Centre for Technology Management working paper series
ISSN 2058-8887

No. 6
October 2015

A HIGH IMPACT FRAMEWORK FOR ACCELERATING INNOVATION

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Biographies

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Robert Phaal is a Principal Research Associate at the Engineering Department of the University of Cambridge. His current research interests are strategic technology management, roadmapping, and the development of practical and well-founded tools to support technology strategy and planning. Rob is a Chartered Engineer, with a PhD in Computational Mechanics from the University of Cambridge, with industrial experience in technical consulting and software development.

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Acknowledgements

The authors gratefully acknowledge the contributions from several colleagues to shape this work, in particular Clare Farrukh and Imoh Ilevbare, whose comments and feedback we found most helpful, and Margarita De la Fuente whose guidance regarding *de Bono thinking* approaches was insightful. We would also like to thank all individuals in organisations that have allowed us to work with them and have facilitated valuable insights for this research and development. We look forward to strengthening these relationships and working together on future research and practical application.

Contents

Executive summary

In a context of intense competition, severe market disruption, and a changing and increasingly competitive global business environment, innovation becomes indispensable. To be successful an organisation must recognise this imperative and an appropriate innovation system should be put in place to support and extend its strategy. However, this is easier said than done. Numerous challenges and barriers are presented to any organisation that tries to innovate, for both established and young organisations.

Many innovation approaches have been developed, addressing innovation challenges to a greater or lesser extent. However, the subject remains highly fragmented in terms of frameworks, models, methods, techniques and tools, which makes the job of practitioners a difficult one. A 'universal' framework is envisioned, which can address innovation challenges effectively and can be applicable to organisations of different types, situated in different contexts. The current status of its development is described in this document.

The framework is called the 'High Impact Innovation Framework For Innovation' (HiFFi) principally because it is intended to support organisations develop and sustain holistic innovation programmes or 'Strategic Innovation Systems' to identify and generate high impact business opportunities and ideas, and transform them into purposeful innovations that create significant value for all stakeholders. HiFFi has been designed to be applied in a flexible, agile, modular and scalable manner, so that it can be accessible to a wide range of organisations and can respond to needs and changes in the internal and external environment quickly and nimbly. The HiFFi framework consists of a set of *principles*, *enabling elements*, *subsystems*, and a *visual management space* (the 'Touch Room').

The *principles* set out the fundamental 'philosophy and rules' under which a HiFFi system and tools should be configured, integrated and applied. The *enabling elements* comprise organisational characteristics that are conducive for an innovative and effective internal environment, and its interaction with the external environment. The *subsystems* comprise collections of resources and tools that are deployed in an adaptive manner, and which interact together by way of driving activities along the innovation journey. The 'Touch Room' is intended to be a people-centred space where collective perception, thinking, decision-making and action are continually promoted and accelerated towards aims with the aid of visual devices/tools such as wall charts and templates. The preferred mode of engagement is facilitated workshops involving participatory processes that incorporate multiple perspectives (e.g. technical and commercial) and structure dialogue through visual representations.

The core device of a HiFFi system is a Roadmap, providing a focal point for strategy and innovation activities, and an integrative framework to which other management tools can readily connect. The Roadmap provides an up-to-date visual representation of strategy in a single chart that seeks to lay out key aims, the means that will be used to deliver them through time, and any required resources. The HiFFi approach aims to articulate a 'complete solution' for strategic innovation management, thus, its design also incorporates 'best of breed' features from both established and progressive approaches that have proven their value (e.g. Stage-Gate, de Bono Thinking, Design Thinking, Lean Startup, and Agile Development), and facilitates the integration of tools/toolkits that such approaches provide. The recommendation is to start with a small set of generic core tools that can be customised to fit a specific purpose along an innovation journey, iterating fast, incorporating more tools as maturity increases and knowledge is acquired.

1. Introduction

The importance of strategic innovation continues to increase in prominence each year, especially in the uncertain and competitive world of today (Cooper & Edgett, 2009; Goffin & Mitchell, 2010). The role that innovation plays in the survival and growth of new ventures and established organisations, and the consequent impact on regional and national economic success, is understood and accepted. More than ever, managers and practitioners of all types of organisations need management approaches to support agile decision making and action (Birshan et al, 2014; Koller et al, 2014). They are faced with hard decisions concerning how best to allocate resources in a context of changing opportunities and demands, and time and resource constraints (Andrew et al, 2009).

