services (e.g. handsets, mobile OS and product portfolio) and strategic associations (e.g. alliances and business partnerships). All these elements should be carefully aligned to deliver maximum value to all involved stakeholders.

Next, traditional manufacturers should monitor and acquire insights about several external elements across the wireless sector. It involves mapping, identifying and analysing competitors' strategies and solutions. These approaches not only help these firms to have a 'snapshot' of the market; but also to become aware of their own commercial strengths and weaknesses. Moreover, by assessing partnerships

with software based firms such as Google and Microsoft, handset manufactures are able to have a detailed perspective of the characteristics of each platform or ecosystem (e.g. Android and Windows Mobile) in order to explore operational benefits and avoid constrains imposed by these alliances.

After scanning the environment, analysing and comparing the evidences collected with their internal corporative assets (e.g. processes and products), mobile phone companies are able to identify emerging opportunities (e.g. the increasing data usage) and avoid challenging circumstances (such as handset commoditization by a given mobile operating system).

Finally, a comprehensive examination of both internal and external factors is determinant for traditional manufactures to set realistic goals and select the most appropriate course of action to achieve these business objectives.

• Landscape phenomena and trends

Landscape phenomena including political, economic, social and technological trends also should be investigated by traditional handset companies to design for the future. For example, ‘convergence’ (of industries and technologies); LTE (Long Term Evolution) and social broadcasting (via social media services) can play important roles in shaping the future of wireless communications.

These phenomena can work as ‘platforms’ offering precious opportunities when aligned with manufacturers’ strengths. Nevertheless, they also can become threats when companies do not have appropriate (or enough) capabilities (e.g. budget or known-how) to take advantage of them. By using methods such as ‘visual boards’, traditional mobile phone firms can track these events’ dynamics, evolution and discontinuities. As a result, this continuous analysis assists in the development of appropriate strategies enabling them to quickly respond to landscape changes.

Finally, trends can start (and expand) in a number of business areas for example, computing, banking and entertainment sectors. Thus, they must be systematically tracked and monitored by traditional manufacturers since they can deliver impacts

on the market due to the increasing convergence of different technologies and commercial approaches towards the mobile communications.

• Users' inputs

Investigating and analysing users' behaviours towards mobile phones can help traditional manufacturers to discover relevant insights about the main drivers concerning acceptance, adoption and usage of wireless technologies by different market segments.

Basically, these factors can be divided in two groups: psychological and physical aspects. The first group comprises users' needs (e.g. reasons for handset usage); behaviours (e.g. habits, utilization routines and patterns); difficulties (e.g. what is missing/complicated in a handset) and also aspirations (e.g. perceptions of what can be improved or offered in future solutions). Conversely, physical factors are related to users' experience concerning interaction and usability in both hardware and software levels (such as the adaptation of handsets according to their usage patterns; understanding and utilization a new/specific feature; finding new usages for embedded resources and customization considering personal taste/style).

Based on a deep and systematic investigation employing different research tools (e.g. surveys, contextual enquiry and ethnography), handset manufacturers are able to identify different users' psychological and physical drivers to efficiently develop suitable future solutions to address their unique requirements.

• Experts' opinions and insights

Specialists and experts from different backgrounds (e.g. academia and industry) can be considered an important source of up to date information and should be carefully considered by mobile phone firms when creating the next generation of wireless products.

Establishing connections and engaging with high calibre professionals can assist traditional manufacturers to access fresh insights and perspectives about a wide

range of topics. Moreover, experts can deliver valuable contributions to handset firms in different ways. Firstly, specialists can provide information about the last events and changes in a given field, for example, under development wireless technologies, consumers' behaviour and environmental trends. Next, they can be invited to take part in a firm's internal design process, supporting and advising in various stages. Finally, when working in multidisciplinary teams (alongside with other professionals), they can offer unique perspectives to analyse and explore a topic through different angles.

Therefore, the combination of up to date knowledge with solid analytical skills make experts an unprecedented asset that traditional handset companies should strongly consider (and engage with) when designing for the future.

6.5.2 Processes and multidisciplinary teams

Taking into account the four domains introduced in the last section (e.g. wireless industry, landscape trends, users' inputs and experts' insights) and the wide scope of inputs that each of them comprises; traditional handset firms should carefully investigate and explore these issues when engaging in a future-led design venture.

In this complex context, internal research teams play important roles in the whole course of the design process. In most cases, they encompass designers presenting different skills (e.g. graphic, product, engineering, interface and user experience design) and also other professionals from different backgrounds. As a result, a multidisciplinary approach regarding the composition of internal design research teams can offer significant contributions to mobile phone companies.

In terms of investigation, a multidisciplinary research team can use an extensive range of design research methods to examine and collected data related to the four dimensions previously introduced. For example, competitors' analysis (to review competitors' strategies and products); PEST analysis (to scan landscape events and trends); ethnography (to survey users' segments) and Delphi panel (to collect specialists' opinions) are examples of practical and useful instruments employed to gather relevant inputs to feed the design research process.

After that, the research team works to ‘make sense’ of data collected. Through brainstorming sections, designers and other professionals explore and scrutinise inputs from different angles ‘translating’ them into actionable innovative insights. The combination of different techniques including formal methods and also non-traditional approaches, for instance, designers’ intuition, judgement and personal experiences as well as the creation of visual metaphors can provide assistance in this stage of the design process.

The insights generated through these discussions help the design research team to create concepts (e.g. illustrations, prototypes and virtual/CAD models) of future products. In addition, ‘personas’ (e.g. profiles of potential users of a product under development) and ‘scenarios’ (e.g. narratives of future situations depicting users’ interaction with products) are developed to support the future-led design process. These highly visual descriptive elements are the outcomes of a thorough analysis process representing the visions of a desire future that will inform the creation of the next generation of wireless solutions.

In conclusion, the aspects discussed throughout this section (from processes to ‘visions’ of future solutions), helped the researcher to have a detailed panorama of potential design research processes undertaken by traditional mobile phone firms to create the next generation of wireless products.

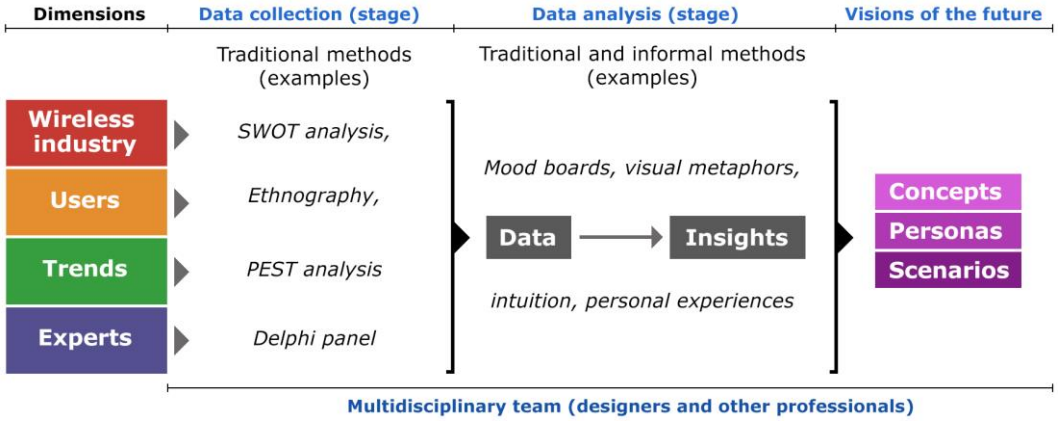


Fig. 6.12 - Traditional manufacturers’ potential future-led design process and related key factors

6.6 Conclusions

Throughout this chapter several topics were addressed and supported by evidences derived, mostly, from primary research findings (e.g. inputs and quotations from exploratory in-depth experts' interviews previously conducted).

To begin with, the radical shifts occurring in the wireless landscape due to the emergence of the mobile internet that led to the digitalization of this industry were presented. Basically, these changes comprise the entrance of firms from other sectors (e.g. computing); the 'integration' of different industries (e.g. mobile telecom and computing); the change in market competition (e.g. dominance of software based firms); the development of new business models/approaches (e.g. partnerships between traditional manufacturers and software companies as well as the establishment of mobile ecosystems) and; finally, the shifts in the nature of value delivered to end-users (from hardware to software).

Next, the current situation of traditional manufacturers (for example, Nokia) was reviewed. Firstly, the approaches employed by these firms to remain competitive after the entrance of software companies (e.g. Apple, Google and Microsoft) in the wireless communications sector were discussed. Among the strategies used, a combination of software (e.g. multiple OS and proprietary UI) and hardware (e.g. integration of resources and technologies) elements have been implemented in a successful by these firms. Finally, examples of emerging market opportunities were presented and explained.

After that, the use of design by companies operating across different industries was discussed (based on case studies' analysis) mainly focusing on the potential contributions of this discipline for traditional manufactures in the context of the wireless communications. This analysis showed that design can be associated with a wide range of issues including strategic and operational; tangible and immaterial aspects of handset companies' business.

Finally, this extensive review helped the researcher to have a deep understanding about the design process key factors and stages used by traditional manufacturers to design future wireless solutions.

7 Model development and evaluation

7.1 Introduction

After introducing the secondary research findings from literature review (chapters two and three); the primary research insights from a series of exploratory in-depth experts' interviews (chapter five) and the analysis of these evidences (chapter six), this chapter is fully dedicated to present and discuss the development process of the design-led future forecasting model for mobile communications (aim of this PhD study).

This segment is divided in three parts. In the first section, a rationale describing all the factors, drivers and milestones associated with the model development are introduced in details. Next, the second part deals with model drafts' evaluation processes based on experts' insights gained through a series of in-depth interviews. After that, the third section introduces the workshops conducted with potential users (e.g. design students) of the framework aiming to assess a wide range of issues from an empirical perspective. Finally, the contributions of the developed design-led future forecasting model for mobile communications are presented.

7.2. Outline of model development

In general, the proposed design-led future forecasting model combines theoretical ideas (derived from an extended literature review and case studies' examination) with practical insights (gained from several in-depth experts' interviews analysis).

The information related to the main topics addressed throughout this research (e.g. design, future forecasting and mobile telecommunications industry) were obtained from several sources. In most part of the cases, the wide spread secondary data were complemented, updated and even ratified by the fresh inputs gained from primary information sources. Despite of not being possible to precisely determine the contributions that each type of data (e.g. secondary or primary) brought to the

development of the intended framework, its strength lays on the convergence and formal integration of both types of inputs.

Fig. 7.1 – A combination of different tools supported the creation of the intended model.

7.3. Model development

The design-led future forecasting model for mobile communications is the final outcome of this research. Basically, it is a combination and synthesis of different insights generated through the course of this study. As a result, it was inspired by a number of theories, premises and opinions. In this section these elements are introduced followed by a detailed explanation about how they were integrated and combined in order to create the intended framework

7.3.1 Inspiration and drivers

To begin with, the scheme that was originally presented in Chapter three, section 3.7 (replicated below) describing the major aspects that a design team should consider when designing for the future, provides important indications for the creation of the intended model that this research aims to deliver.

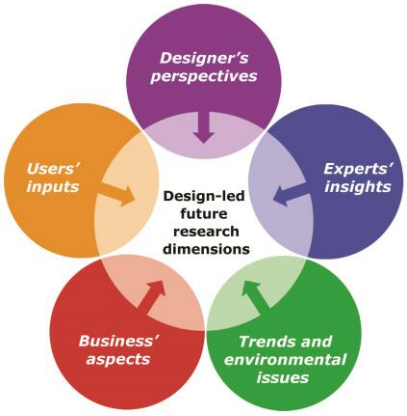


Fig 3.8 - Design-led dimensions towards the future (from Chapter 3, section 3.7)

Resulting from the analysis of four design-led future forecasting case studies considering industrial (e.g. Apple, Philips and Seymour Powell) and academic (e.g. Design future framework) perspectives, the past diagram combines elements of these narratives, synthetizing them into five generic dimensions. Named 'Designer's perspective'; 'Users' inputs'; 'Business aspects' and 'Trends and environmental issues' and 'Experts' insights', these dimensions can work as 'guidelines' offering valuable insights to support the development of the design-led future forecasting model for mobile communications.

As a starting point, each diagram dimension informs the researcher about a set of ideas related to a specific topic. Yet, since this study focuses on a particular sector (e.g. the wireless sector), the general approach of the 'design-led future research dimensions needs to be adapted to address the particularities of this industry.

Taking into account this requirement, the dimensions were renamed using basic and straightforward words related to the scope of ideas that each of them conveys, making the identification of these groups simpler. The selection of the new names was inspired by the labels of the design-led future dimensions towards the future previously presented (see Chapter 3, section 3.7).

Therefore, 'Designer's perspectives' changed to 'Design'; 'Users' inputs' became 'Users'; 'Experts' insights' was renamed to 'Experts'; 'Trends and environmental issues' shifted to 'Trends' and 'Business aspects' turn to 'Wireless sector' (here, the name was altered to match the specific industry investigated throughout this study, the mobile telecommunications).

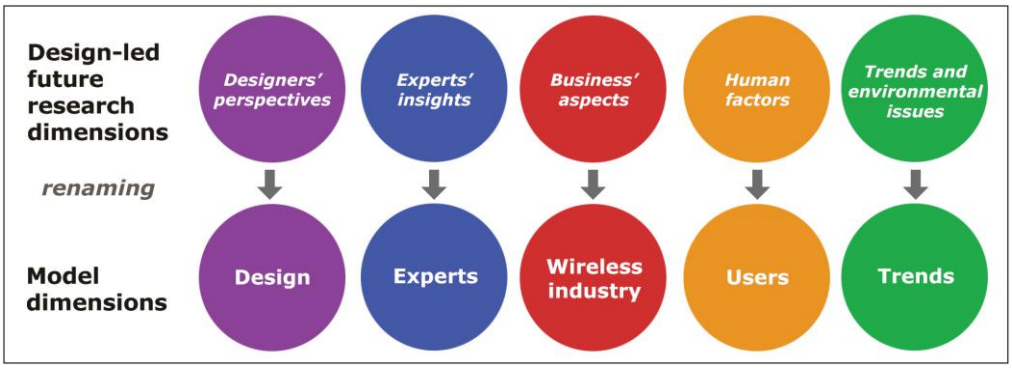


Fig. 7.2 - Adaptation of the Design-led future research dimensions to create the (future) model dimensions

From another perspective, the seven theoretical clusters derived from the experts' interviews analysis (see Chapter five, section 5.10) also provide key inputs to support the creation of the intended model.

Mapping these seven theoretical clusters against the renamed dimensions, some relationships can be drawn. From a semantical point of view, four out five (4/5) renamed groups' names match most of the theoretical clusters' labels (similarities highlighted with a grey double arrow in the following chart).

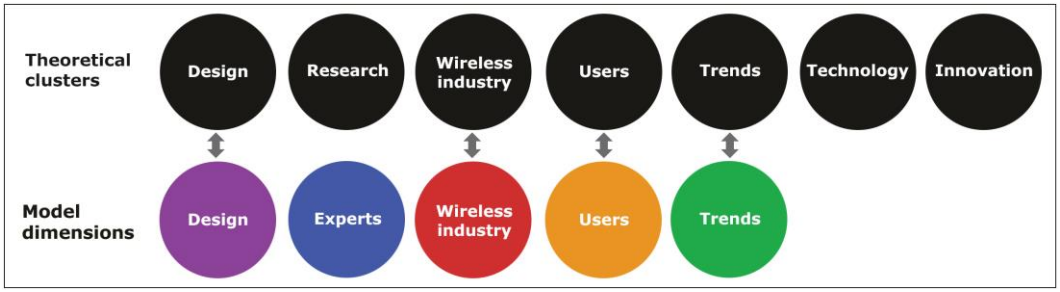


Fig. 7.3 - Relationships between Theoretical clusters and model dimensions

In terms of content, since the theoretical clusters introduce more specific insights related to the wireless sector, this information can be used not only to fulfil; but also, to complement those already introduced in the model dimensions creating a rich balance between secondary and primary inputs.

With respect to the highlighted groups that share direct semantic relationships, the insights presented in these four theoretical clusters ('Design'; 'Wireless Industry'; 'Trends' and 'Users') can be promptly used to populate their correlated model dimensions.

By reviewing the 'Research' (cluster) and its content, it is possible to say that the disclosed data is associated with investigation processes and methods in the design domain. Based on this link, 'Design' (cluster) can encompass 'Research' (cluster) working as an umbrella and feeding all the information incorporated into the 'Design' model dimension.

The insights introduced in the cluster 'Innovation' are mostly related to a firm's strategic planning and product development. Consequently, these propositions can be placed under the 'Design' model dimension as well.

Finally, the inputs displayed in the 'Technology' cluster refer to product adoption and user experience drivers regarding the audience lifestyle/stage. Based on these ideas, wireless technologies (e.g. hardware and software) can only deliver these contributions when embedded in handsets. To achieve that, firms use a wide range of inspiration sources (e.g. trends, expert's ideas and competitors solutions) to improve, combine and develop features for their products. Despite the increasing importance of external inputs for the design process to create new solutions, it is through the unique integration of technological resources that companies achieve ground-breaking innovations, influencing and shaping users' experiences. As a result, despite of not being explicitly displayed (in a graphic way) in the model, 'technology' work as a function of design since it is through the designers' inspiration, data interpretation and value proposition that it can be developed and delivered in handsets.

After introducing the inspirations and drivers that helped outlining the model dimensions, the following chart displays the rebranded five dimensions exhibiting an updated collection of topics that each of them now encompass.

Table 7.1 – Updated dimensions and respective topics covered (overview)

Design	Design as a: philosopy, mindset, thinking, process and outcome. Strategic design: decision making processes and flexible research methods (formal & informal). Roles of Design (wireless sector): products, services, processes and shaping the future. Designers: different skills, multidisciplinary teams and visionaries of the future.
Users	Market segments: drivers for handset adoption and usage. Phisical and psychological (emotional) drivers towards mobile technology. User experience: hardware and software (interface and operating system).
Experts	Specialization in different fields (within and outside the wireless sector). Fresh and updated information and insights. Analytical skills: exploring data and market gaps. Engage in corporative design processes (as part of a multidisciplinary team).
Wireless sector	Wireless industry structure: players, nature of firms (hardware/software) and business alliances. Wireless market: opportunities, threats, challenges and trends. Traditional manufactures: strategies, product portfolio, mobile platforms, ecosystem of services. Holistic approach: players' evaluation (handset companies and software based firms).
Trends	Political, social, economical, technological and Design issues. Trends within and outside the wireless sector. Examples: convergenge, social media, mobile ecosystems, NFC, cloud computing and others.

7.3.2 Model concept and building blocks

After renaming the dimensions and introducing the scope of information that each of them convey, they can be formally appointed as ‘signposts’ that will guide the creation of the framework that this research aims to deliver.

In a general perspective, the intended model aims to integrate the ideas that these five dimensions (e.g. ‘Design’; ‘Users’; ’Experts’; ‘Wireless sector’ and ‘Trends’) convey. At a first glance, they seem to be positioned in the same ‘level’ (without any specific order or priority). However, this fact could lead to a false impression that any of them could act as the ‘chief parameter’ to inform the creation of the intended design-led future forecasting model for mobile communications.