It would be desirable to have an effective and efficient innovation approach that can support managers in the context of their own organisation and industry (e.g. de Jong et al, 2013). However, this is challenging because it represents a state of excellence in managing uncertainty and risk according to specific needs; in making sense of what is important, feasible and viable; in dealing with the complex web of internal and external resources and interactions; in enabling a fertile ground for all activity; in managing the inherent contradiction between exploring and exploiting; and in promoting continuity and a long term perspective.

Many management approaches have been devised and applied through time, achieving different rates of adoption and success. However, the basis of the subject is fragmented, making understanding and application difficult for stakeholders, who have different backgrounds and needs and act in different contexts. This results in several issues that present opportunities to improve the discipline of innovation management. The aim of this research is to contribute to alleviate these issues by facilitating a flexible 'universal' framework that can readily be configured and applied by a wide range of organisations and stakeholders around the world (rather than a 'one size fit all', 'off-the-shelf', 'ready-to-use' solution), and can guide the development of the strategic innovation capabilities over time with a strong foundation. The current situation and issues that give rise to this opportunity are discussed below.

1. Innovation models or reference frameworks are either too abstract and daunting to be applied, or practical but too specialised, incomplete, disjointed and/or underdeveloped in some areas. In either case, practitioners are confronted with the challenging task of integrating disparate management frameworks, methods, processes, techniques and tools[1] with little or no guidance, and to develop new approaches in order to form their own 'complete solutions'. For example, there are approaches focused on creativity, such as Lateral Thinking (e.g. de Bono, 1990; Myers & Thompson, 2007), CPS (e.g. Isaksen & Treffinger, 2004) and TRIZ (e.g. Altshuller, 1994; Savransky, 2000). Others have been designed to address the needs of a particular type of project or organisation. For example, approaches for entrepreneurial ventures typically immersed in a highly uncertain technical and market environment, such as Customer Development (e.g. Blank, 2013), Lean Startup (e.g. Ries, 2011) and Lean Canvas (e.g. Maurya, 2012); and others that focus on social projects, such as Human-Centred Design (e.g. IDEO.org, 2012, 2015). In most cases the role of some key elements of an innovation system are ignored

[1] A management tool in this context refers to practically applicable devices that support techniques, methods and processes that intend to link technological resources and organisation objectives (Keltsch et al, 2011). See Figure 1.2 for an example. Further explanation can be found in Section 2.1 (Definitions).

or weakly covered, such as strategy, leadership, team structure, culture and partners. As the analysis of some authors corroborates, no approach can claim to be fully comprehensive, covering all needs (e.g. du Preez, 2008). Even the most adopted innovation management approaches, such as the Stage-Gate™ process, are now being criticised as having considerable limitations (e.g. Lenfle & Loch, 2010; Cooper, 2014), especially in today's fast-changing and uncertain environment.

2. The number of management tools available to facilitate the practical application of activities and decisions along the innovation journey are vast and the effective use of this resource is not straightforward (Kerr & Phaal, 2015a). For example, Phaal (2006a) identified many tools of the '2×2 matrix' type, of which approximately 40 were classified as strategic portfolio tools, at innovation and business levels. Of these, 60% were instances of a single generalised 'OxF' form – Opportunity (or impact / value / benefit), set against feasibility (inverse of difficulty / effort / risk). The other 40% were interesting – supporting portfolio-level thinking and decision-making, for example balance, dependency, synergy and tradeoffs. The general OxF form can then be translated from one context to another, configured to purpose and integrated with other tools and processes and systems.

3. There is little consistency in the definition and use of representations and approaches, which makes comparison and adoption difficult. As identified by Phaal et al (2006a), a number of related terms are used in various ways by different management authors and practitioners, with little rigour or consistency. Koen et al (2001) faced this challenge when examining innovation processes across several companies: "Comparing one company's processes to those of another proved insurmountable because there was neither a common language nor clear and consistent definition of the key elements of the front end".

4. The proliferation of tool variants and the lack of consistency in their definition and use also impose challenges regarding the arrangement, configuration and integration of tools and toolkits to support innovation processes seamlessly. Conceptual representations such as frameworks, maps and models as well as different kinds of practical approaches such as processes, methodologies, techniques and other methods are often treated in isolation and considered to be 'tools' (e.g. Koen et al, 2002; Whitney, 2007; Dornberger & Suvelza, 2012).

The vision for a 'universal' framework implies flexibility but also complexity to some extent. Thus, a pragmatic suggestion is to start with a basic approach so that practitioners get used to the functionality and the concept behind it before more functions are incorporated (Keltsch et al, 2011).