Since this research is conducted in the domain of design, supported by design strategies, methodology, methods and its outcomes are also communicated from a design-led perspective, ‘Design’ (as a dimension) becomes the natural choice to be the major driver for visual and conceptual development of the framework. Another reason to support this selection is related to the fact that among the different clusters presented; ‘Design’ is the only one that covers a wide spectrum of applications including strategic issues; future-led approaches; methods and specialized professionals (e.g. designers) that, effectively, ‘practice’ design.

Based on the premises presented, ‘Design’ becomes the leading driver for model formulation; while the remaining four dimensions (‘Users’, ’Experts’, ‘Wireless sector’ and ‘Trends’) should be, somehow, linked to the first.

Taking into account the approach used to support the primary data analysis and informed about the relationships among abstractions within and across different theoretical clusters (see chapter five, sections 5.10.2 and 5.10.3), it can be used in the same way to assist in the visual development of the intended model. By underlining the connections among the ideas across the different dimensions (e.g. ‘Design’; ‘Users’; ’Experts’; ‘Trends’ and ‘Wireless sector’), it is possible to say that they are symbiotic, sharing meaningful and complimentary associations.

The following scheme represents briefly how these five dimensions (or building blocks) can be visually organized in the space.

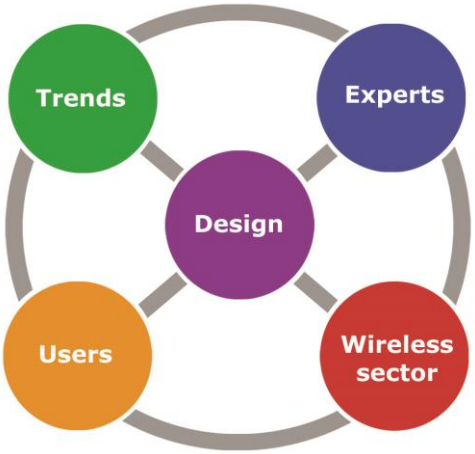


Fig. 7.4 - ‘Design’ (centre) is the leading driver ‘guiding’ the model development.

7.3.3 Dimensions

After defining important directives about the model development process such as the establishment of the five key dimensions; the selection of ‘Design’ as a major driver; the (potential) graphic representation of the framework´s main elements and the relationships among different clusters, this section focuses on the visual arrangement of the ideas that each dimension comprises.

As it was briefly introduced in section 7.3.1 (Inspiration and drivers), to select the ideas that each dimension should cover, data gathered through literature review, case studies and experts’ interviews were widely used. The researcher proceeded to a constant comparative analysis to check the information collected through these methods. In most cases, the findings matched corroborating each other (in terms of meanings). However, when there were divergences (e.g. lack of depth or details) about a topic, they were confronted and the insights collected using one method were ratified and/or complemented by the findings from the other. These procedures guaranteed a balanced mix of inputs gathered from both secondary and primary research to produce the content of each dimension and the entire model.

Despite the fact that the dimensions are linked (as it was explained in the last section); they are self-contained and exclusive in terms of ideas. As a result, they were created in an independent way. To arrange the distinct elements that they comprise, the researcher acquired inspiration from different sources.

Firstly, from an academic point of view, the theoretical clusters resulting from the primary data analysis (Chapter five, section 5.10) worked as platforms providing valuable support for the selection of relevant insights and also informing about the associations of several ideas particularly inside of each dimension.

Considering a 'visual' perspective (related to the dimensions' organization in the space), the applications of 'mind map' principles, technique by which information is converted and displayed into diagrams representing key words associated with a specific topic (Buzan and Buzan, 1997), provided important contributions for the arrangement of these ideas within each dimension. Moreover, this instrument is employed to organize and visualise complex data in an easy and convenient way (Crowe and Sheppard, 2012), emphasizing their links and associations (Farrand, Hussain and Hennessy, 2002).

Therefore, the distribution of the distinct elements is carried out in order to make sense, expressing the correct meanings that they convey through visual cohesion and consistence.

In the following pages, the visual/graphic arrangement of the ideas inside of each dimension will be introduced. After that, the five dimensions will be brought together forming the first draft of the intended framework.

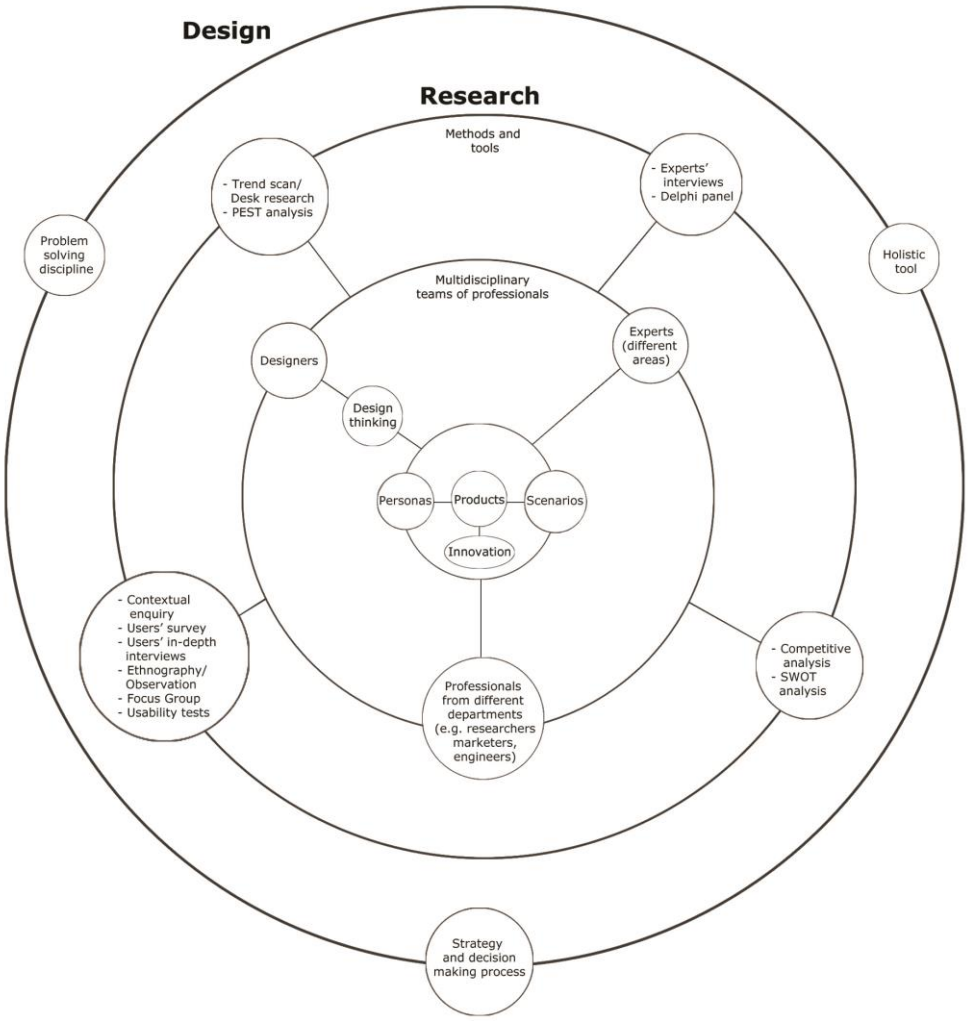


Fig. 7.5 – 'Design' dimension and its key aspects

The first dimension, 'Design' is divided in five segments (circles). The 'strategic level' (1st and most external circle) presents Design as a holistic discipline, associated with problem solving roles (for example, improving handset usage experience) and providing unprecedented support to decision making procedures (e.g. efficient planning and execution of proposed actions to achieve corporative objectives). Due to its importance, it encompasses all other areas. Next, (2nd circle) Design is linked to different research methods and techniques used to explore and collect a wide range of data. The investigated issues include users (e.g. needs and experiences with mobile phones); trends and landscape events (within and outside the mobile telecom sector); experts' opinions (from different fields) and the wireless industry (e.g. players, strategies and products). The instruments placed in that segment are connected to the next area, 'multidisciplinary teams of professionals' (3rd circle). In this part, designers (supported by design thinking

and informal research approaches); professionals from different manufacturer departments and also external experts from several backgrounds, work together analysing information previously collected. They ‘translate’ data into insights creating ‘personas’ and ‘scenarios’ (4th circle) that support and inform the creation of concepts related to innovative future solutions (5th circle).

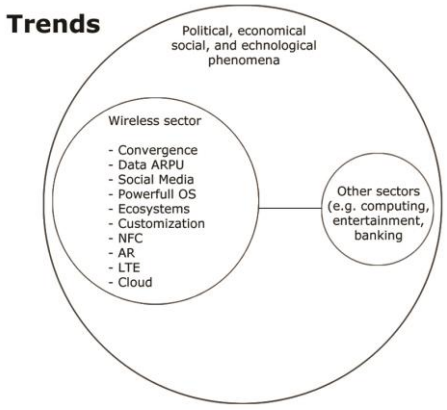


Fig. 7.6 – ‘Trends’ dimension and its key aspects

The next dimension, ‘Trends’ comprises two main parts. In the first one, examples of major phenomena taking place in the current wireless industry are displayed. The exhibited list of issues is illustrative rather than exhaustive. Conversely, the other segment is related to potential trends and events that occur in different business areas, for example, computing, entertainment and banking. These two circles are connected denoting that they share some sort of relationship. The reason to highlight this particular link is related to the increasing convergence of industries and associated technologies towards the mobile telecommunications. Therefore, these phenomena, more than never, can deliver impacts influencing the wireless communications industry.

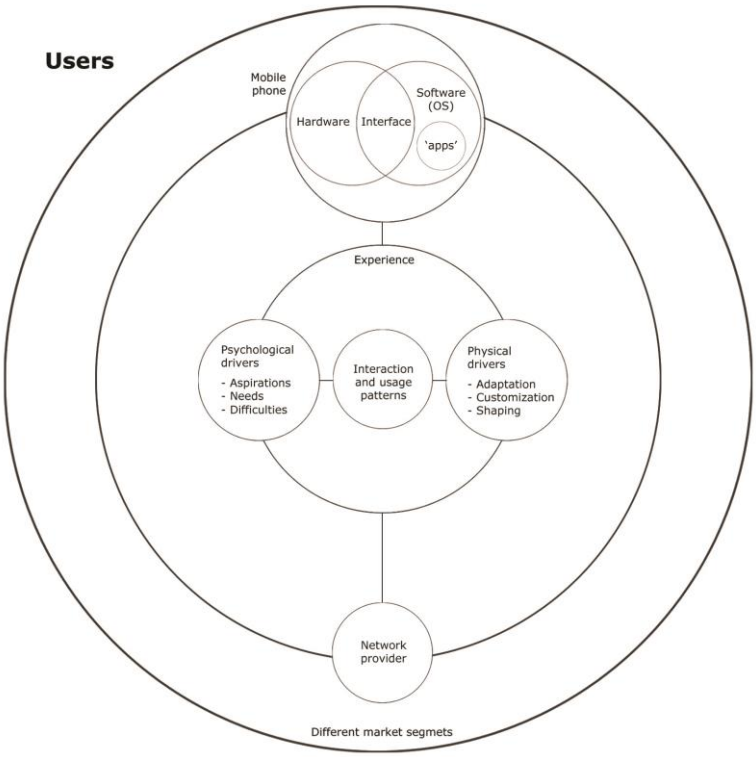


Fig. 7.7 – 'Users' dimension and its key aspects

The third dimension, 'Users' is divided in three parts (circles) exhibiting different factors related to users' experiences with mobile phones. The most external area (1st circle) represents different segments of consumers in the market. After that, the next section (2nd circle) comprises two areas. The first (top) shows different elements that a current mobile handset comprises such as hardware (for example, materials and embedded technologies), software (e.g. mobile OS), interface and applications (associated with a particular platform). Its counterpart (bottom) refers to network providers and their services (e.g. voice and data). These two areas are connected, converging to the centre emphasizing that they deliver impacts on the users' experience. Next, the segment 'Experience' (3rd circle) is divided in three parts. The sections on the left and right sides, psychological and physical drivers are related to users' emotional and physical factors when they are manipulating their gadgets to perform different tasks (e.g. making phone calls, browsing the internet, taking pictures and using 'apps'). These two complimentary segments converge, once again, to the central part, since they can shape and define users' interaction/utilization patterns with their handsets.

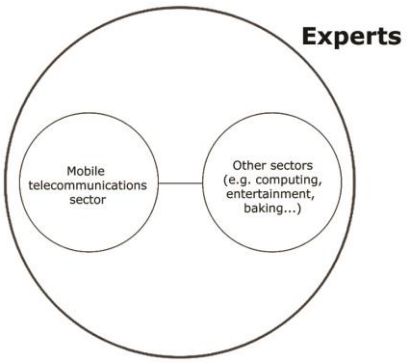


Fig. 7.8 – ‘Experts’ dimension and its key aspects

The fourth dimension, ‘Experts’ is simple and straightforward. This dimension is divided in two areas (circles) that are connected to each other. Firstly, experts can be linked to mobile telecommunications or other industries (e.g. computing and entertainment). In addition, they present unique expertise in different areas, for instance, hardware, software, applications and services (wireless telecom); finance (banking sector); and online services including social media platforms (digital entertainment). Their skills are linked to unique data analysis approaches leading to ground-breaking perspectives and insights. The combination of these different talents and proficiencies make these professionals valuable assets that traditional mobile phone companies should rely on and integrate in their internal design-led future forecasting processes assisting and supporting strategic decision making.

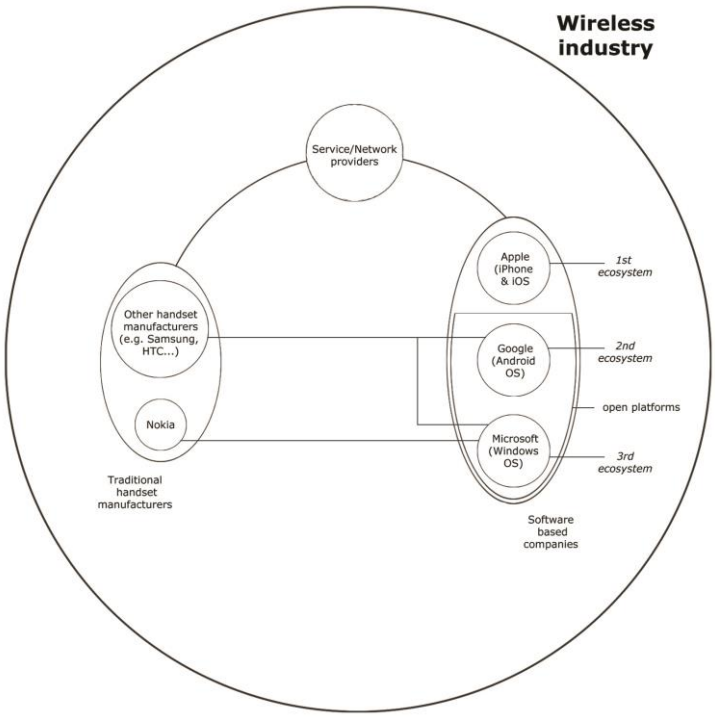


Fig. 7.9 – 'Wireless Industry' dimension and its key aspects

Last but not least, the 'Wireless industry' dimension covers an extensive range of topics related to the mobile telecom landscape. This cluster is divided in three major and interconnected areas. The first part, 'Traditional handset manufacturers' comprises established mobile phone companies such as Nokia, Samsung and HTC. In the current market, they mainly create hardware and integrate technologies in mobile handsets. On the other hand, 'Software based companies' stands for the new entrants. These companies originally from other sectors (computing industry) have been dominating the wireless market with innovative products and software linked to specific ecosystems. In addition, while Apple pursues a closed approach towards its ecosystem; Google and Microsoft follow a different strategy allowing their platforms to be open. Apart from Apple that produces its own hardware and software (e.g. iPhone and iOS); the other two firms (e.g. Google and Microsoft) rely on business partnerships with traditional manufacturers to promote their mobile OS, Android and Windows Mobile, respectively. That is the reason why these two areas (e.g. 'Traditional handset manufacturers' and 'Software based companies') are interconnected. A highlight is made in here to indicate the exclusive alliance between Microsoft and Nokia in order to promote Windows mobile in Nokia's high end line of handset devices. Finally, 'Service/Network

providers' are responsible for enabling the wireless signal bridging the two other segments allowing full communication services (through voice and data).

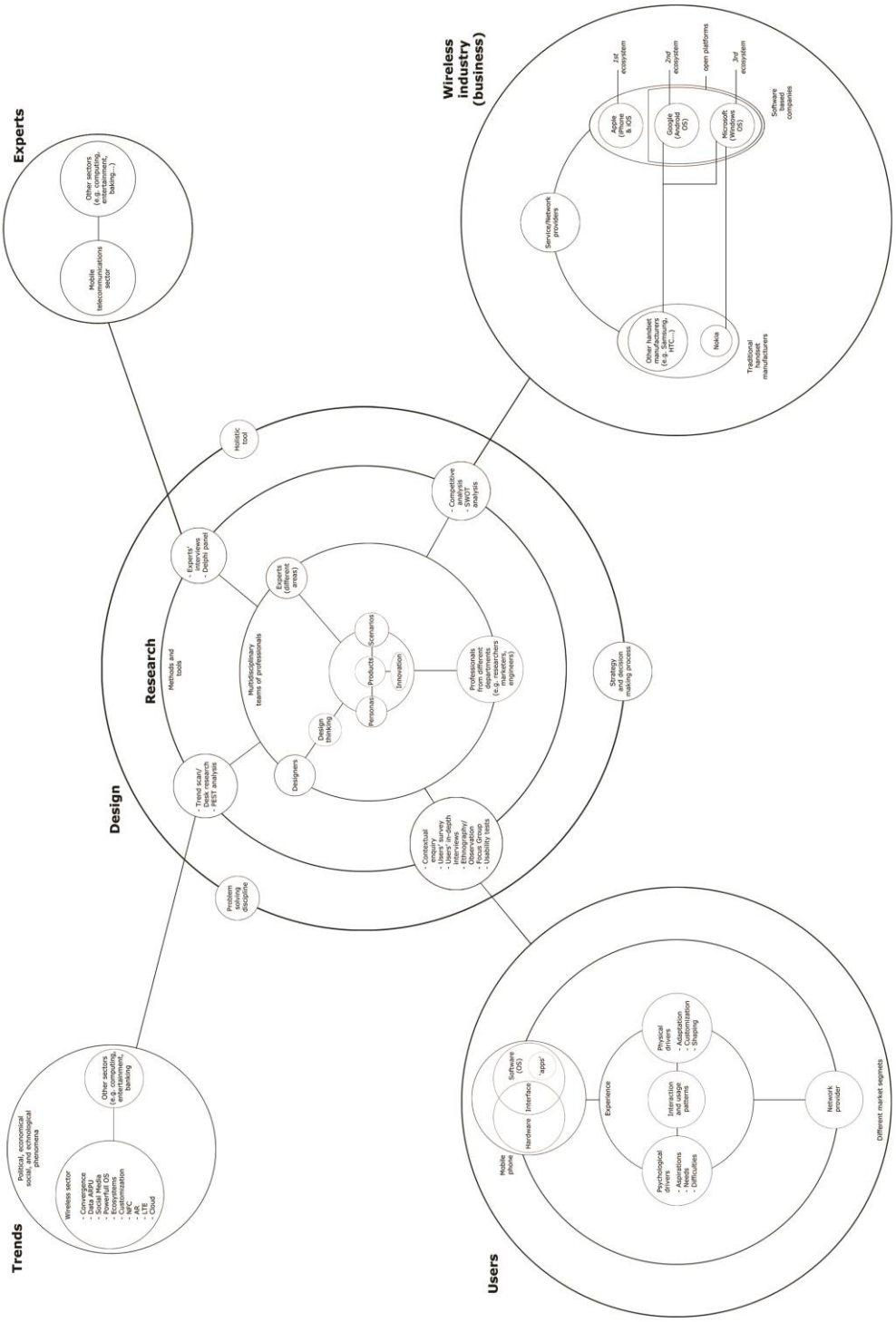
7.4 Model (Draft 01)

After presenting the five dimensions in the last section, these clusters are ready to be combined generating the first draft of the intended model. As it was mentioned on the section 7.3.2, 'Design' will be at the centre; while the others dimensions will be surrounding it (see figure 7.3)

This draft aims to be as complete as possible. At this stage, the main objective is to 'translate' the key ideas derived from both secondary and primary research into visual inputs highlighting the connections among them. Nevertheless, due to the considerable amount of information and the complexity of the topics investigated, some pieces of data cannot always be represented in a visual way. Thus, they are not presented through the model itself (in a graphic way), but in the background as part of the explanation and description of the themes displayed.