An advantage of a small complementary set of core generalised frameworks and flexible tools is that they provide a good starting point for many strategic situations and contexts (Kerr and Phaal, 2015b) – see Figure 1.1, for example. This approach is designed to counter the trend towards tool proliferation, typified by titles such as "Key Strategy Tools: The 80+ tools for every manager to build a winning strategy" (Evans, 2013). All of those 80+ tools may be interesting and useful, but how do they relate to each other and adapt to fit the organisational context to build a management process and system?

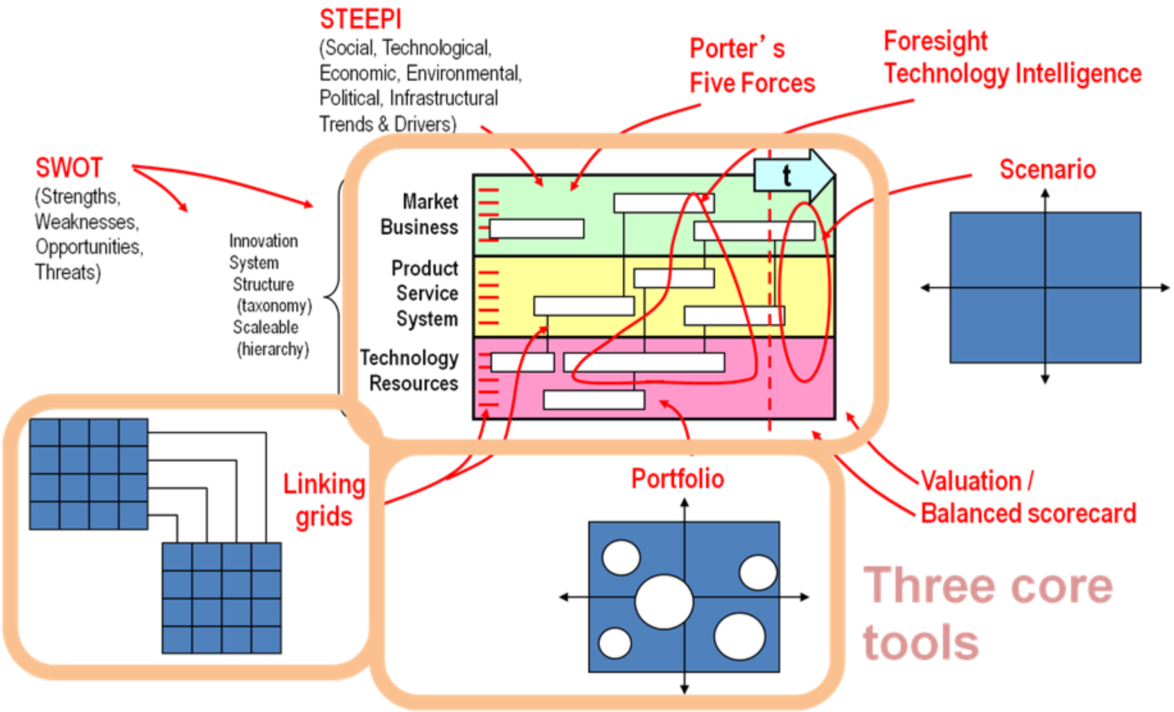

Figure 1.1 Example of a small set of flexible tools.
Source: Adapted from Phaal et al (2005).

Thus, although in theory a wide range of management tools could be configured and 'plugged in' to an innovation system, any additional tool should be integrated only if it has the potential to deliver better results and can be neatly synchronized with the dynamics of the particular business setting. In order to ensure this, a rigorous process to manage the tool lifecycle should be used (e.g. Keltsch et al, 2011), from understanding the event or situation triggering the need for an additional tool, to its application and improvement, in order to reduce problems associated with the suitability and usability of the tool.

The combination of generalised conceptual frameworks and agile application techniques enables a responsive approach for developing innovation and strategy management toolkits and approaches (e.g. see Figures 1.2, 1.3 and 1.4). As a rapid prototyping approach, the first step (diagnostic) represents a low risk (effort) step, to enable the methods to be piloted and adjusted in response (Farrukh et al, 2014; Kerr & Phaal, 2015b). Following the principles set out by Kerr et al (2013) for strategic management approaches, "the preferred mode of engagement is facilitated workshops with a participatory process that enables multiple perspectives and structures the conversation through visual representations in order to manage the cognitive load in the collaborative environment".

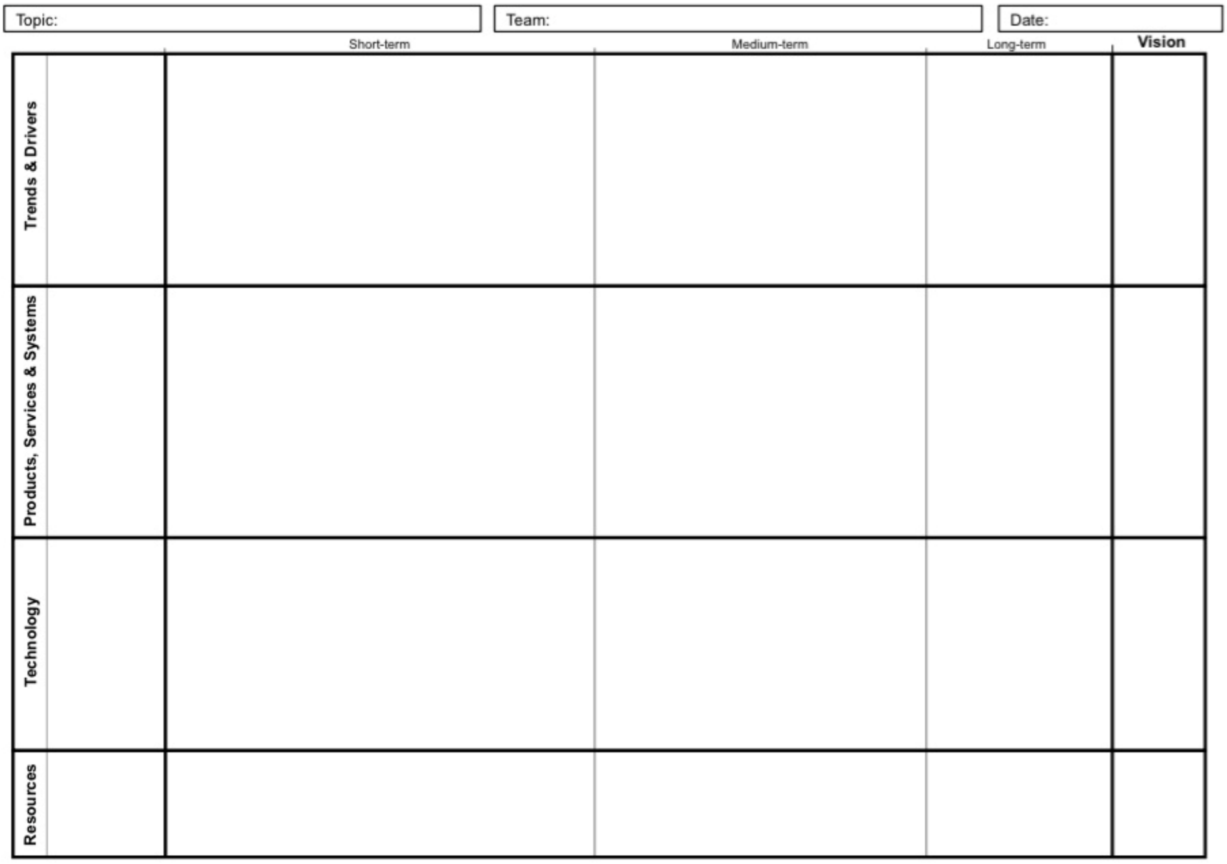

Figure 1.2 ‘Classic’ roadmap workshop template.
Source Phaal et al (2007).

Figure 1.3 ‘Strategic landscape’ activity of the S-Plan roadmap approach.
Source Phaal et al (2007).