A critical aspect during the model development process is how to connect the five dimensions and bring them together. Since 'Design' works as a hub bridging the other four clusters, this particular dimension exhibit one part dedicated to display and describe several design research methods. These techniques were arranged in four groups taking into account the topics that they address. From a practical perspective, to design for the future in the wireless sector, it is imperative that traditional manufacturers investigate a myriad of factors that can impact on their businesses. Through the use of a wide collection of tools they are able to acquire and analyse important data, developing insights and strategies to tackle proposed objectives. Therefore, the instruments presented in the 'Design' dimension work as platforms linking 'Design' to the other four clusters (e.g. 'Trends', 'Users', 'Experts' and 'Wireless Industry').

Finally, after introducing the five dimensions and how they should be brought together, the first model draft can be presented in full details.


Experts
Other sectors (e.g. computing, entertainment, baking...)
Mobile telecommunications sector
Wireless industry (business)
1st ecosystem
2nd ecosystem
open platforms
3rd ecosystem
Apple (iPhone & iOS
Google (Android OS)
Microsoft (Windows OS)
Software based companies
Service/Network providers
Other handset manufacturers (e.g. Samsung, HTC...)
Nokia
Traditional handset manufacturers
Design
Research
Methods and tools
Holistic tools
- Experts' interviews - Delphi panel
- Competitive analysis - SWOT analysis
Multidisciplinary teams of professionals
Experts (different areas)
Designers
Design thinking
Personas
Products
Scenarios
Innovation
Professionals from different departments (e.g. researchers, marketers, engineers)
- Trend scan/ Desk research - PEST analysis
- Contextual inquiry - Users' survey - Users' in-depth interviews - Ethnography/ Shadowing - Focus Group - Usability tests
Strategy and decision making process
Problem solving discipline
Trends
Political, economical social and technological phenomena
Other sectors (e.g. computing, entertainment, baking...)
Wireless sector
- Convergence - Data ARPU - Social Media - Powerful OS - Ecosystems - Customization - NFC - AR - IPTC - Cloud
Users
Mobile phone
Hardware
Interface
Software (OS)
'apps'
Experience
Psychological drivers
- Aspirations - Needs - Difficulties
Interaction and usage patterns
Physical drivers
- Adaptation - Customization - Shaping
Network provider
Different market segments

7.4.1 Model evaluation (Draft 01) - Processes

After the model´s first draft development, it was ready for assessment. Aiming to evaluate it, the researcher conducted a series of interviews with experts and specialists from different backgrounds in the same way as those used to collect data in the early stages of this PhD study (see Chapter four, section 4.4.2. for further details).

To assess this first draft, five interviews were conducted, in total. Some of the professionals approached were in the 1st experts' pool used to gather information during the data collection stage of this research. The duration of these meetings ranged from 45 up to 60 minutes. Firstly, the model's draft was presented by the researcher followed by interviewee´s examination and discussion. Despite of a formal, structured and straightforward list of questions to be answered, the interviews followed a more open discussion procedure. The chart bellow displays the profiles of the five experts approached in this stage.

Table 7.2 - Profiles of the professionals interviewed (draft 01 evaluation)

Proficiency	Interviewee profile	Remarks
Independent consultant & lecturer	• Founder and director of his own design consultancy company. • Part time lecturer in the field of design, design management, branding and innovation. • Extensive international academic and industrial experience	• Interviewee (11) • Face-to-face interview
Design director	• Founder and director of his own design consultancy company. • Design director of an international design consultancy firm. • Holds a PhD degree in design from a world class British University.	• Interviewee (12) • Skype interview
Senior lecturer	• Senior Lecturer (Information systems) of a leading British University • Holds a PhD degree founded by a major British telecom company. • Worked in several projects supported by wireless companies.	• Interviewee (13) • Face-to-face Interview
Head of strategy	• Head of strategy for a leading British design consultancy firm. • Solid expertise developing strategies across different areas such as technology, packaging and transport. • Coordinates distinct multidisciplinary teams and professionals from different backgrounds including designers and engineers	• Interviewee (14) • Face-to-face interview
Design director	• Founder and director of a leading design consultancy company. • Over 20 years of experience in design across different roles including design research, design strategy and design management • Manages and coordinates multidisciplinary teams of professionals including designers from different backgrounds	• Interviewee (15) • Face-to-face interview

The primary aim of these meetings was to introduce the framework and check its usefulness, practicalities and comprehensiveness regarding content and elements' visual distribution. Moreover, aligned with these issues, the researcher probed the interviewees to find out any particular aspect, topic or piece of information that could be missing and should be considered. As a result, the secondary goal of the assessment process was also clarify and collect relevant information.

7.4.2 Model evaluation (Draft 01) - Feedback and key points

The feedback acquired from the interviews were analysed based on the principles of the Grounded Theory supported by professional qualitative software, Nvivo. These approaches were already employed in the early stages of this study (data collection, see Chapter four, section 4.4.3).

The outcomes of the qualitative analyses were divided in three areas: 'Questions', 'Content' and 'Visual elements'. The first group, 'Questions', deals with experts' opinions about how comprehensive, practical and useful the presented model is to support the research team to design for the future in the wireless sector. Next, 'Content' comprises information covered inside of each dimension such as topics, processes and their roles. Last but not the least, 'Visual elements' addresses the graphical aspects of the framework including colours, shapes, visual integration and links within and outside dimensions.

This section will introduce the highlights of the evaluation processes displaying the key issues that should be taken into account to improve the proposed model (draft 01). (See Appendix, section 1.2 for the complete interviews)

• Questions

In general, the experts found the model draft very comprehensive. According to Interviewee 13, the framework is very rich in details covering most of the elements and events in the wireless sector: *'That's why I think it's comprehensive because you've got trends; you've got research, design, users, experts and the technical aspects. All different platforms…'* Considering a different perspective,

by looking at the framework, it was difficult to spot missing gaps; as a result, it seems to be complete (Interviewee 15).

In terms of practicality, experts presented different opinions. From a 'theoretical' point of view, the framework could be handier if the information displayed had been split in different layers for example, one for contents and another for methodologies (Interviewee 15). Conversely, from a commercial perspective, the level of practicality is directly related to the framework's applicability in a real world context (Interviewee 13) where priorities can be set, particularly regarding data collection to meet the nature and demands of a project (Interviewee 11; Interviewee 12; Interviewee 14).

Finally, concerning the usefulness of this model, different specialists (Interviewee 12; Interviewee 13) agreed that it is adequate to promote assistance do design managers and the design team. Also, it becomes very useful when it structures the data facilitating the understanding and absorption of information by stakeholders leading to the development of new ideas and insights (Interviewee 14).

• Content

With respect to users, there are a number of aspects converging, shaping and influencing their experience and interaction with mobile handsets (Interviewee 11). Among the different research methods to gather data from users, ethnography is a widespread tool used to understand users' behaviours and attitudes based on their current reference frame. Moreover, 'Big data' is becoming very popular to survey users in a less intrusive way (Interviewee 14). When employed with other tools, the findings collected through these methods assist to 'break down' users into specific groups, helping manufactures to develop more tailored solutions. On the other hand, *'... consumers aren't very good at knowing what they're going to want in a year's time. That's where experts come in...'* (Interviewee 15). Often, users' opinions lead to incremental levels of innovation regarding new product development (Interviewee 14). In this particular context, experts work as a counterpoint since they possess a unique skills and knowledge about the wireless

industry offering outstanding contributions for handset manufacturers to design for the future.

In general, experts are recognized as an ultimate source of information since they have deep knowledge about the wireless industry and, potentially, what is going to be the 'next big thing' (Interviewee 14). Their expertise is associated with either technical or commercial aspects covering a number of issues such as business models, specific information and under developing technologies. When working together as part of a Delphi foresight team/panel, they can deliver instrumental contributions to develop future scenarios and market solutions (Interviewee 11).

Researching about trends is also an important activity conducted by manufactures to engage with future time frame assignments. Trends are sources of inspiration for innovative ideas that will lead to the development of future products' concepts. In addition, trends define, in certain extension, what the future will hold providing directions and clues for business to take action and explore them (Interviewee 14). Thus, is necessarily to carefully proceed to goal-oriented investigation, scanning wisely to find what is relevant for a particular assignment (Interviewee 15). For example, *'... if you look at, sort of, social media... it's an amazingly powerful trend that seems to shape all sorts of industries, you know... from brands to I guess to politics'* (Interviewee 11).

From a business point of view, investigating the wireless landscape including its numberless players (e.g. manufactures, service providers, software based firms and developers) as well as their strategies and business models are vital in order to have a complete picture of this sector's structure. In addition, issues related to ecosystems are close related to portfolio planning. For example, while Samsung presents a wide handset portfolio to cover different market segments; Apple only produces the iPhone aiming to wealthy consumers. Next, technology and trends also play substantial roles in the creation of new products (either a single handset or a line of devices) impacting on manufacturers' offers (Interviewee 15). Another key aspect is linked to licenses and patents that can be obtained through strategic merges and partnerships (e.g. Microsoft-Nokia) to gain *momentum* in the market. Finally, the boundaries between users and developers are becoming blurred since

they are creating their own ‘applications’ and publishing them across different ecosystems to address their needs (Interviewee 14).

With respect to research approaches, the use of multidisciplinary teams (including designers) can offer paramount contributions for creating and delivering the next generation of wireless solutions. The deep interaction and involvement of distinct stakeholders promotes a continuous exchange of *stimuli* and insights fostering the development of future products (taking into account new technologies and trends) bringing more appeal to consumers. An important aspect regarding this process is related to the ‘randomness’ of the idea generation process that is not necessarily associated with any logical or formal analytical approach. In fact, freedom and flexibility are key elements that lead to ‘strange’ and ‘odd’ mental connections generating wildcard ideas and thoughts that can be pinned down immediately during a brainstorm section (Interviewee 14). Last but not the elast, other sources of inspiration, for example different industries (e.g. music and computing) bring new perspectives and technologies that can be integrated into wireless solutions (Interviewee 11; Interviewee 14).

• Visual elements

In a general perspective, the presented model *‘... is a very strong visual, kind of, check list about whether it’s applicable in the real world’,* comprising a number of design tools, assisting in the clarification and communication of different issues to design managers (Interviewee 11). It also can be regarded as a memorable platform or map with defined ‘spaces’ covering a number of aspects allowing people to have a social argument, exchanging insights and inspiring ideas for concepts of new products (Interviewee 14).

Among the different contributions for design-led forecasting processes, the model provides aid to managers to tackle a wide range of challenges (Interviewee 15). Depending on the nature of the situation addressed, it supports an efficient choice of appropriate processes to tackle specific issues. Thus, by carefully scanning the mobile telecom landscape, the design manager can rely on the framework to check which areas are more critical and should receive higher priority, allocating more

resources (e.g. time and budget) and extensive research efforts to address these demands (Interviewee 14; Interviewee 15).

Concerning the 'shape' and other graphic aspects of the model, it should adopt a more 'fluid' approach to represent the links among different dimensions aiming to accommodate potential changes in the landscape (Interviewee 11). In addition, the dimensions' different sizes (circles) might convey the wrong meaning (e.g. 'the bigger; the more important it is'). Finally, different colours could be used to identify different aspects and the description of certain processes (Interviewee 12).

At last, the model conveys a considerable number of inputs, *'... there's different sort of topic areas within this as I can see... and then there's another layer of, in terms of appropriate methodologies – now... I'm not sure how important it is to mix...'* Therefore, to better identify and clarify these several aspects, the model could be divided in two or three different layers highlighting the 'contents' and the 'processes' (e.g. methods) or integrating all these information in just single layer (Interviewee 15).

7.5. Model (Draft 02)

Based on the feedback gained from the experts' evaluations, a second draft of the design-led future forecasting model was prepared aiming to addresses different aspects that were missed in the first draft.

One of the most difficult parts of the process was to 'translate' the interviewees' statements (e.g. verbal inputs) into visual/graphic elements that could be displayed in the model. In general, the researcher found that some of the insights could be applied straight away (such as the description of processes as well as the use of colours and links); while others were more related to the rationale supporting the arrangement, purpose and usage of the framework itself. Thus, at this stage, not all the recommendations and suggestions could be directly integrated in the model.

Overall, the second model draft presented noticeable differences in comparison to the first one. Firstly, different colours were used to identify and highlight each dimension (e.g. green for 'Trends'). Next, the labels of numberless processes (or

actions) were incorporated using italic text format (for instance, '*Data collection'*) alongside with arrows displaying the dynamics of these processes. Finally, the links connecting 'Design' to other dimensions were redefined to 'address and cover' (in a graphic way) a wider scope of topics that impact and influence the design-led research process towards the future.

In the following pages the revised dimensions will be presented followed by a brief rationale about the modifications undertaken. Later in this chapter, the full model (draft 02) will be displayed in details.

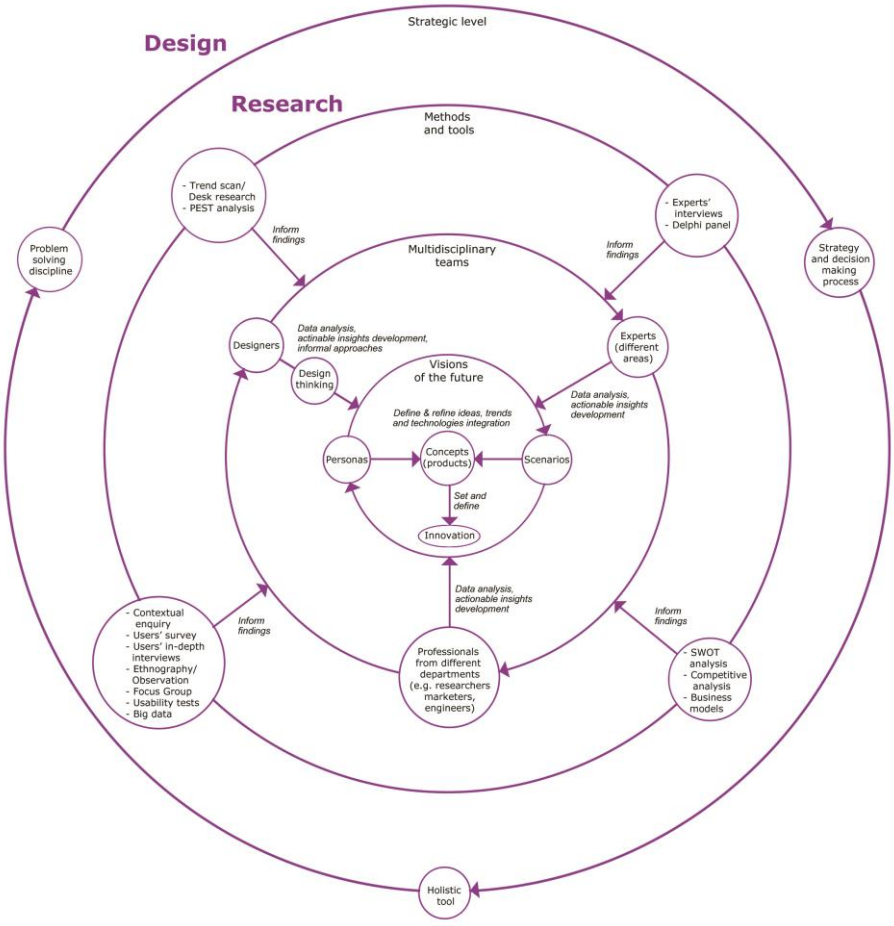


Fig. 7.10 – 'Design' dimension and its key aspects (Draft 02)

Overall, the original structure of the Design dimension was kept very similar to the previous draft model. In addition, the purple colour was adopted to highlight this particular dimension and arrows were added to display the flow of distinct processes. While some of them are 'direct' (one way); others are more 'inclusive' (forming a 'loop' for example, the arrows connecting 'Personas' to 'Scenarios' at

the ‘Visions of the future’ circle). Labels were also added to briefly describe the nature of actions and their purpose. Finally, two new research tools were added: ‘Big data’ and ‘Business models’ in ‘users’ and ‘business’ research methods.

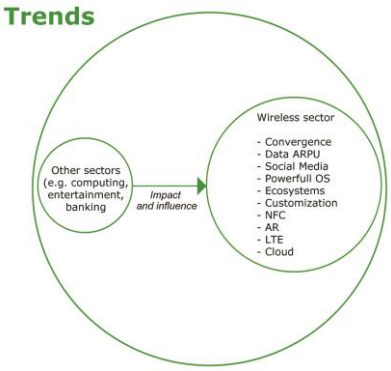


Fig. 7.11 – ‘Trends’ dimension and its key aspects (Draft 02)

With respect to Trends, the two circles representing events inside and outside the wireless sector were inverted. Also, the green colour was selected to identify this dimension. Finally, a single arrow was added emphasizing the fact that different phenomena outside wireless sector can influence and impact this business area.

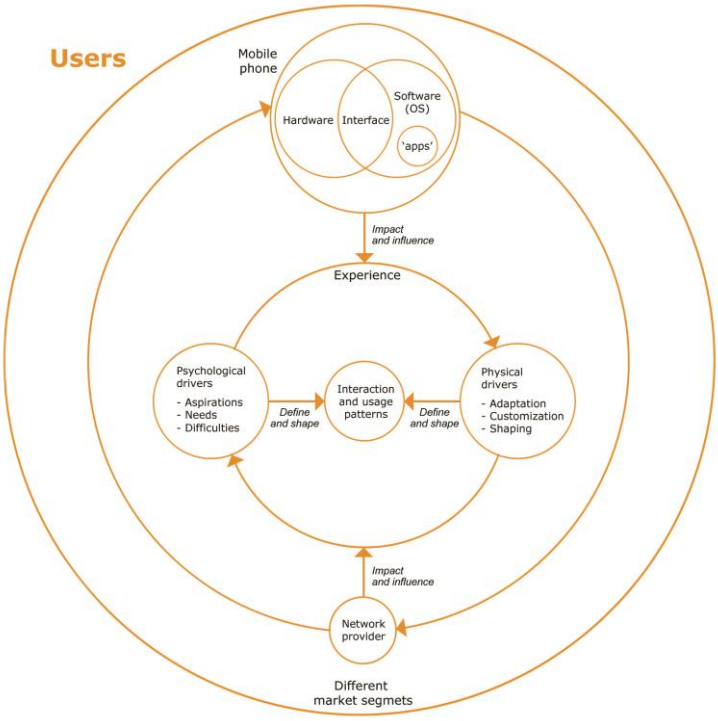


Fig. 7.12 – ‘Users’ dimension and its key aspects (Draft 02)

The ‘Users’ dimension kept exactly the same visual display seem in the original model (draft 01). In addition, the orange colour was selected to represent it and all its content. Finally, arrows were inserted to indicate the directions of actions and their impacts in different aspects presented (e.g. ‘Mobile phone’ and ‘Network providers’ complement each other influencing users’ experience drivers).