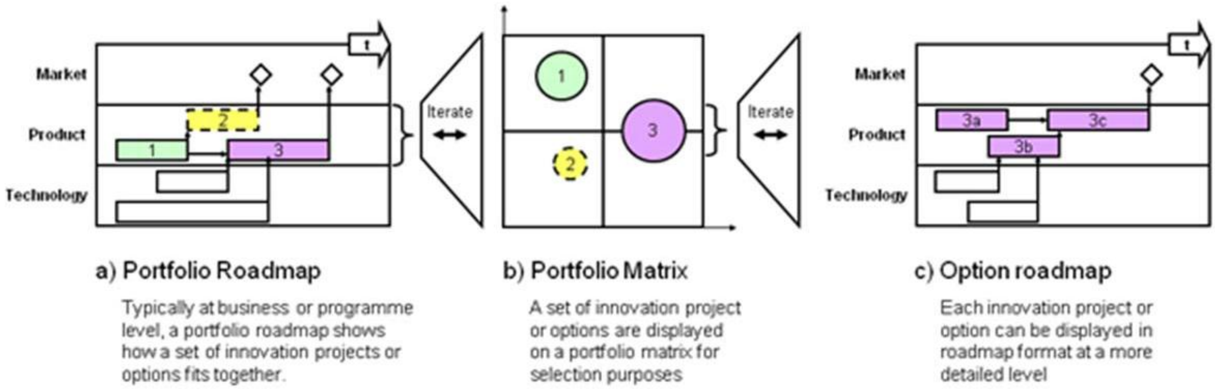

Figure 1.4 A 'light-weighted' Roadmap-Portfolio toolkit.
Source: Farrukh et al (2014).

1.1 Current work and aspirations

This document introduces a reference framework (HiFFi), as a step towards the vision of a 'universal' approach for strategic innovation management. Thus, it aims to set the stage for addressing the issues mentioned above, through the orderly development, testing, promotion and facilitation of a body of knowledge for the implementation of a strategic innovation system (SIS) that is holistic, flexible, adaptable, lean and agile, which not only increases innovation effectiveness but also accelerates its realisation while minimising costs. It is envisioned that the body of knowledge required to achieve this ambition will encompass various aspects as the system is developed, such as:

- Adaptable process templates extracted from 'good' industry practice that might develop into a significant shareable resource.
- Core tool templates (e.g. roadmap) and toolkits that are purposeful and easy to configure, integrate and use.
- A common language and definitions of key terms and concepts, and increasingly intuitive mechanisms that best facilitate the realisation of outcomes (e.g. 'self-facilitating' management tools – Phaal et al., 2015).

As an initial stepping stone to this endeavour, a set of framework elements and principles, as well as project design considerations, are proposed and exemplified in this document so as to facilitate an understanding of how to define and configure a fast start or entry point and subsequent innovation activities. Although the core device (i.e. roadmap) embedded in the framework, as well as other tools exemplified in this document, are well established in industry and academia, testing will be necessary to establish that all the pieces of the framework (e.g. methods, procedures, techniques and tools) work together and deliver desired outcomes in a variety of real world contexts. Thus, the body of knowledge is expected to accumulate as a result of lessons learned from future research and development, as well as real world implementation.

The proposed 'HiFFi' (High Impact Framework for Innovation) framework combines concepts from well-established models and also from state-of-the art and progressive approaches identified through literature review, specialised training, and practical experience in various industrial settings. This is a multidisciplinary endeavour, reflected in the literature review, incorporating a variety of disciplines and areas, including entrepreneurship, creativity, design, strategy, innovation and technology management, organisational development, and systems theory.

The framework seeks to support managers and practitioners in all types of organisations to deal with the challenges associated with innovation in today's competitive, fast-paced, changing and uncertain world. The scope of potential application ranges from new entrepreneurial ventures, to small and medium sized organisations, to large mature enterprises, to improve and accelerate their activities and outcomes.

Although the holistic and systems-oriented design of the framework is presented in Section 2, including a real-world case of an assessment based on the framework, this document mainly focuses on 'process' aspects, as it is here that value is actually explored, developed, realised and improved. Innovation processes enable transformation of understanding of the environment into ideas/opportunities, and these in turn into products, services, capabilities and business models that can lead to impactful results (e.g. high financial growth). They facilitate the 'orchestration' of all the other elements and resources to make it happen. In order to exemplify this in the context of a HiFFi system, another two real-world cases in different contexts and stages are described in Section 5. The cases expose key innovation challenges and illustrate how they *could have been* better addressed through the practical customisation of an adaptive and accelerated process, enabled by visual and social settings and integrated toolkits.

1.2 Structure of the document

Building on the introduction above, the Section 2 introduces several important themes. Foundational terms are defined, with 'management tools' established as the most basic devices for practical implementation, related to other forms of practical approaches (e.g. techniques, procedures, functions and processes). Key innovation challenges are described, as well as a high-level view of the HiFFi framework. It is suggested that in order to address these challenges, the framework should provide: a) a set of *principles* that guide assessment, design and application of a HiFFi Strategic Innovation System (SIS); b) a framework to support understanding, development and manage the *enabling elements* of an SIS according to context and needs; and c) guidelines for a visual management room ('*Touch Room'*) intended to facilitate SIS interactions and outcomes. Although this section provides an overview of the components that can potentially make HiFFi an holistic system, and provides a short case to illustrate an innovation capability assessment, it should be recognised that further research and development will be needed to fulfil the vision, as is discussed in the previous section. Most research and development work to date has focused on 'project processes', which is represented in the framework as one of the enabling elements. This element is considered to be key for driving value creation by bringing other elements and resources together to produce outcomes, which is achieved through the deployment of subsystem functions/tasks designed in a purposeful, agile and adaptive manner.