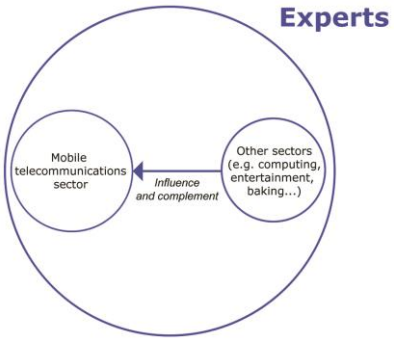


Fig. 7.13 – ‘Experts’ dimension and its key aspects (Draft 02)

Concerning the ‘Experts’ dimensions, it is now identified by the blue colour. The single arrow represents the influence that specialists from other sectors have on those from wireless sector, complementing their knowledge with fresh insights.

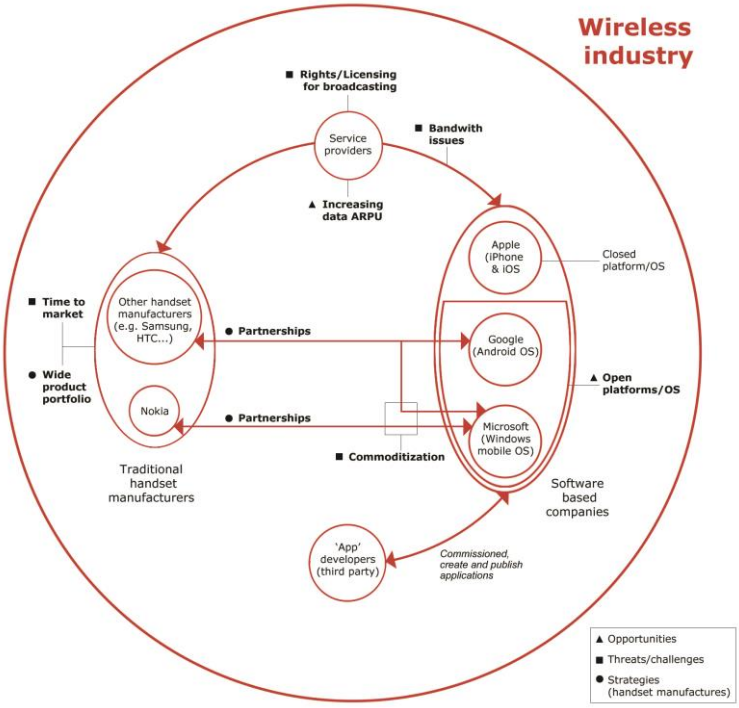
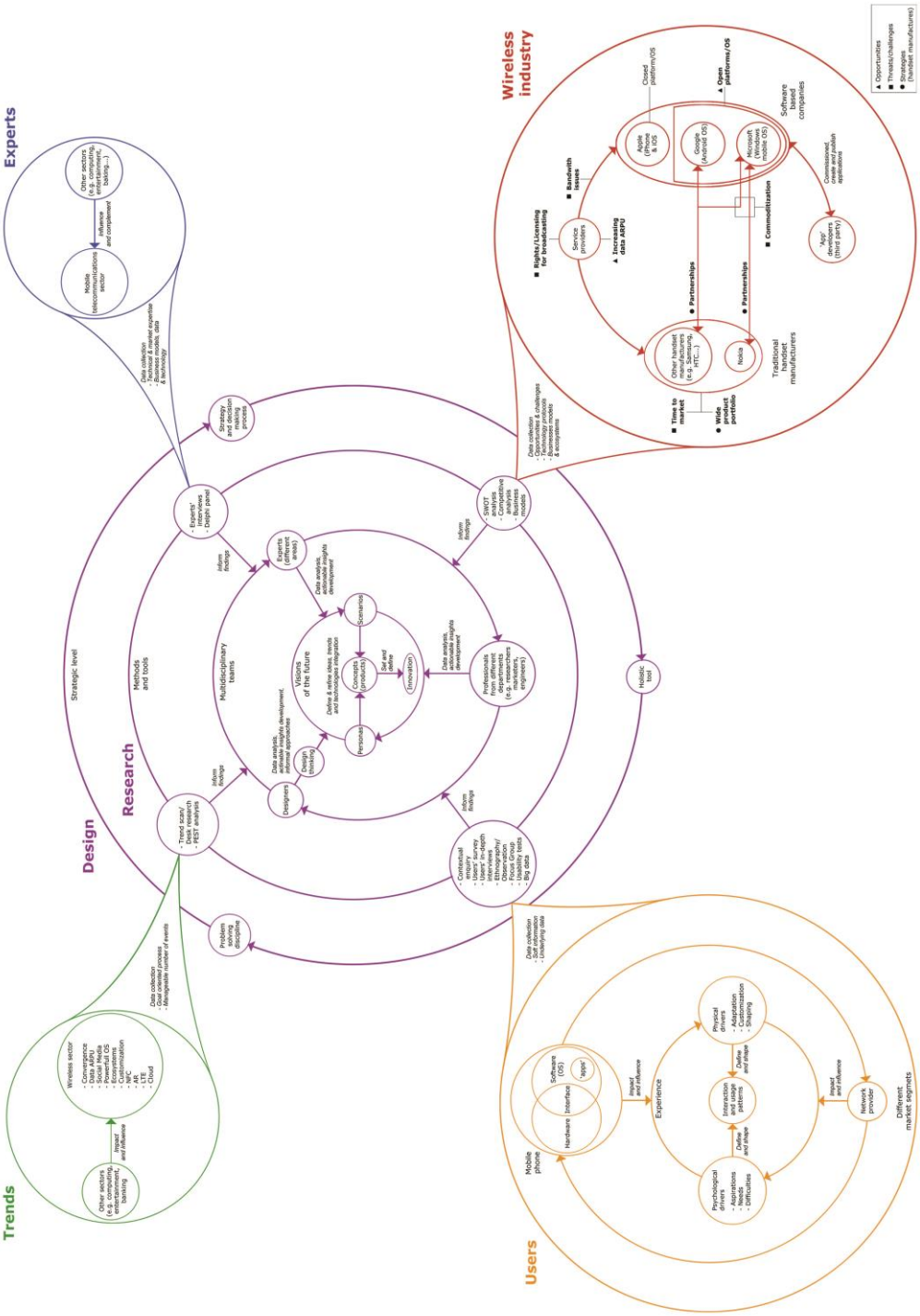


Fig. 7.14 – ‘Wireless Industry’ dimension and its key aspects (Draft 02)

Last but not the least, in comparison with the original version presented (draft 01); the ‘wireless industry’ dimension went through substantial changes. Firstly, it is now identified by a red colour. In addition, a new element named ‘App developers (third party)’ was introduced in this updated version. After that, arrows were also incorporated to indicate the connection of elements and related actions. Finally, this dimension now portrays a series of ‘opportunities’ and ‘threats’ for handset manufacturers as well as strategies employed to tackle these issues (the related box shows the ‘key’ introduce these distinct phenomena).

After presenting the updated dimensions (reviewed considering the feedbacks and insights gained through the experts’ interviews), the second framework draft was created. Following the same approach used in the previous model (draft 01), in this second version, the four dimensions (e.g. ‘Users’; ‘Trends’; ‘Experts; and ‘Wireless industry’) were put together and linked to the core (‘Design’ dimension) through the distinct design research methods. These links were also modified in order to be visually more comprehensive (in comparison to those depicted in the first model, draft 01). Finally, the general graphic distribution of these five groups in the space remained exactly the same.

In the next page the complete proposed model (draft 02) is presented in full details.


Experts
Other sectors (e.g. computing, entertainment, banking...)
influence and complement
Mobile telecommunications sector
Data collection
- Technical & market expertise
- Business models data
& technology
Wireless industry
Closed platforms/OS
Open platforms/OS
Apple (iPhone & iOS
Google (Android OS)
Microsoft (Windows mobile OS)
Software based companies
Bandwith issues
Right/Licensing for broadcasting
Service providers
Increasing data ARPU
Partnerships
Commoditization
Commissioned, create and publish applications
App' developers (new APPS)
Other handset manufacturers (e.g. Samsung, RIM...)
Nokia
Traditional handset manufacturers
Time to market
Wide product portfolio
Data collection
- Opportunities & challenges
- Technical constraints
- Businesses models
& ecosystems
Opportunities
Threats/challenges
Strategies
(handset manufacturers)
Design Research
Strategic level
Methods and tools
Strategic and decision making tools
Experts' interviews
- Deeper points
inform findings
SWOT analysis
- Competitive analysis
- Business models
inform dialogs
Holistic tool
Multidisciplinary teams
Experts (almost) alone
Data analysis, ideation & insights development
Designers
Design thinking
Data analysis, informal insights development, informal approaches
Vision of the future
Define & refine ideas, trends and scenarios integration
Personas
Scenarios
Concepts (products)
Set and solve
(Innovation)
Professionals (marketers, developments, engineers)
Data analysis, ideation & insights development
Trend scan/ Desk research - PEST analysis
inform dialogs
inform findings
- Contextual inquiry
- Users' survey
- Users' in-depth interviews
- Ethnography/ Observation
- Focus Group
- Usability tests
- Big Data
Problem solving discipline
Trends
Other sectors (e.g. computing, entertainment, banking)
impact and influence
Wireless sector
- Convergence
- Cloud computing
- Social Media
- Powerful OS
- Ecosystems
- Customization
- NFC
- AR
- IoT
- Cloud
Data collection
- Goal oriented process
- Navigate master of events
Users
Mobile phone
Software (OS)
Apps
Hardware
Interface
impact and influence
Experience
Physical senses
- Adaptation
- Customization
- Shaping
Interaction and usage patterns
Define and refine
Psychological drivers
- Aspirations
- Needs
- Attitudes
Define and refine
Network provider
Different market segments
Data collection
- Soft information
- Underlying data

7.5.1. Model evaluation (Draft 02) – Processes

After developing the model´s second draft, it was submitted for expert valuation. To evaluate this updated and revised version (draft 02), the researcher employed the same approach used previously for assessing the first model draft (see Chapter 7, section 7.4.1)

At this stage, four in-depth experts' interviews were conducted. Despite of the similar process employed in the first round of interviews (to assess the first model draft); for this second panel, different experts were approached. For this second round, three out of four specialists presented extensive working experience in the mobile telecom field. They work for global handset manufacturer firms occupying senior positions. In addition, they are familiar with design; design processes and design management liaising and managing multidisciplinary teams, including designers from distinct backgrounds.

Overall, the length of these meetings ranged from 45 up to 60 minutes in total. The interviews followed the same procedure used to evaluate the first framework (draft 01) Firstly, the updated version of the model was briefly introduced by the researcher followed by expert assessment and discussion. The same questionnaire used in the first round of evaluation was again applied.

The following chart exhibits the profiles of the four interviewees approached to evaluate the second version of the model (draft 02)

Table 7.3 - Profiles of the professionals interviewed (draft 02 evaluation)

Proficiency	Interviewee profile	Remarks
VP, Head of Integrated Design & Strategy	• Over 10 years of working experience with mobile communications. • Works across different departments to create consistent product and brand experience through numberless consumers' touch points. • Coordinates multidisciplinary teams (including designers)	• Interviewee (16) • Face-to-face interview
Director of Visual Communications	• 10 years of working experience with mobile communications • Works across different areas focusing on brand experience through different touch points (from both end-users and corporative sides) • Manages different teams of professionals particularly bridging design, branding and marketing areas.	• Interviewee (17) • Face-to-face interview
Head of Technology	• Over 10 years of working experience with wireless technologies, Research & Development (R&D) and software development • Manages a global team of professionals, focusing on user experience design (liaising directly with the design team) • Holds a PhD degree in Physics from a leading British University	• Interviewee (18) • Face-to-face Interview
Independent Consultant	• Over 20 years of experience working and consulting for international companies across different industries • Solid experience in the field of innovation (including future-led strategies, branding, NPD, packaging and marketing) • Founder and owner of its own innovation consultancy firm	• Interviewee (19) • Face-to-face interview

Finally, the objective of these interviews was to check the model draft usefulness, practicalities and comprehensiveness regarding its content and graphic elements. Moreover, the researcher used these meetings to clarify the inputs disclosed in this updated version and also to uncover any missing relevant information.

7.5.2. Model evaluation (Draft 02) - Feedback and key points

The ideas from the second round of evaluations through experts' interviews were analysed using the same procedure employed during the first model draft examination entailing the use of Grounded Theory supported by the Nvivo data analysis software (see Chapter 7, section 7.4.2)

In this stage, the evaluation outcomes were grouped in three categories named 'Questions', 'Content' and 'Visual elements'. These are exactly the same groups created to display the insights collected in the first assessment round. In the following pages the key ideas that emerged from these processes will be presented

and highlighted with supporting evidences. (See Appendix, section 1.2 for the complete interviews)

• Questions

According to experts, the revised framework seems to be very comprehensive. Interviewees 17 and 19 highlighted the amount of crucial issues identified and displayed in draft model. *'...It looks as if you've got all the main parameters there, so that's good'* (Interviewee 19).

The experts agreed that the proposed framework provides a 'hands-on' assistance. Interviewees 17 and 18 pointed out that the model 'ticks all necessary boxes' in terms of critical referencing points that need to be taken into consideration in a future-led project. In addition, Interviewee 17 explained that the draft can be used as a practical asset when negotiating with different stakeholders (e.g. head of departments, directors and senior executives) to acquire 'buy-in' and support the development of specific solutions to be delivered in the right time frame. Finally, interviewee 19 stressed that the practicality of the model is associated with the fact that it is 'future-led'. Thus, for effectively employ it, a company just need to choose the time frame ('when in the future').

In terms of usefulness, interviewees presented contrasting perspectives about the model. While some experts argued that the model is a relevant asset to check how different key issues converge when conducting a future time frame assignment (Interviewee 17, Interviewee 18); Interviewee 16 explained that the framework confirmed all the necessary requirements for future forecasting in the wireless industry; yet, it does not show clearly how it can foster disruptive approaches.

• Content

As Design is considered a holistic discipline, design-led research combines both 'rational' and 'emotional' approaches that enable designers to develop ideas in order to propose potential solutions for problems (Interviewee 16; Interviewee 18).

While formal research provides raw data that needs to be translated into useful and meaningful insights (Interviewee 16); serendipity, gut feeling, intuition and personal experience work as counterparts, stressing that the 'spark' of ideas do not necessarily *'…come through pragmatic, logical collection of data. Sometimes… a connection just happens and somebody will have a probing thought and it's actually a very good thought'* (Interviewee 18). These 'connections of ideas' can lead to new disruptive approaches, processes and products (Interviewee 16). The use of multidisciplinary teams also, plays crucial roles in design research. It integrates different professionals including designers from distinct backgrounds (e.g. interface, user experience, graphic and industrial design). By developing an exclusive set of 'design principles or drivers' to guide the design process based on the combination of formal research inputs and informal approaches, the research team can envision and create new ideas, prototyping and testing their feasibility (Interviewee 16; Interviewee 17). In addition, the development of future product's concept is a compelling way of promoting ideas and supporting decision making processes involving stakeholders from different backgrounds (e.g. system analysts, strategists and marketers) and departments (engineering, business and technology) (Interviewee 17; Interviewee 18). Finally, interviewees stated that a visionary CEO (for example, Steve Jobs from Apple) or an iconic design champion plays important roles for a design-led company to thrive. These individuals have clear ideas and know-how to engage with the future, setting high standards, simplifying processes, choosing promising scenarios and defining directions (Interviewee 17; Interviewee 18). They are experience-led thinkers that challenge the logical aspects of researched data using intuition and emotional flare to support their decisions (Interviewee 19).

With respect to trends' research in the wireless sector, it should consider a time frame of one year, maximum (Interviewee 19). In general, social phenomena are appointed as the most influencing issues in mobile communications, particularly those related to social media platforms (Interviewee 17). Nevertheless, from an engineering point of view, technological standards are regarded as key factors for the development of new products, since handset have to offer straightforward specifications to create and end-user appeal (Interviewee 18).

In contrast, users are a great source of inspiration for designers. Their inputs can help the design team to create and validate their ideas (Interviewee 18). Moreover, 'geographic locations' (e.g. emergent markets such as China and Brazil) in association with 'price points' can be used by researchers to define a 'consumer segment'. These stratifications help them to understand handset interaction and track platform purchase patterns to uncover potential market opportunities (Interviewee 17).

Experts play an 'analogical' role in future-led design processes offering insights about trends (within and outside the wireless sector) and about users (Interviewee 16). They should be carefully selected to engage in a corporative project (e.g. in-house) and their ideas should be not undermined nor constrained by the firm's internal philosophy (Interviewee 17).

Concerning the current wireless landscape, software based companies are the dominant players in this industry. Apple brought huge disruption to the mobile telecom sector due to its computing background. Next, Apple and Google control different ecosystems creating a huge barrier for competitors. In contrast, the partnership and later acquisition of Nokia by Microsoft enabled the development of the Windows phone to compete in the market. In terms of business strategy, while Nokia presents an extensive product portfolio (using 'Windows mobile' and 'Asha' OS) in the same way as Samsung (that uses Android OS in its products); Apple focus only in one product (e.g. iPhone) to compete for the high end market. That is the reason why this particular firm (e.g. Apple) is struggling to address low end segments (Interviewee 16; Interviewee 18).

Since the wireless telecom is in constant change, technology plays paramount roles in these dramatic transformations. Nevertheless, Interviewee 18 argued that the creation of new products *'…is more about how we tackle users rather than developing new technology and integrating it on a new hardware'* (Interviewee 18). Aligned with these ideas, products should appeal in an emotional way to consumers instead of just offering high-tech resources. That is the reason why a new piece of technology should be developed aiming to tackle and solve users' needs. Despite of the high investments to create innovative features; they cannot be recouped by just integrating them in future solutions without a clear purpose.

Finally, a ‘race towards technology’ is ‘race to the bottom’, as this new standard, potentially, will be copied and used by competitors in the future (Interviewee 18).

• Visual elements

The arrangement of different dimensions in the space was also well regarded by the experts approached. Interviewee 17 highlighted that *‘… It’s wonderful, I just go quickly, sort of, go through the five areas that you’ve identified but, you know, it looks like you’ve covered all the areas that we get data on, or we’ve got teams working in. These things are getting you straight into the centre, because that’s almost like, you know, into the bull’s eye, things like the prototypes and scenario. We have a target consumer and we also think about how we communicate it to them and also how that is a great halo for others’*. In addition, the same interviewee stated that ‘Trends’ and ‘Users’ dimensions are allocated in the same side, side-by-side. Thus, they share a strong connection and relationship. Finally, Interviewee 16 explained that it is necessary to ‘distil’ how the insights derived from the outer circles (e.g. dimensions) are ‘processed’ in the inner circle (Design dimension) by experts and how they can be used.

7.6. Model (Final version)

After analysing the insights derived from the experts’ evaluation concerning the second model (draft 02), some improvements for the final version of the design-led future forecasting model for mobile communications were proposed. This version not only considered the new aspects raised by the specialists (in this last assessment round); but also, it reviewed those inputs gained in the first evaluation process that could be still missing

To begin with, there were some alterations in the model’s dimensions, particularly in the ‘Design’. An updated version of this dimension is displayed below followed by a brief explanation.

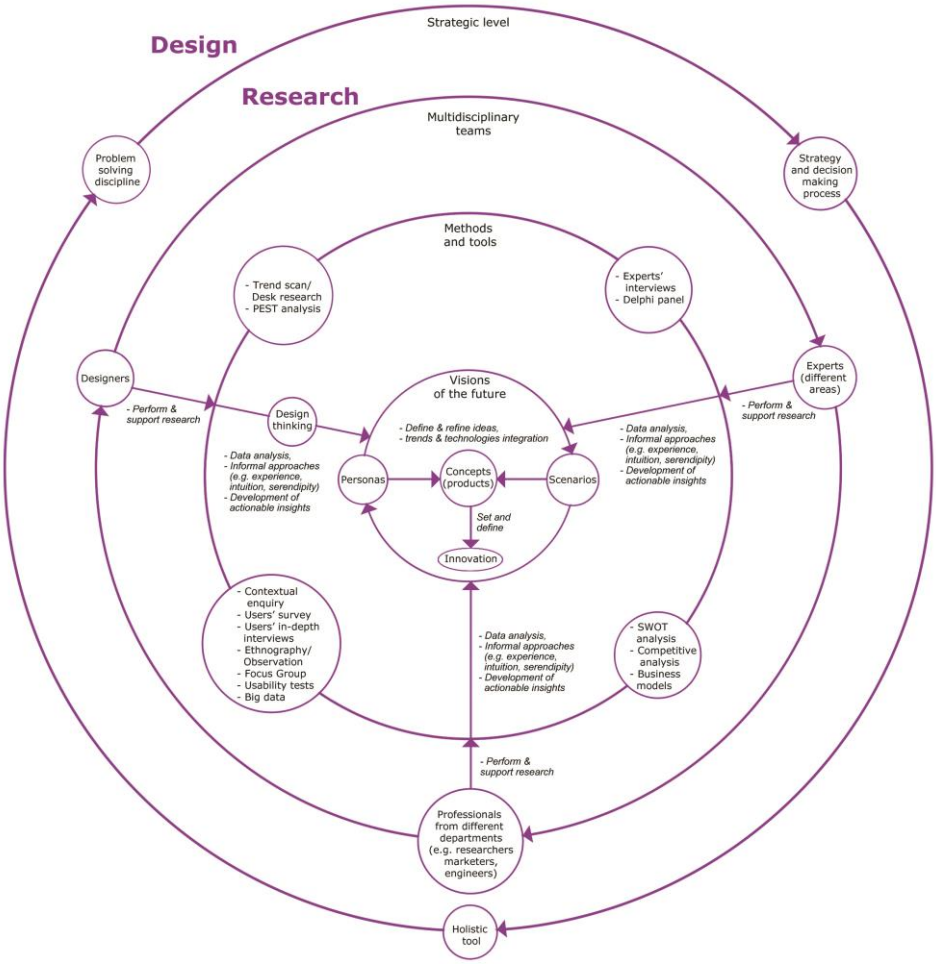


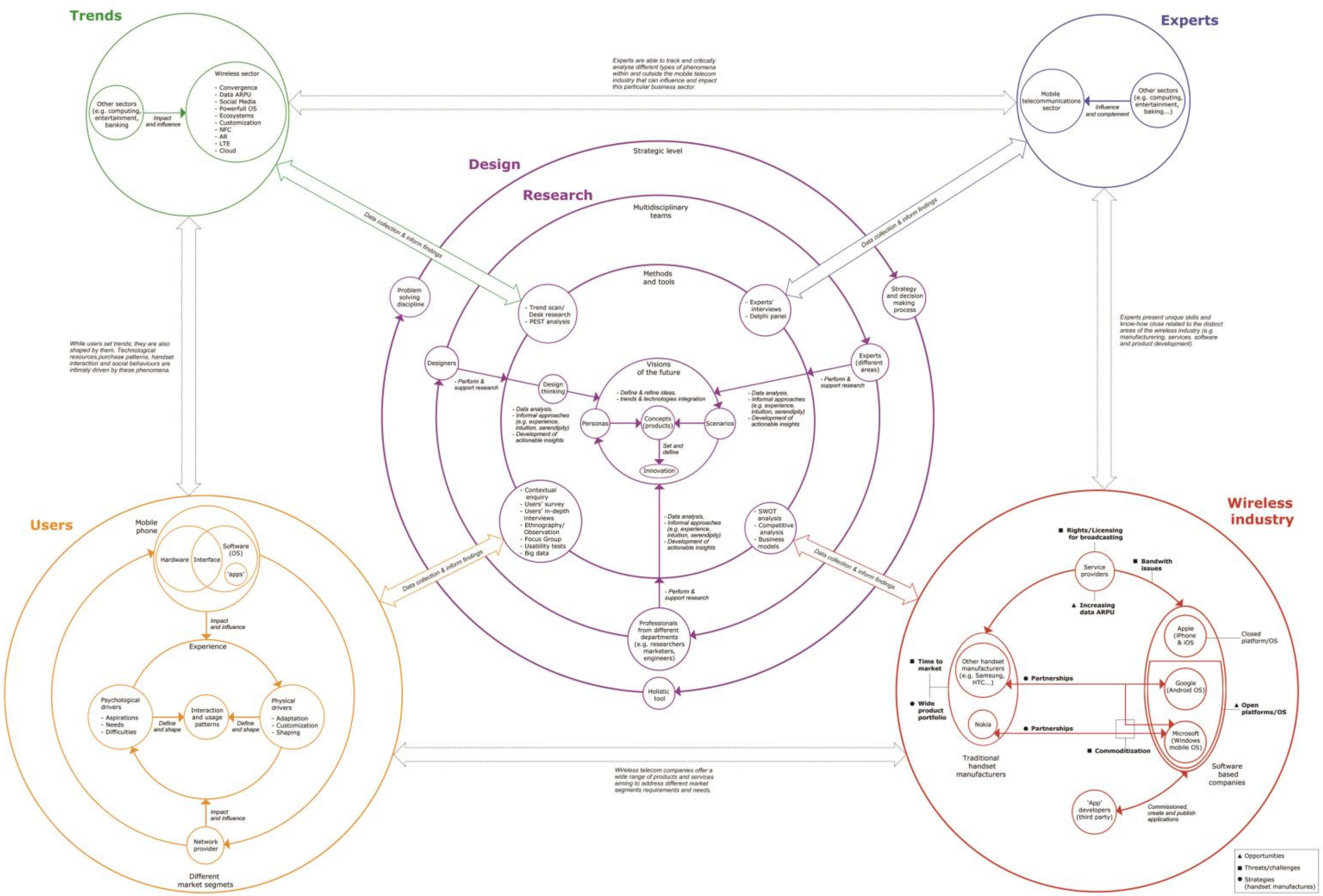
Fig. 7.15 - 'Design' dimension and its key aspects (final version)

In this updated version of the 'Design' dimension, 'Multidisciplinary teams' and 'Methods and tools' (circles) were swapped. As a result, the visual distribution of some elements within these areas changed. Now, it is clear that designers, experts and professionals from other departments perform and asupport research efforts employing a wide scope of instruments displayed in the 'Methods and tools' (circle). These techniques are used to collect data that later will be analysed using formal and informal approaches (e.g. intuition and personal experience) and; finally, 'translated' into insights leading to the creation of personas, scenarios and future products' concepts.

Concerning the visual and space distribution of the model five dimensions, it remained exactly the same ('Design' placed in the centre surrounded by 'Trends', 'Experts', 'Users' and 'Wireless industry'). However, in comparison to the second model (draft 02), this final version exhibits some differences with respect to the

graphic elements linking the different dimensions. For example, arrows replaced the ‘organic’ structures connecting ‘Design’ to the other four groups. In addition, based on a review of the first model (draft 01), the four previous mentioned dimensions are now interconnected.

In the next page, the final version of the design-led future forecasting model for mobile communications that this study aims to deliver is introduced.



Trends
Other sectors (e.g. computing, entertainment, banking
Impact and influence
Wireless sector
- Convergence
- Data ARPU
- Social Media
- Powerfull OS
- Ecosystems
- Customization
- NFC
- AR
- LTE
- Cloud
Experts
Experts are able to track and critically analyse different types of phenomena within and outside the mobile telecom industry that can influence and impact this particular business sector.
Mobile telecommunications sector
Influence and complement
Other sectors (e.g. computing, entertainment, baking...)
Design
Research
Strategic level
Multidisciplinary teams
Methods and tools
Data collection & inform findings
Problem solving discipline
- Trend scan/ Desk research
- PEST analysis
- Experts' interviews
- Delphi panel
Strategy and decision making process
While users set trends; they are also shaped by them. Technological resources,purchase patterns, handset interaction and social behaviours are intimaly driven by these phenomena.
Experts present unique skills and know-how close related to the distinct areas of the wireless industry (e.g. manufacturering, services, software and product development).
Designers
- Perform & support research
Design thinking
Visions of the future
- Define & refine ideas,
- trends & technologies integration
Experts (different areas)
- Data analysis,
- Informal approaches (e.g. experience, intuition, serendipity)
- Development of actionable insights
Personas
Concepts (products)
Scenarios
Set and define
Innovation
- Contextual enquiry
- Users' survey
- Users' in-depth interviews
- Ethnography/ Observation
- Focus Group
- Usability tests
- Big data
- SWOT analysis
- Competitive analysis
- Business models
Professionals from different departments (e.g. researchers marketers, engineers)
Holistic tool
Users
Mobile phone
Hardware
Interface
Software (OS)
'apps'
Impact and influence
Experience
Psychological drivers
- Aspirations
- Needs
- Difficulties
Define and shape
Interaction and usage patterns
Physical drivers
- Adaptation
- Customization
- Shaping
Network provider
Different market segmets
Wireless telecom companies offer a wide range of products and services aiming to address different market segments requirements and needs.
Wireless industry
■ Rights/Licensing for broadcasting
Service providers
■ Bandwith issues
▲ Increasing data ARPU
Apple (iPhone & iOS)
Closed platform/OS
■ Time to market
● Wide product portfolio
Other handset manufacturers (e.g. Samsung, HTC...)
● Partnerships
Google (Android OS)
▲ Open platforms/OS
Nokia
Microsoft (Windows mobile OS)
■ Commoditization
Traditional handset manufacturers
Software based companies
'App' developers (third party)
Commissioned, create and publish applications
▲ Opportunities
■ Threats/challenges
● Strategies (handset manufactures)

7.6.1 Model evaluation 01 (Final version) - Process

During the model development stage, different model drafts were examined by a number of experts. Taking into account the insights and ideas collected, they were improved and refined (see sections 7.4 and 7.5 including subsections for further details). After that, to complement the experts' evaluation, the final version of the framework was tested considering an empirical perspective by groups of potential stakeholders (e.g. design students) through a creative task.

The first workshop aimed to explore different usability and practical issues such as the usefulness and relevance of the model to address a specific activity; how participants used this platform to tackle this task; if the information conveyed was appropriate to support students during the proposed assignment; if the framework supported participants' interaction and decision making within the task's context and; finally, discover and identify new possibilities of model utilization and related contributions.

The first workshop was divided in three main parts. In the first section, the researcher introduced the research topic, including a general explanation about the framework covering the inputs conveyed across its different dimensions (30 minutes). Next, the students were divided in two independent groups and asked to address a specific creative task whose briefing was *'you are part of a design team of a traditional mobile phone manufacturer and by using the model as an inspirational platform among other resources, design a future wireless phone/solution considering a 5 years' time frame*' (1 hour) followed by a brief presentation of the ideas developed and feedback (around 10 minutes). Finally, in the last section, participants were interviewed in group (one group after the other) to check and explore their experiences concerning their perception; interaction and use of the model to accomplish the required task (30 minutes). In total, the workshop last around two hours.

The use of multidisciplinary teams of potential stakeholders/users (e.g. design strategy students) to test the framework aimed to simulate how it could be applied in an industrial context where participants should work together to address a given task under severe time limitations. To fulfil this requisite (e.g. multidisciplinary teams), the researcher recruited Masters' students from a wide range of design

related working experiences (such as web, product, service and graphic design) presenting formal training and understanding of this discipline from two different postgraduate courses of Brunel University including Design & Branding and Design & Innovation. Furthermore, students undertaking Research (e.g. PhD students) in different design areas (e.g. cultural and manufacturing design) were also invited to participate in the workshop. Other criteria to be met were related to include participants from both genders (e.g. male and female) and origin (e.g. Europe, Middle-East, Asia and Americas).

In total, 12 students enrolled at Brunel University from different design related backgrounds and levels of expertise participated in the first workshop, most of them were Masters' students (9 participants in total) and few PhD students (3 participants). Participants' profiles are displayed in the following charts. Students' names and other personal information are not displayed due to non-disclosure agreements (participants are identified by a code, comprising their group and a number, for example 'A1').

Table 7.4 - Profiles of the participants - Group 'A'

Participants	Participants' proficiency	Remarks
Participant A1	• Master's student - Design	• Male; Americas
Participant A2	• PhD student/Researcher - Design	• Male; Europe
Participant A3	• Master's student - Design	• Female; Middle-East
Participant A4	• Master's student - Design	• Female; Asia
Participant A5	• Master's student – Design	• Female; Asia
Participant A6	• Master's student – Design	• Male; Asia

Table 7.5 - Profiles of the participants - Group 'B'

Participants	Participants' proficiency	Remarks
Participant B1	• PhD student/Researcher - Design	• Male; Europe
Participant B2	• Master's student – Design	• Male; Europe
Participant B3	• Master's student – Design	• Male; Americas
Participant B4	• Master's student – Design	• Female; Europe
Participant B5	• Master's student – Design	• Female; Asia
Participant B6	• PhD student/Researcher - Design	• Female; Asia

As it was mentioned before, the students were divided in two multidisciplinary teams (named team ‘A’ and ‘B’) that worked independently using the same model as a starting point/source of inspiration for addressing the required creative task (‘*you are part of a design team of a traditional mobile phone manufacturer and by using the model as an inspirational platform among other resources, design a future wireless phone/solution considering a 5 years’ time frame*). To allocate the students in these two groups, firstly, it was considered the number of participants that agreed to take part in the study (an even number of participants either 10 or 12 was considered optimum). Other criteria were to mix students from different levels (e.g. Masters’ and PhD students) as well as different genders and cultural backgrounds to have a good balance within the groups. Moreover, having six participants in each group allowed them to work closely with their teammates discussing and exchanging insights to create approaches and strategies to address the objectives of the proposed task.

7.6.2 Model evaluation 01 (Final version) – Feedback and key points

During the second part of this first workshop (e.g. creative task), the researcher was able to observe the students’ interaction with their peers and the model itself, assisting them when required. However, his main roles were mostly related to encourage participants to work on the task and keep the time of the activity (one hour). By the end of this task, each group presented its ideas. Some pictures of conducted the workshop are displayed in the next page.

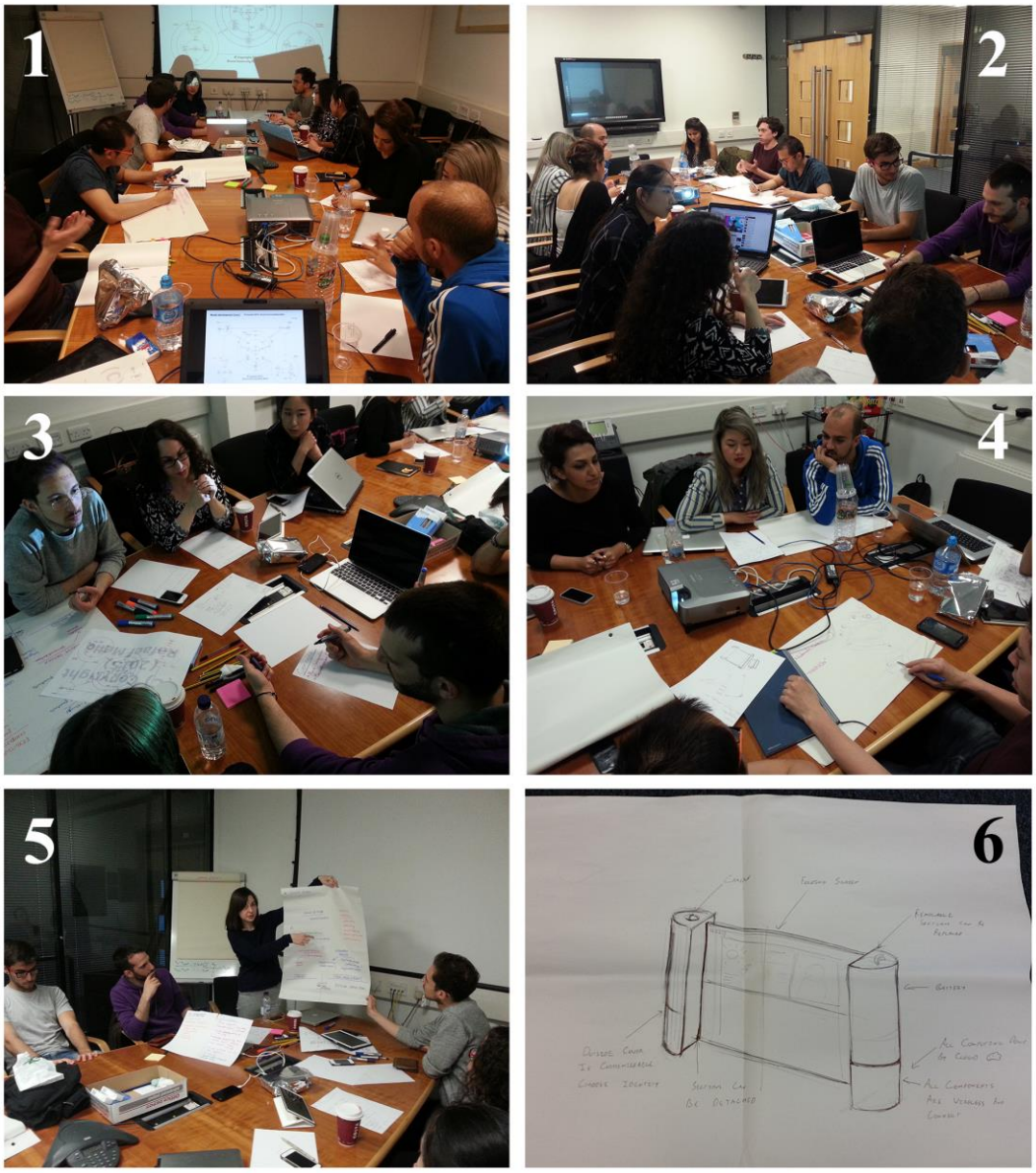


Fig. 7.16 - Collection of pictures from the students' workshop (for model evaluation): (1) and (2) students attending the workshop and tackling the proposed creative task; (3) Group 'B' working on the creative task; (4) Group 'A' working on the creative task; (5) Group 'B' presenting its ideas; and, (6) Group 'A' handset concept and key points.

The previous pictures show the students working within their groups using the 'design-led future forecasting model for mobile communications' as an inspiration platform to tackle the proposed creative task (see section 7.6.1 for the further details). Based on the outcomes produced after this process, it is possible to say that the developed framework played important roles supporting participants to achieve their objectives. While group 'B' followed a 'pragmatic route' preparing a set of guidelines displaying the features and benefits of the envisioned future solution (5); group 'A' adopted a more 'hands on' approach creating a concept

highlighting its key functionalities and integrated technologies (6). Despite of the different 'types' of outcomes (the first can be considered more 'strategic'; while the latter, more 'practical'), the model demonstrated to be an important asset helping participants to interact; making decisions and developing insights that led to future-led drivers for potential wireless solutions.

The two group interviews, one with each team (see Appendix, section 1.3 for questionnaire and interviews), were conducted in the end of the workshop. Each group interview last around 10 minutes and the insights collected were analysed using the Grounded Theory supported by the qualitative analysis software, NVIVO. (The same analysis approach was employed during model evaluation with experts - see sections 7.4.1 and 7.5.1 for more details).

The results of the analysis processes of these interviewees were grouped in five categories: 'Tool'; 'Content and displayed information'; 'Interaction and usage'; 'Stimuli for discussion/ideas exchange' and 'Time constrains'. The following pages present the key findings highlighted by participants' quotes.

• Tool

To begin with, some participants presented distinct; yet, positive views about the model concerning its use as a holistic design tool. The opinions of participants A1 and B3 complemented each other. While the first regarded the framework as a useful platform to tackle the proposed task; the later explained that it could be considered as a valuable attempt of a design-led instrument since there is not a 'universal' framework addressing the particularities of the researched topic (and the task). Moreover, the model plays a role inspiring users/designers to interact with it (Participant B1). Last but not the least, the previous ideas also share a relationship with the impressions of Participant B2 towards the framework, in this case, as a holistic problem-solving instrument: *'… it's a framework that can guide you to finding all the knowledge that you need, all the information you need and how to solve it [the task], but we can… the user [of the model] can use tools depending on the different sector'.*

• Content and information display

Concerning the inputs conveyed in the model and its graphic display, participants presented contrasting points of view. Participant B2 stated that the framework was considered comprehensive since it introduces different aspects (about the topic) that users should be aware of and focus on. On the other hand, other participants (e.g. Participant A2, Participant A3 and Participant B3) presented negative first impressions about this platform, describing it as *'intimidating', 'overwhelming'* and *'complicated',* particularly considering the extensive amount of information introduced. Participant A5 went further suggesting 'possible' ways to explore its potentialities. As the quantity of inputs displayed across the different dimensions differ from one to another, the framework should be approached as a whole in order to understand it and distil its content.

With respect to one particular dimension of the model, 'Design', Participant A2, explained that the information conveyed in this specific part is very familiar for a individual with formal design training/background; therefore, its content simply just 'makes sense' for a designer. *'…what it does recommend is actually similar to what I'd have a look at, as a designer…'* In addition, the same participant complemented his views stating that no further guidance was actually required in order to understand the various elements and information displayed in this section. Finally, aligned with these ideas, participant A3 declared that the familiarity with design (and the design process) allows designers to pay 'less attention' to this specific part of the model.

• Interaction and usage

The utilization of the model to tackle the creative task (e.g. '*you are part of a design team of a traditional mobile phone manufacturer and by using the model as an inspirational platform among other resources, design a future wireless phone/solution considering a 5 years' time frame')* raised contradictory opinions, particularly concerning how they interacted with it. One key point highlighted by several participants was the fact that, apparently, the model did not present a 'start and finish points'. Participant A1, A4 and B3 shared similar and complementary

views. They stated that it was not clear how to start using the framework because they could not find the 'starting point' and, for that reason, it was rather difficult (and not intuitive) to use, at the first glance. Participant A2 argued that it was not clear how to 'move around' this platform (e.g. navigation) either starting from the centre to the fringes or the other way around. Nevertheless, the 'non-linear' visual approach of the framework received some positive reviews. Participant B5 noticed that *'…actually, you can start from wherever you want, as I understand.'* In addition, participant A2 immediately explained that since the design process does not follow a rigid progression and designers do not work in a strict linear way; it makes sense that the model does not present this feature (e.g. 'linearity'). In addition, there was a consensus about the freedom that the framework promotes, allowing data selection on demand without forcing participants/users to prioritize or follow a given routine (participants A2 and B1). Finally, participant B1 emphasized that this freedom also enabled them to designate a 'starting point' to begin using the framework.

In terms of data selection, participants proceeded in similar manner to choose information to address the proposed task prioritizing required data. Participant A5 labelled this process as '*Lego approach*', where data was selected *'piece by piece'.* Moreover, since dimensions conveyed information related to a specific topic; prioritization occurred in that level. For example, participant A2 prioritized and paid more attention in inputs from some dimensions (e.g. 'Users') in comparison to others (such as 'Experts'). Participants' backgrounds and experiences also influenced in the way data was used and combined to create strategies to tackle the proposed task (participant B1). At last, participant B5 stated that 'key words' employed to identify methods, topics and actions inspired teammates rather than the model 'mechanics' itself.

Concerning model utilization (and related design process) employed to address the creative assignment, some participants presented divergent points of view. Participant B4 explained that the framework could be helpful for users that are not familiar with the design process in order to guide them in similar projects. On the other hand, participant B3 stated that non-designers, possibly, would have some difficulties to interact with it and accomplish the activity. At last, participants A4 and B3 agreed on the fact that since their team members present formal design

background, they were used to this type of exercise, allowing them to be familiar with the framework´s content to support them in this proposed task.

Overall, the model was well regarded as an instrument to guide the design process (in the context of the creative activity). In a general perspective, participant B3 declared that *'the elements that compose the future forecasting [model], like you have to go through these main areas… trends, and users, and I think... for someone new (using the model for the first time), it drives well [the process]*. In addition, the framework supported brainstorming processes (participants B2 and B4), enabling a group to create future guidelines (to address the task) based on insights generated during students' discussions (participant B2). Participant B2 highlighted the number of methods used to collect data from different dimensions, stating that there was a preference for using familiar techniques rather than new tools. Finally, from a managerial point of view, the model was considered a useful resource to be placed in the wall supporting brainstorming workshops; delegating tasks to different team members (for example, researching about a given topic) and integrating collected data (participant B2).

• Stimuli for discussions/ideas exchange

Several participants (participants B1, B2, B3 and B4) agreed on the fact that the model worked as a platform supporting and promoting discussions, leading to rich ideas' exchanges. Participant B2 explained that the framework alongside with his teammates' backgrounds helped them moving on with conversations and finding news paths of discussion. From a different point of view, a group member acting as a 'facilitator' leading the process, particularly in its beginning would encourage participants' to 'break the ice' and interact promptly (participant B4).

• Supporting decision making

The framework not only promoted rich discussions (through its extensive amount of information); but also, it supported participants to make decisions during the proposed task. Participants A2, A4 and A5 shared similar views about the model,

stating that it helped them to formulate strategies to tackle the creative assignment. However, they explained that it did not support them to validate their ideas. In addition, participants A4 and B2 stated that the framework could have been employed for this specific purpose (validating developed strategies and ideas).

• Time constrains

The duration of the creative task (1 hour) influenced in the model utilization and, in some extension, delivered impacts on the design process associated with the proposed activity. Several participants highlighted this factor taking into account distinct points of view. Participant A2, B1 and B2 explained that due to time constrains, they had to select and prioritize resources displayed in the framework, giving preference to familiar and/or specific information. In addition, participant B2 explained that the time limitation forced his teammates to assign a 'starting point' to use the model. Finally, the same participant (B2) summarized the whole issue (e.g. time constrains) emphasizing that *'time was limited in order to use the full extension of it (model).'*

7.6.3 Model evaluation 01 (Final version) – Discussion

The workshop conducted with design students aiming to evaluate distinct aspects of the design-led future forecasting model for mobile communications (such as usability, relevance, information appropriateness's and, support for participants' interaction, discussion and decision making), helped the researcher to have a comprehensive view of this platform.

In a general perspective, the model proved to be a useful and practical future-led design tool. Considering the requirements of the proposed task (e.g. designing for the future in the wireless telecom sector), participants working in teams employed the extensive range of information introduced in the framework to create concepts and ideas of potential future wireless solutions.

The model showed potential to support a design-led future forecasting assignment in the context of wireless telecom through its comprehensive range of appropriate

information about this particular field. Its rich visual display is directly associated with the complex nature of the topic that it addresses. This characteristic led to surprising insights. While for some participants, the amount of data presented was considered ‘overwhelming’ (negative); for others, the robust body of knowledge disclosed conferred the framework a comprehensive attribute. This can be verified by two significant evidences. First, the richness of the model comprising relevant content and several design research methods employed to investigate different issues/dimensions (e.g. ‘Experts’; ‘Users’; ‘Trends; and ‘Wireless Industry’) was underlined by some participants. After that, no negative reviews concerning either lack of information or inappropriate data were revealed.

The design-led future forecasting model for mobile communications attested to be appropriate and suitable for the target audience that took part in the creative task. Since all participants presented a design background, they were familiar with design process, research methods and the content introduced within the ‘Design’ dimension. In addition, evidences indicated that participants did not actually need guidance to ‘understand’ this particular dimension, whose inputs ‘makes sense’ for an individual with formal design training. As result, participants tended to spend more time exploring other parts of the framework.

The general usability of the model was promising despite of some difficulties faced by participants to start using it. At the first glance, some of them stated that the framework was not intuitive as it did not display a clear ‘start and finish points’. Nevertheless, other participants highlighted that this lack of ‘linearity’ (‘step-by-step approach’), led to alternative ways of utilization. In fact, the unique ‘networked’ or ‘web shaped’ visual of the model (deliberately designed in this way), aimed to invite participants to explore it without restrictions. This specific attribute was perceived and underlined by some participants. While some of them realized that they, actually, could start using the framework from any point; others emphasized the freedom they had to select the most suitable input on demand considering their needs (and the strategies to tackle the assignment). In addition, this distinctive characteristic of the model (e.g. ‘open approach’) was associated with the fact that the design process, due to its nature, is neither linear nor rigid; therefore, the framework can be considered in line with this premise.

The framework revealed to be efficient in promoting and supporting participants' interaction and discussion. The information conveyed triggered rich conversations that unfold to other related topics (This issue was also observed by the researcher during the course of the proposed task). Moreover, since the model did not present a clear 'start and finish points', it 'pushed' participants to prioritize information to be used. In fact, this process can be considered normal and also expected since a careful selection of inputs in line with the strategies to be developed was crucial. Furthermore, the use of simple and straightforward words to identify different elements (such as topics and actions) worked as 'signposts' inspiring this process (rather than the whole mechanics of the framework itself). Finally, the design background of participants also played a key role in data selection and utilization.

When applied to assist the design process undertaken to address the creative task, the model revealed to be useful and practical. Some Participants stated that its broad range of inputs (including a number of design research methods), helped during brainstorming to create strategies in order to accomplish the proposed assignment. In addition, the model dimensions could be displayed in the wall facilitating both data selection and integration during the course of the design process. Finally, remarkable evidences emerged from a managerial point of view as the framework could be employed to designate specific activities (such as data collection) to different stakeholders, maximizing its usage and time allocated for a project, for example.

Finally, apart from assisting the design process, the framework played valuable roles to support decision making process. Overall, the vast amount of information conveyed, helped participants to formulate ideas, develop insights and create possible solutions to address the proposed task. On the other hand, the model was not employed to validate or confirm these newly created strategies, according to some participants. In fact, this issue is in accordance with the model propositions as this tool was not primarily designed with the purpose of verifying or ratifying approaches/strategies developed; but, to aid and provide support to stakeholders.

7.6.4 Model evaluation 02 (Final version) - Processes

As it was mentioned early (in section 7.6.1), to evaluate the proposed design-led future forecasting model, the researcher conducted two workshops with design students from Brunel University. In this section, the particularities of the second workshop will be introduced.

In a general perspective, to run this second workshop, the researcher employed a similar approach used previously (to conduct the first study) with some slight modifications. To begin with, its aim differ (in some extension) in comparison to the first model evaluation. Despite of addressing similar issues, the focus of this experiment was to check how the framework supported and influenced group dynamics concerning ideas generation/evaluation; data prioritization; decision making processes and future solutions development.

With respect to format, the second workshop was also divided in three stages. In the first part, a rationale about the topic was introduced to the audience (30 minutes). After that, the students were invited to take part in the same activity using the model a starting point/inspiration tool *'you are part of a design team of a traditional mobile phone manufacturer and by using the model as an inspirational platform among other resources, design a future wireless phone/solution considering a 5 years' time frame*' (1 hour). Finally, in the last part, the students were interviewed as a group (10 minutes). The interview served for two distinct purposes. Firstly, it focused on ratifying (or adding) information that was previously collected through observations during the proposed activity and compare the undertaken project with their experience at the master´s course module, 'Design Futures' (explained later on this section).

Once again, students were recruited from two Design Masters´ courses enrolled at Brunel University, Design & Branding and Design & Innovation to participate in the workshop. All participants had already finished the 'Design Futures' module. This particular module is a core segment of the design programs where students must develop a design-led future solution for a given situation of their choice. They work in independent groups for nearly 3 moths. In the meantime, they must select a topic; search for relevant data taking into account appropriate research methods/methodology to collect evidences; develop their ideas (e.g. solutions and

future scenarios) and explain the roles and contributions of design to achieve it (no extra resource is provided to them apart from a general guidance of module lecturer/leader).

The reasons behind the choice of asking students to compare their experienced in the workshop and at the 'Design futures' module are related to three factors. Firstly, the 'Design futures' module and the workshop activity presented the same driver: to create a design-led future solution for a given situation. Next, in both assignments, students had to work in teams to develop an outcome. Finally, the third reason (and the major difference between these two design-led projects) is that students had access to the developed model ('design-led future forecasting model for mobile communications') during the workshop creative task to support them addressing its goals and the particularities of the wireless sector (linked with the proposed activity).

A multidisciplinary approach was used concerning the composition of the group. Students recruited presented formal understanding and training in design related fields. Despite the efforts made by the researcher to invite students to attend this second workshop, a small number of participants took part on this study (only four). This factor can be regarded as a limitation since all of them came from the same geographical area. However, this limitation (reduced number of participants) presented benefits for the process. First, it contributed for the approach adopted in this experiment: to compare students´ experiences during the workshop creative task with the 'Design futures' module. In addition, during the workshop activity, the researcher not only observed; but also, talked and engaged with students, enquiring and collecting key inputs concerning group dynamics and solutions' development process.

The following chart displays the participants' information. Their names and other sensitive information are not disclosed. Participants are identified by specific codes considering their allocated group and a number (for example, 'C1').

Table 7.6 - Profiles of the participants - Group ‘C’

Participants	Participants’ proficiency	Remarks
Participant C1	• Master´s student - Design	• Male; Asia
Participant C2	• Master’s student – Design	• Male; Asia
Participant C3	• Master’s student – Design	• Female; Asia
Participant C4	• Master’s student – Design	• Female; Asia

7.6.5 Model evaluation 02 (Final version) - Feedback and key points

In this second workshop, the researcher focused more on observing and engaging with participates during the creative task to understand their thoughts and the processes of decision making concerning ideas generation, evaluation of potential alternatives and solutions’ development. This observation process was possible due to the small group of students that took part in the experiment.

The insights captured during the workshop’s task and group interview were video recorded. Also, field notes were taken to support observation and future analyses processes. In this second workshop, the value of the inputs collected through the observation process was more important than those gathered through the interview. In fact, they complemented each other. Based on these ideas, the researcher chose to present the outcomes of these processes together, combined in one narrative divided by topics.

Before proceeding to the findings, some pictures of the workshop activity as well as the group interview are displayed below. The position of the video recording device was the same during the whole workshop.

Fig. 7.17 - Collection of pictures from the second students' workshop (creative activity): (1) Students examining the model (first contact); (2) Student sharing an example with his peers; (3) Student takes notes of key topics discussed during creative task; (4) Student presenting her views to team members; (5) Group discussion and ideas´ generation; (6) group´s final solution (handset concept and key points).

The following pages will present the key findings that emerged from the second model evaluation student workshop. As it was mentioned before, the collected information will be divided in topics accordingly.

• Participants' first impressions (towards the model)

The first impressions captured were related to participants' perceptions about the framework. In the beginning, students seem to be ´surprised' or 'overwhelmed' with the model. They spent some time (e.g. minutes) carefully looking at it, trying to make sense of the inputs displayed and how to use it to tackle the proposed task.

The model mechanics ('navigation') was another issue that intrigued participants in this first stage. Somehow, they searched for a 'starting point' in the model to begin using it. The size of the different dimensions' circles led them to think that some of them could be more important than the others. Nevertheless, they soon realized a major difference among the dimensions' position: the one in the middle (e.g. 'Design') was associated with processes, tools, philosophy and stakeholders; the other four (e.g. 'Trends'; 'Experts'; 'Users' and 'Wireless Industry') orbiting around the first were 'subjects' with displaying issues to be investigated. This analysis led them to prioritize 'Design' as the most critical part of the framework helping them to identify and easily select the topics that they would like to discuss to address the assignment (e.g. issues from these adjacent dimensions). From that moment, their approach towards the model became more 'logical' and structured.

• Ideas generation (inputs, triggers and discussions)

To begin with, the group briefly discussed about the timeframe proposed for the activity (e.g. 5 years). This process helped participants to evaluate what should be a 'reasonable level of innovation' for the potential solution(s) to be developed.

During the 'ideas generation' phase, the framework played interesting roles. In a general perspective, the model informed about a wide range of issues related to designing for the future in the wireless sector (that was also directly linked with the workshop activity brief). Its information (e.g. straightforward key words and expressions) enabled students to visualise and understand the complexity of the topic. These 'tiny pieces of information' worked as 'triggers' driving them to start conversations and selecting factors.

For example, after exploring the framework, at the core of the ‘Design’ dimension, there is a circle named ´visions of the future’ comprising ‘concepts’. This is the key deliverable of any design-led future process (and exactly the same goal of the creative assignment). Based on this idea, participants understood that the inputs displayed in the four adjacent dimensions should be integrated, ‘converging’ to the middle and feeding the design-led future process. Thus, they started scanning these four areas (‘Trends’; ‘Experts’; ‘Users’ and ‘Wireless Industry’) for relevant issues prioritizing them along the development process.

When discussing about ‘concepts’ (the main deliverable of the task), participants turned their attention to the ‘Users’ (dimension) focusing on both ‘physical and psychological drivers’ concerning handset experience. Their debate reached a conclusion that the psychological part was related to ‘pleasure’, ‘efficiency’ and ‘emotional attachment’. An example provided was the ‘caring relationship’ that some participants have with their Apple laptops for years. In contrast, the physical aspects were basically associated with ‘hardware’, ‘features’ and ‘services’.

The use of examples ‘triggered’ by the content provided in the model through key words and brief expressions was something that participants used to raise points, explain personal experiences, benchmark ideas and visualise potential futures (for the developing concepts). Examples were also employed by the researcher to probe participants. For instance, students expressed that they did not have much interest on ‘wearable technologies (a benchmark from Apple´s iWatch previous conversation). The researcher provided further details based on his know-how on this particular field boosting conversation around this topic.

Another dimension that participants spent some time discussing and exploring was the ‘wireless industry’, particularly the ‘ecosystem’. The managerial approach issue (e.g. closed vs. open system) was brought about considering the possibility of selecting one specific software platform to ‘integrate’ the solution and address the task in easier way. Once more, a brief discussion and a comparison between the iOS (Apple) and Android (Google) platforms was made.

• Concept development

The concept development stage is a natural extension of the ‘ideas generation’ phase where students expressed and combined insights (based on their examples and experiences) throughout rich discussions.

As a result, this is the phase where the outcomes started to ‘materialize’ through sketches and 2D representations based on notes previously taken during their debates. During this particular stage participants, once again, worked collectively to refine their ideas and ‘make sense’ of that information exchanged to create a final outcome/solution.

Following their discussions, students presented their ideas about features that a future mobile phone could offer. The group agreed to not follow a ‘wearable technology’ route (since it requires charging via USB); therefore, deciding that the handset should be simple and modular with a removable battery; yet, introducing an innovative form factor. Aligned with these ideas, the group considered and decided in favour of a foldable system capable of ‘rolling’ the screen to keep it inside the handset body.

In terms of hardware features, the future mobile phone should also embed cutting edge technologies including eye-tracking sensors and 3D virtual reality for a more immersive experience in context base environments. The screen should present a ‘multitasking channel’ attribute allowing users to use it as hybrid device (to access handset, TV and tablet functions the go).

With respect to software and wireless services, the group agreed that Facebook, still, would be a major player in the mobile internet business. Companies would be even closer to the consumers via the mobile phones, becoming their ‘partners’ providing products and services via an ‘integrated value system’. Finally, phones would make broadcasting and data ubiquitous since files would be kept in the ‘Cloud’ to be accessed and exchanged any time, hassle free.

In addition, participants pursued a ‘blue sky’ scenario for the developed solution rather than a ‘wild card’ future vision of mobile utilization. The aim of the group was to create a concept that would make current mobile phones looking, somehow, ‘primitive’.

In conclusion, the concept developed during the creative task embodied different aspects from the framework. Among different factors, it is possible to highlight the integration of technologies (e.g. eye-tracking sensors); services (e.g. Cloud computing and Facebook); hardware (e.g. foldable materials and battery) and software (e.g. 3D virtual reality and 'multitasking approach') features concerning a better and more immersive user experience. All of these issues, somehow, are associated with the 'convergence' trend in both industrial and technological levels.

• Decision making process

To begin with, the reduced number of participants (regarded as a limitation), in fact, brought advantages for the group during the workshop activity. This element made them 'closer' during debates and when decisions had to be made, following a consensus approach.

Participants demonstrated kind and careful behaviour when interacting with each other. They presented their ideas 'in turns', which means that each student had time to explain his arguments and listen to the others in a respectful and organized manner, without rushing and allowing space to think and respond.

In the very beginning two students took the 'leadership' of the activity in a very polite way. The first participant (C1) was very argumentative bringing ideas and offering examples for debates; the second (participant C2) was more 'provocative' (in a respectful way) encouraging peers to talk, searching for agreements and taking notes about the topics discussed throughout the activity. The other two (participants C3 and C4) contributed with ideas during the co-creation process. Finally, all participants effectively engaged during the task, turning the activity into a highly participatory brainstorming process.

With respect to the model usage, it supported participants making decisions in different ways. Firstly, the framework provided a solid structure for the debate, giving directions about the issues to be covered and offering a fresh perspective of the 'design for the future in the wireless industry' topic shaping students´ thinking.

Next, the rich graphics helped participants to identify, select and prioritize issues. For example, they immediately ranked the ‘Design’ dimension as the key driver for the process due to two reasons: it was in the heart of the framework and it presented similar deliverables in comparison to the proposed activity (e.g. future concepts and scenarios). Thus, the inputs displayed on the other four dimensions should be brought to the ‘middle’ feeding the design-led future process (assisting them on the proposed assignment).

After that, by interacting with the model´s extensive information and its unique ‘web shaped’ format, participants started regarding it not only as a comprehensive tool; but also, as a ‘check box guideline’ with all the information necessary for the creative task. Furthermore, its several ‘visual connections’ (‘lines’) assisted students to understand how different issues were connected (information flow), helping saving their time to easily identify topics, making the ‘navigation’ through the model faster and ‘linear’.

Finally, other approaches used in association with the model helped students to make decisions, including personal experience, factual examples, intuition and logic (particularly these two were employed to ‘read’ the framework and develop a solution). All of these elements helped them to build knowledge (by ‘stacking information’), make sense of insights, refine ideas and create the final outcome in a collective and collaborative manner.

• The ‘Design Futures’ vs. workshop task (model utilization)

Participants were invited to presented their opinions concerning their experience during the workshop activity and those that they had during the ‘Design Future’ MA module (see section 7.6.3 for further details). To begin with there was two major differences between them. They were related to ‘time’ (while the ‘Design Futures’ last nearly three months; the creative activity had a duration of one hour) and ‘resources’ (during the workshop, the design-led future forecasting model was provided to participants; whereas in the ‘Design futures’ students had find all the information and resources by themselves to developed an outcome).

These two elements (‘time’ and ‘resources’) delivered an impact on participants’ experiences. However, the key aspect explored in this section was the presence and utilization of the model to support the workshop creative task concerning ideas generation and decision making during the process. Participants stated that despite of having a reasonable amount of time to accomplish the ‘Design futures’ assignment, they ‘have got lost’ because they did not know ‘what to do’ with all the information collected, spending a lot of time to ‘sort them out’. This fact can be possibly linked to data interpretation; how to ‘connect’ different ideas and how to evaluate and prioritize inputs for the context of the topic addressed.

On the other hand, during the fast-paced task at workshop, the model provided for the activity played major roles driving participants’ experience to a level beyond in comparison with the ‘Design Futures’ practice. According to participants, the model worked as a structured and complete tool since it captured all necessary inputs for the task. It brought light to participants, speeding up the whole process including ideas generation, discussions and concept development. Basically, they ‘knew what to do’ because the model informed them the key issues and the ‘steps’ to be taken (e.g. how information is linked); thus, assisting them to accomplish the task faster. Finally, participants enquired the researcher about the possibility of having similar framework focusing on different industries, since it could deliver benefits for potential users to understand other business sectors’ landscape.

Summing up, the proposed model (with its extensive information) worked as a comprehensive ‘shortcut’ providing direction and focus supporting the workshop activity; while in the ‘Design futures’, students reported that its ‘open approach’ (and the lack of supporting resources) pushed them to go ‘blind’ through all the development stages in a very slow pace to create an outcome.

7.6.6 Model evaluation 02 (Final version) – Discussion

During the second workshop conducted with design students the researcher was able to collect a wide range of valuable insights concerning model utilization and how it influenced and supported the ideas’ generation; decision making processes and; finally, the development of solutions.

The following diagram presents an overview of the major drivers involved in the group interaction mechanics and their relationship. After that, these issues will be explained (taking into account the ideas presented in the previous section).

Table 7.7 - Group interaction drivers towards model utilization

Stages	Drivers	Actions
'Problem' (context)	Creative activity briefing	
Model (aspects)	Key words, graphics, links and navigation	
Individual (reasoning)	Examples, personal experiences and intuition	'inputs'
Collective (reasoning)	Brainstorming and collaboration	'insights'
'Solution' (outcome)	Mobile phone concept	'consensus'

To analyse these elements, the researcher reviewed and explored business related literature, particularly those linked with decision making process. It is important to highlight the difficulties of finding only one specific theory that encompasses and integrates all the issues under one 'framework umbrella'. Thus, the researcher investigated these factors, one by one, as they emerged during the creative activity, looking for academic evidences that could bring light, describing and explaining the phenomena encountered.

To begin with, the model presents four 'attributes' that are interconnected sharing a relationship. The first parameter, 'key words/expressions' is related to content or information. These ´tiny pieces of data' aim to be simple and straightforward to explain (or label) several key issues. After that, 'graphics' is associated with the dimensions' arrangement in the space (e.g. position); appearance (e.g. colours) and the major topic addressed ('Users' and 'Trends', for example). Next, the 'links' are the numberless 'visual connections' (e.g. lines, circles and arrows) that connect different dimensions, information and processes within and outside each cluster. Finally, the 'navigation' deals with the model´s 'reading mechanics' and the 'flow of information'. The framework was purposively created to be 'non-linear' and 'open' without restricting users to 'start' and 'finish' in specific points.

All these ‘inputs’ (and their combination) basically, ‘triggered’ distinct responses from participants during the workshop creative task. For example, the information provided in the model (trough ‘key words and expressions’) induced students to think about their personal experiences (with products) and examples related to the explored topic. Both the ‘examples’ and ‘personal experiences’ shared during the debates can be considered as a way of ‘benchmarking’. Kotler (2008) explains that firms use benchmarking to compare its products with those from competitors or leading enterprises from other sectors in order to improve its goods´ efficiency and quality. In the context of the workshop creative task, this makes perfect sense since participants had to create a solution and raised examples (e.g. Apple and the ‘wearable technologies’) as reference points for discussions and ideas´ generation.

Encompassing (in some extension) the previous two qualitative ‘approaches’ (e.g. the use of examples and personal experiences), another aspect of group dynamics (applied in both individual and collective levels) was the use of ‘intuition’ during the creative activity. Smith (2008) defines ‘intuition’ as a rapid and affectively way of judging without conscious awareness of the reasoning process involved with potential of influencing, informing and enhancing individual and collective learning process. This definition can explain participants’ selection of ‘Design’ dimension as key part of the framework. Moreover, it was potentially used to decide between going forward (or not) with the ‘wearable technology’ idea for the final solution. Finally, Rosanoff (2000) states that ‘intuition’ enhances analytic thinking focusing on current issues to devise innovative timely strategies. Based on the ideas presented, it is possible to say that an ‘intuitive approach’ was used to ‘envision’ and ‘set’ the innovation level of the solution to be created during the proposed task (this issue was discussed among participants).

From a different perspective ´leadership’ was another relevant aspect during the group interaction with the framework. Raducan and Raducan (2014), explain that ‘leadership’ is the ability of a person to determine how other people will behave or participate; being a process of someone´s orientation through communication and conviction based on complex elements including trust to direct people to the same direction or objectives; promoting and supporting collective decisions. In the particular case of the group experiment, this role was played by participants C1 and C2. These two participants presented different ‘leadership styles’. The

first shared personal stories, examples and ideas triggered by the model's content; while the second encouraged participants' discussions (by raising issues from the framework); taking notes (also comprising concept's sketches) and establishing peers' agreement that led to decisions concerning directions to follow during the solution development stage. Despite the fact that participants were in the same (hierarchical) level, these examples highlighted the leaders' effort to communicate and propose ideas influencing teammates' behaviour to make collective decisions aiming to reach a common goal.

All these 'individual' characteristics (e.g. 'examples'; 'personal experiences' and 'leadership'), basically, promoted and supported the development of key insights based on the different model attributes.

Considering a different perspective, the approach used to conduct the creative task known as 'brainstorm' also played significant roles during group dynamics. Best (2006) declares that 'brainstorm' is an established technique that involves the participation of stakeholders to generate ideas in order to address a problem. It is a practical, collaborative and research based approach that considers several aspects of the problem in order to propose ways to solve it. Quality (and not the quantity) of insights generated is important, ranging from outlandish to *avant-guarde* ideas. Decisions are made on a collective way to access them considering their potential to sort the situation. Taking into account the ideas presented, the group dynamics and the outcomes produced, it is possible to say that students worked in a highly cooperative way. They explored the model (its structure and contents), creating ideas, making consensual decisions concerning which direction to follow in order to develop a ('blue sky') final solution (e.g. mobile phone concept) to address the proposed task's briefing (*'you are part of a design team of a traditional mobile phone manufacturer and by using the model as an inspirational platform among other resources, design a future wireless phone/solution considering a 5 years' time frame*').

Summing up, the developed handset concept is the end result of an extensive process that started with the problem definition (stated in the activity´s briefing), passing by different types of analyses and reasoning in individual and collective levels. It integrates the information displayed in the framework and the insights

generated (based on its content), taking into account the proposed time frame (one hour) and task´s objectives.

7.6.7 Model (Final version) - Contributions

After reviewing and exploring the two workshops´ creative activities undertaken by participants and putting the particularities of these experiments into perspective, they attempted to emulate the real life conditions of multidisciplinary teams of designers working for a handset manufacturer (beneficiary of this study) when designing future wireless solutions. Based on these premises, participants were asked to work in teams to address a given task considering specific requirements (e.g. using the design-led future forecasting model for mobile communications) and limitations (e.g. time).

Taking into account participants' insights and experiences with the model (e.g. utilization, interaction, discussions and reasoning) and extrapolating these inputs into the context of a traditional handset manufacturer's design team, it is possible to outline a number of contributions of the proposed framework for a design-led future project.

Firstly, the model's design-led attributes (including elements of the design process as well as a wide range of design research methods) are recognizable and familiar to designers, facilitating its use when designing for the future in the context of the wireless communications.

Next, the framework introduces a comprehensive amount of information (through simple words to identify elements, actions and processes) working as a 'check list' helping designers to be aware of these aspects since they can influence and impact in future-led design projects undertaken in the wireless sector.

After that, the unique 'networked' graphic display of the model invites designers to explore its content and dimensions using it without any restrictions (or a rigid linear order) enabling them to choose key information on demand, hassle free.

As a holistic platform, the model fosters interaction among designers. Its structure and inputs encourage discussions, supporting participants' reasoning and decision

making taking into account the selection and prioritization of information that leads to the development of insights and strategies to tackle future-led design projects in the wireless field.

Finally, from a managerial point of view, the framework facilitates design related activities for example, brainstorming sections (comprising data collection, ideas generation and consensual decision making) not only supporting them; but also, 'guiding' designers to fulfil specific steps along the process that will lead to the creation of concepts of future wireless solutions.

Based on the mentioned contributions, the model itself combines both descriptive and prescriptive characteristics at the same time. Firstly, the framework can be considered descriptive because it introduces a wide range of key factors (and their relationships) that a design team of a traditional handset manufacturer should strongly consider when designing for the future. Next, the disclosed information is appropriate and 'makes sense' for designers, facilitating model utilization. Finally, due to its visually rich outlook, the design team is able to easily search, find and select the required input since they tend to be heavily affected by visual stimuli.

Conversely, the model can be regarded as prescriptive asset since it goes beyond than introducing relevant information to a manufacturer's design team. Based on its graphic approach, designers can identify and prioritize critical issues that require more attention supporting reasoning and decision making. Furthermore, as it displays a wide range of approaches and methods, it provides aid in different stages of the design process ranging from research to process management (with respect not only to related activities; but also, to stakeholders' roles)

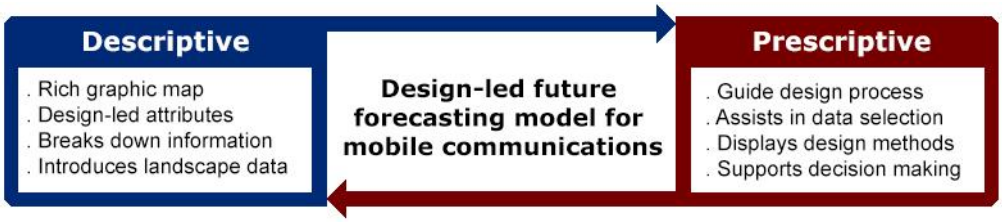


Fig. 7.18 - The proposed model presents descriptive and prescriptive attributes

7.7 Conclusions

Throughout this chapter, the milestones related the development of the design-led future forecasting model for mobile communications and the thorough evaluation process comprising different stakeholders (e.g. experts and design students) were presented and discussed.

To begin with, the inspirations and key drivers that led to the development of the model's five dimensions, 'Design'; 'Trends'; 'Users'; 'Experts' and 'Wireless Industry' were introduced and explained in details. After that, the first model draft was created considering a number of primary and secondary research inputs.

To evaluate it, a series of interviews with experts (from academia and industry) were conducted. The feedback collected provided valuable contributions to update the initial draft leading to the second version. Next, the second model draft was also submitted for expert assessment through another round of in-depth interviews with professionals from handset manufacturers. Once more, the insights gathered through these meetings supported the development of the third and final model version.

The practicalities of this final version were evaluated by groups of stakeholders and potential users (e.g. design students) through two workshops (aiming to simulate a real industry context) were participants used the framework to address a specific future driven design activity. Based on the outcomes produced and the feedback gained, the framework demonstrated to be a useful and practical asset when designing for the future in the context of the wireless sector. Finally, its wide scope of contributions were introduced and explained.

8 Conclusions and future work

8.1 Introduction

This chapter summarises the milestones and processes undertaken throughout this research, explaining the relevance and contributions of this PhD study. Basically, it is divided in five sections. Firstly, a brief review of the objectives and how they were addressed is introduced. The next section revisits the research questions and how these lines of enquiry were answered. After that, an overview of the whole research process conducted is presented. Subsequently, the contributions delivered by this study for the body of knowledge through the proposed design-led future forecasting model for mobile communications are discussed. Finally, in the last two parts, the limitations faced during the course of this research as well as the potential directions for future studies are presented, respectively.

8.2 Review of research aim and milestones

In this section the objectives that this study comprises (previously introduced in Chapter 1, section, 1.9) are reviewed. The processes and research instruments employed to address each of them as well as their contributions for the creation of the design-led future forecasting model for mobile communications are explained.

• **Objective 1 -** To examine the mobile communications industry in order to identify current players, products, landscape phenomena as well as future design directions.

To address this objective, the researcher conducted a comprehensive literature review comprising a wide range of sources including academic publications, business reports, books and specialized websites. Through this extensive review, the researcher acquired relevant knowledge to have a complete picture of the major transformations occurring in the wireless sector. For example, the shift from value chain to network value leading to a highly complex and networked

industry structure; the progressive ‘integration’ of different sectors into the mobile telecommunications (such as computing and entertainment); the changes on the nature of competition (e.g. decline and emergence of players, particularly handset manufacturers); the increasing industry dominance of new entrants, Apple and Google, through innovative market solutions (e.g. iPhone and Android) and successful business strategies (e.g. ecosystems) and; finally, the major landscape phenomena/trends (for example, convergence and social media) and their impacts on the design of future solutions. These findings were mainly presented in details in Chapter two.

• **Objective 2 -** To review existing future forecasting theories and frameworks used by design-led companies.

This objective was achieved through an extensive literature review, the analysis of future-led design approaches and specialized case studies. The five approaches reviewed helped the research to explore how different stakeholders (both private and public) from different sectors interact/engage to envision, create and deliver long term solutions. After that the selected four case studies (three presenting an industrial point of view, Philips Samsung/Seymour Powell and Apple) and (one introducing a theoretical insights; Evans, 2011) assisted the researcher to have a holistic perspective about how design-led firms create future solutions. Based on the cases studies analysis, five major areas that a firm should strongly consider when designing for the future were identified: ‘Designers’ perspectives’; ‘User’s inputs’; ‘Experts’ insights’; ‘Trends and environmental issues’ and ‘Businesses aspects’. They formed the backbone that supported the creation of the model’s five dimensions developed in later stage of this study. These findings were reported and discussed in the Chapter three

• **Objective 3 -** To explore the roles of design and the contribution of this discipline to future forecasting

The objective three was accomplished through the review of specialized literature. The collection of findings revealed that to formulate an effective ‘forecast’ is

necessary to plan ahead. As design is considered a holistic discipline committed with the future, it offers relevant contributions to future-led ventures. For example, it helps outlining the stages of a project; it supports the definition of actions and processes; it aids in the selection of appropriate methods to collect and analyse information and; finally, it plays important roles in the development of future solutions. Therefore, design can be considered an instrumental asset for future forecasting due to its strategic capability of translating different types of data into useful propositions to create innovative future solutions and services. Finally, and extensive list of interdisciplinary research methods employed by designers to collect and consolidate information is introduced and explained. All findings were presented and discussed throughout the Chapter three

• **Objective 4 -** To identify the key stakeholders' opinions about the use of design, current market issues and future opportunities/challenges in the wireless industry that will influence the creation of new products and services.

To tackle this objective, a series of in-depth interviews with experts from different backgrounds including academics and industrialists was conducted. Interviewees presented different levels of working experience in the wireless sector (while some of them consulted for mobile telecom companies; others worked for these firms). A substantial amount of information about the investigated issues was collected. To analyse these inputs, the Grounded Theory was used supported by professional data analysis software, Nvivo. The outcomes were summarised and grouped in seven theoretical clusters (named 'Wireless Industry (business)'; 'Trends (in wireless industry)'; 'Design'; 'Research'; 'Users'; 'Technology' and 'Innovation'), assisting the researcher to have a broad perspective about the data collected, uncovering new and meaningful relationships. The ideas conveyed in these clusters were, in some extension, aligned with those introduced in the five dimensions resulted from the case study analysis. As result, they confirmed many of the preliminary findings, helping to define the basic foundations of the model development. The main findings derived from the experts' interviews as well as the analysis of these insights were presented in Chapter five and discussed in details throughout the Chapter six.

• **Objective 5 -** To develop a design-led future forecasting concept framework for mobile communications

This objective was accomplished through the development of the intended model (aim of this research). The design-led future forecasting model for mobile communications was created taking into account both secondary and primary inputs acquired from the literature review, case studies examination and the analysis of experts' in-depth interviews. It comprises five dimensions named 'Design', 'Users', 'Trends', 'Experts' and 'Wireless Industry'. Each of them conveys a wide range of ideas that are interconnected. Moreover, the dimensions also share relationships among them, including links to the 'Design' (dimension) in the heart of the framework. Due to its nature, the proposed model presents both descriptive and prescriptive characteristics. Based on these characteristics the framework presents a wide range of applications and contributions. For example, it displays a number of relevant aspects that a manufacturer's design team should consider when designing for the future as well as informing about the key stages of a future-led design process, assisting the multidisciplinary research team to select suitable approaches and methods to tackle each of them. The processes and milestones concerning model development were presented and discussed in Chapter seven.

• **Objective 6 -** To evaluate the proposed model with key stakeholders.

This last research milestone can be considered as a 'natural extension' of the previous objective (number five). To accomplish it, the researcher conducted two rounds of in-depth interviews with experts from different backgrounds (including design) from academia and industry. While the first set of meetings comprised experts with different working experiences in the wireless telecom field; the second round encompassed professionals that worked for handset manufactures, particularly in design related senior positions. The feedback gained in each round of interviews helped the researcher to improve the subsequent framework versions. These on-going processes were extremely valuable not only to evaluate the proposed model drafts; but also, to collect any information that could be missing or not addressed. Next, the researcher organized two workshops with potential

users (e.g. design students) to test the model's final version in an empirical way through a creative activity. Several aspects of the framework were explored and based on the participants' observation and feedback; the potential contributions of the framework for a design-led future forecasting project were uncovered and explained. The steps related to the model evaluation processes (including experts' interviews and the students' workshops) were displayed and discussed in details in the Chapter seven.

8.3 Review of research questions framework

After reiterating the objectives that this PhD study comprises by explaining the actions, processes and methods employed to address each of them; this section will revisit the research questions framework introduced in Chapter two (section 2.4). Despite of being primarily used to analyse the future forecasting approaches and case studies in Chapter three, deep and more comprehensive answers to these enquiries can also be found along the chapters of this report. The following table summarizes the topics addressed through the research questions framework.

Table 8.1 – Research questions and answers

Research questions	Answers in	Remarks/comments
(Q1.1) What are key dimensions that handset manufacturers should constantly monitor to design for the future?	Chapter 3 Chapter 6 Chapter 7	Generic (dimensions) Specific (dimensions) Specific (dimensions/model)
(Q1.2) What are the interrelationships of these key dimensions? How do they affect and/or influence each other?	Chapter 3 Chapter 6 Chapter 7	Generic (relationships) Specific (relationships) Specific (relationships/model)
(Q2.1) What types of information do handset developers require to identify emerging opportunities in order to plan new offers and make better design decisions?	Chapter 3 Chapter 5	Generic (types/information) Specific (types/information)
(Q2.2) Where and from whom the information can be acquired and/or captured?	Chapter 3 Chapter 5	Generic (source/contexts) Specific (source/contexts)
(Q2.3) How should these types of data be used to inform future-led design process?	Chapter 3 Chapter 5 Chapter 6	Specific (data usage) Specific (data usage) Specific (data usage)
(Q3.1) What design research approaches, tools, methods and/or models can be used to capture information required for design-led future projects?	Chapter 3 Chapter 5	Specific (methods/approaches) Specific (methods/approaches)

(Q3.2) Does one tool inclusively collect one type of data? Or can one tool be used to gather more than one type of information?	Chapter 3 Chapter 5	Specific (methods/approaches) Specific (methods/approaches)
(Q3.3) Is there any approach, tool, method, framework or model comprehensive enough to integrate all these required features to help a company to design for the future?	Chapter 3 Chapter 5 Chapter 7	Specific methods/approaches) Specific (methods/approaches) Specific (design process/model)
(Q4.1) Which stakeholders are involved in identifying opportunities and planning future products?	Chapter 3 Chapter 5	Generic (stakeholders) Specific (stakeholders)
(Q4.2) Does a multidisciplinary approach is employed in future-led design process?	Chapter 3 Chapter 5 Chapter 6	Specific (multidisciplinar approach) Specific (multidisciplinar approach) Specific (multidisciplinar approach)
(Q4.3) How design can contribute to plan and create future products?	Chapter 3 Chapter 6 Chapter 7	Generic (contributions) Specific (contributions) Specific (contributions/model)

8.4 Research summary

After reviewing the main enquiry lines through the research questions framework, this section will be dedicated to present an overview of the whole PhD research process, summarizing its key milestones.

This research was motivated by the limited number of publications addressing the future forecasting topic from a design perspective. In addition, the uses of design to support future forecasting processes in the context of wireless communications have not been formally reported, yet.

The initial literature review was employed to examine the dynamics of the wireless industry. It included an investigation about the current market landscape including its structure, competition, players, strategies and products. In addition, it revealed that the use of design was only reported in connection with product development related issues (e.g. shapes, colours and materials of mobile phones).

Next, specialized literature concerning the use of design and its contributions to future forecasting process was also reviewed, showing that this discipline plays several roles including strategic and operational functions supporting the design team to shape and create the future. In order to investigate further its applications, five design-led approaches employed by firms operating across different business sectors and four cases studies (combining industrial and academic points of view)

from design-led companies engaged in design-led future projects were examined and explored. Based on the analysis of these inputs, several research milestones, processes and methods were identified alongside with five key dimension that should firms be aware of and consider when designing for the future: ‘Designers’ perspectives’; ‘User’s inputs’; ‘Experts’ insights’; ‘Trends and environmental issues’ and ‘Businesses aspects’.

After that, several in-depth interviews with experts from different backgrounds were conducted to check and explore previous secondary research findings. The information collected was recorded and analysed using the Grounded Theory supported by the Nvivo software. The outcomes were classified and grouped in seven theoretical clusters: ‘Design’; ‘Research’; ‘Wireless Industry (business)’; ‘Users’; ‘Trends (in wireless industry)’; ‘Technology’ and ‘Innovation’.

After revising the findings from the experts’ interviews and comparing them with the data collected through the literature review and the case studies, the ideas provided by the experts were, many cases, in line with the insights that emerged from the secondary research. Therefore, the evidences from both primary and secondary research complemented each other. Based on this extensive collection of information, the researcher was able to have a comprehensive panorama of all research findings in order to start the model development.

The ideas presented in the five dimensions identified from the case study analysis and the inputs displayed in the seven theoretical clusters formed the backbone of the proposed model. As a result, the framework combines secondary and primary information; theoretical and practical aspects.

The model presents five major dimensions: ‘Design’; ‘Trends’; ‘Users’; ‘Experts’; and ‘Wireless industry’. While ‘Design’ was placed in the centre of the model; the other four dimensions are orbiting around it. Each dimension displays its own set of parameters, ideas and associations, despite of showing interrelationships.

The model was evaluated through two rounds of in-depth interviews with experts from distinct backgrounds, including designers working for traditional handset manufacturers. After each round, the inputs were consolidated and analysed using the principles of the Grounded Theory supported by Nvivo software. Based on

these insights, the drafts were revised and enhanced until reaching its final version. After that, the model's final version was tested in two workshops by groups of potential users (e.g. design students) through a practical task to check a number of aspects (e.g. practicalities and influence in group decision making dynamics) Based on participants' observations and feedback, the contributions of this model to support handset manufacturers to design for the future were highlighted and explained.

Finally, taking into account the outcomes of the practical activity conducted with the design students, it is possible to say the applications of the model can be generalized, for instance, to assist a given company operating in a different sector to design future solutions. Since each model dimension is independent and deals with specific issues (design; users; trends; market; and, experts), by employing a 'Lego approach' (e.g. process of model utilization described by a workshop participant) towards the investigated industry, 'piece by piece', all key inputs (related to the model dimensions' topics) can be collected and brought together, mapped (by populating the five dimensions accordingly with relevant evidences) and analysed. Thus, the design research team of a firm operating in this industry can have a comprehensive picture of the market landscape in order to make better informed decisions to design for the future in this business sector.

8.5 Contributions to knowledge

Through the development of the 'design-led future forecasting model for mobile communications', this PhD research has made distinct contributions to the body of knowledge. Basically, these contributions can be divided in three topics that share a complementary character.

• **Contribution 1 -** This study enhances the knowledge (in terms of approaches) about future forecasting from a design perspective through the development of a comprehensive and integrate framework focusing on the particularities of the wireless telecom industry.

Despite of some reported attempts in the literature to address and describe future forecasting processes from a design perspective, they are scarce and limited. Due to commercial sensitiveness (associated with competitiveness loss concerns), design-led companies tend to not publish to the general public their business approaches. In addition, with respect to the wireless sector, there is a lack of studies addressing future forecasting from a design perspective in this particular industry. Based on these premises, this research aims to bridge these two areas, future forecasting and the wireless sector, through design by developing a design-led future forecasting model for mobile communications. The model produced is considered comprehensive because it addresses a number of key issues and dimensions from different areas that influence and impact in future-led design processes in the context of mobile communications. In addition, it is integrated because it brings together knowledge and insights from different fields such as design, forecasting and wireless communications acquired from secondary and primary sources of information. In conclusion, the developed framework can be considered as a novelty in terms of knowledge ('knowledge of approaches') since this new platform brings light about the particularities of future forecasting in the wireless telecom industry from a design perspective.

• **Contribution 2 -** This research provides an insight into the roles of design in the mobile communications industry

The use of design by mobile phone manufacturers in their products have been extensively reported alongside with the evolution of the wireless communications itself. The vast majority of publications available deals with the integration and development of new technologies comprising hardware and software parts. On the other hand, evidences displaying the use of this discipline and its contributions for future forecasting procedures have not been formally reported yet. During the course of this research, particularly through the development of the design-led future forecasting model, it was possible to identify new roles of design to support future forecasting in the wireless sector. Apart from operational functions (related to engineering and manufacturing of mobile phones), design assumes instrumental strategic responsibilities in future-led design process. Basically, it assists handset

manufactures to identify problems (and their scope); it supports landscape investigation (including topics such as users, trends and competitors) through the use of appropriate design research methods and; finally, it helps to analyse data in order to create new value propositions informing the development of innovative future solutions.

• **Contribution 3** - This research provides a holistic view of the mobile telecom sector enabling and supporting handset manufacturers' design team to make better informed decisions (and firms operating in different businesses sectors as well).

This PhD research provides relevant support to traditional handset manufacturers' design team through the developed design-led future forecasting model for mobile communications that combines both descriptive and prescriptive attributes. Firstly, the framework displays a wide range of factors (e.g. users' experience drivers and environmental trends) that play significant roles in the mobile telecom landscape, impacting on traditional manufacturers' businesses. From a different perspective, it informs about the key processes and research milestones assisting the design team to select actions and appropriate research methods (including data collection and analysis tools) to address different issues according to their nature. Based on these ideas, the comprehensive collection of inputs introduced in the model (ranging from factors to processes) helps handset companies' design research teams to make better informed decisions concerning the most suitable approaches to design for the future in the wireless telecom industry. Last but not the least, by keeping the same basic foundations and mechanics, but making adaptions on its dimensions such as renaming the clusters (when necessary); restructuring links (within and across dimensions) and filling them with appropriated information (to address the particularities of a specific business sector), the proposed framework can deliver contributions beyond its original purposes (e.g. design for the future in the wireless industry). Thus, through this 'flexible customization', it can provide substantial help and assistance to design teams of firms operating across different business areas (for example, the automotive industry) to make better decisions when designing for the future.

8.6 Limitations

After reviewing the research milestones and the contributions delivered by study to the body of knowledge, this section will introduce the limitations faced during the course of investigation.

• From the topic - Wireless telecommunications

In a general perspective, researching about the mobile telecom industry proved to be a challenging exercise. Firstly, its 'web-shaped' structure underlines a complex network of firms that either cooperate or compete depending on the type of value produced (e.g. hardware and software) leading to innovative business models and market approaches (for example, strategic partnerships, acquisitions and mobile ecosystems). Next, as a high technology driven sector, new wireless protocols, equipment and services gradually emerge replacing outdated standards creating a new critical mass of consumers and initiating new landscape events (e.g. social and technological trends). As a result, keeping informed about these phenomena (such as new technologies and trends) demands an extensive effort. Due to its complexity and speed dynamics, it is not possible for the researcher to be fully updated about the numberless issues surrounding the wireless sector. As a result, in practical terms, this research focuses on traditional handset manufactures operating in western markets, considering the changes in the wireless telecom occurred until 2012 (for example, it does not cover the complete acquisition of Nokia by Microsoft; only their partnership prior to the full merge).

• From the topic - Limitations of publications (case studies)

During this PhD study, the researcher faced severe difficulties to find specialized literature (e.g. case studies) informing about how design-led firms employ the design discipline across its business to support the creation of future solutions. The limitations achieved different levels. First of all, the case studies were scarce due to the fact that design-led firms cannot (or are not interested) in disclosing strategic information to the public. After that, the second limitation is related to

scope. The revised case studies tended to focus more on the outcomes of future-led projects rather than providing extensive inputs about processes, steps and stakeholders involved in the different stages of the design processes. Next, the vast majority of case studies were written taking into account a business point of view (and not a design perspective). Potentially, this is reason why design related information (concerning both narratives and contents) were not provided in details. All these facts confirm the obstacles faced by the researcher to find appropriate resources informing about how design is used by companies engaged in future-led projects. Conversely, these limitations showed a clear opportunity to advance in this field through a comprehensive formal study (through this PhD research) that contributes to body of knowledge by addressing these issues (and other aspects) considering the particular context of mobile telecommunications sector.

• From the research - Qualitative approaches

This PhD research was conducted in the domain of design supported by design related qualitative techniques. The researcher used both secondary (e.g. literature review) and primary (e.g. experts' interviews) research methods to gather an extensive amount of data followed by the use of Grounded Theory to analyse information. The inputs collected complemented each other and assisted in the development of proposed model. Since this research is conduct exclusively by the author in an independent environment employing qualitative tools, research biases and also subjective interpretation of findings are very difficult to be avoided. As a result, the combination of these aspects may have influenced in the outcomes produced by this study.

• From the research – Social/cultural gaps and sensitive data

During the course of this study, the researcher faced severe difficulties to contact experts working for some mobile phone manufacturers. While some professionals were recommended and introduced by lecturers and other practitioners; others were directly contacted via professional e-mail or through social media services such as Linkedin. Those professionals introduced through third party connections,

presented a higher rate of replying the interview requests in comparison to others. Another key aspect is related to the fact that professionals working for western mobile phone companies were keener to engage in these meetings in comparison to their Eastern/Asian counterparts that, in most cases, ignored the first contact (done via e-mail) without further notice. Possible reasons to explain this issue can be related to cultural (e.g. Western and Eastern) and/or business (e.g. trust and reputation of the interviewer) 'gaps' where the lack of a person (e.g. 'middle-man') acquitted to the interviewer to bridge and facilitate these processes can be named as one potential factor for the frustration in connecting some of the target experts. Finally, also related to 'trust' issues, the fear of disclosing confidential information that 'could' lead to the loss of competitive advantage can also be appointed as an element that brought obstacles for some interview processes.

8.7 Future research

In this section, suggestions for future research are introduced using this study as a starting point.

• Empirical validations

One recommended direction for a future research is related to the validation of the proposed design-led future forecasting model for mobile communications. A future study can be designed and conducted to explore the different aspects of the proposed model through empirical approaches from a commercial point of view. By liaising directly with the design team of a traditional handset manufacturer engaged in a future-led design project, the researcher can submit the model to real market situations in order to evaluate its numberless elements and applications from a 'practical and hands-on' perspective.

• Applying mixed research methods

Another direction for a future study is related to the use of different approaches combining both qualitative and quantitative research tools to generate findings. For example, the use of qualitative in-depth interviews with experts associated with quantitative questionnaire surveys with participants and stakeholders of a manufacturer multidisciplinary research team (including designers) may assist in offering different perspectives about the roles and applications of design to support future forecasting procedures in the wireless telecom sector.

• Using multidisciplinary approach

As this study was fully conducted in independent way by the author, subjective interpretations of findings and insights collected might have, in some degree, resulted in biased analysis. Thus, a future study could be undertaken considering a multidisciplinary approach. The use of a team involving different stakeholders and members from a variety of backgrounds can considerably decrease the risk of bias in qualitative research since multifaceted perspectives and opinions can be taken on board in several stages of the investigation process (e.g. data collection, data analysis and final outcomes' presentation).

• Comparative analysis using the proposed model

A future study can be conducted using the design-led future forecasting model in a comparative basis considering distinct geographical markets. For example, a handset manufacturer operating in a mature market (e.g. UK) and in a developing economy (e.g. Brazil), can use the proposed model to explore the particularities of each country. Since they present different market conditions comprising political and economic issues; users' preferences and segments; landscape phenomena and a 'local' wireless industry structure (including players such as service providers and third party suppliers) their dynamics are different. As a result, the forecasting model can assist the manufacturer's design research team to explore the unique

characteristics of each region, supporting the researchers to propose tailored future solutions that are more aligned with each country's market peculiarities.

• Exploring a different sector applying the model foundations

Considering a different perspective, a future study can be conducted applying the model's basic foundations and ideas to investigate a different context or sector such as the automotive industry. To address this new business area, adaptations and changes in the original framework should be done. For example, renaming the dimensions (e.g. 'automotive' instead of 'wireless' industry); populating them with relevant information (e.g. trends in the automotive sector; consumers' driving experience factors; naming the key experts in this industry and the major players, strategies, products and services) and reorganizing the model's structure (e.g. arrangement of inputs, links and associations across the different clusters). Finally, the practicalities of this 'design-led future model for automotive sector' can be tested and evaluated considering a theoretical; practical or a combination of these two approaches.

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