Section 3 is comprised of four parts. The first discusses general representations of an innovation system from a macro perspective along an innovation cycle, from the identification of opportunities to the introduction of an innovation. The traditional funnel depiction is shown and depicted in the context of HiFFi, where two development variants are considered: an early technology development funnel and an application-oriented innovation development funnel. The second part describes a HiFFi staged model that supports the management of uncertainty and risk by making decisions, at both portfolio and project levels, based on observation and experimentation rather than detailed upfront planning (Satpathy, 2013; Maurya, 2012; Ries, 2011; Cooper, 2014). This approach combines key features and benefits of well-established approaches such as Stage-Gate, as well as of other modern approaches such as agile development, design thinking and the lean start-up approach. The third part presents the HiFFi subsystem framework, which serves as practical guidance to operationalise the identification/generation of opportunities/ideas in an SIS and to design/manage a particular 'project process' in order to transform an opportunity/idea into an innovation. The framework is designed to flexibly govern the configuration and arrangement of tools to fit the purpose, enabling an arrangement to be swiftly adapted as new knowledge or unexpected events emerge along the innovation journey. Finally, three distinctive aspects of HiFFi are introduced that are common to all projects with regard to tool/toolkit configurations: divergence-convergence cycles, thinking modes, and enabling elements.

Section 4 describes each of the seven subsystems of the HiFFi framework in detail: *Orchestration*, *Investigation*, *Generation*, *Understanding*, *Evaluation*, *Implementation* and *Value Capture*. An account of their purpose, functions, thinking modes, and some of the associated tools and techniques, is provided. The role of the roadmap tool, as a focal device is explained, acting as the central hub to integrate and synchronise knowledge in a HiFFi system, along with two supplementary tools: the project brief and the experiments board.

Section 5 illustrates how the HiFFi framework supports diagnosis and design of project processes and tools/toolkits. Since the front end of innovation represents a key area for success, understanding and mapping its logic in a HiFFi context (e.g. starting points, types of activities and typical flows) is important – particularly the selection of a starting point, not only in terms of activities but also of the tool(s) enabling them. In order to facilitate this guidance, an established model of the front end of innovation, the NCD model (Koen et al, 2002), is used as a reference to derive a model that can support the definition of a starting point within the HiFFi logic. The potential flexibility and utility of HiFFi is demonstrated by presenting and analysing two short cases of entrepreneurial ventures in different contexts and stages. For each case, a diagnostic based on the HiFFi framework was carried out, to establish how the case might have been, had the HiFFi system been used, to illustrate the process, and as a thought experiment to explore its applicability, merits and challenges. One case, presents a scenario where a team of inventors is attempting to find routes to market for a technology originating from university applied research (i.e.'technology push' situation). The other presents a scenario where an entrepreneur's vision drives the efforts, based on presumed market needs (i.e. 'market pull' situation).

Section 6 reviews the current status of the HiFFi system. Although significant progress has been made, especially in the area of project processes, important challenges lie ahead. Several milestones have to be achieved on the way towards the vision of a universal framework, which include validation of the system as a whole, adoption by a set of organisations in different industries and contexts, and development of a community of practice.

Section 7 concludes with a brief discussion of the way forward, indicating a need for further research and development. Key areas that require additional research include some enabling elements of the framework (e.g. structures and culture), the visual management 'Touch

Room', and the experimentation approach in HiFFi. This should can carried out in parallel with the testing of the current framework in a range of contexts, such as corporations, small and medium businesses, start-ups, supply chains and networks, and pre-commercial university applied research. As more progress is made, practical guidance could be developed and made available to potential users of HiFFi. A virtuous cycle of development can potentially be established with the support of academic and industrial communities. However, initial traction will have to be achieved and basic systems must be put in place so that knowledge can be generated and shared, and improvements made, developing a community of practice.

2. Strategic Innovation System framework ('HiFFi')

From a theoretical perspective, the HiFFi framework supports understanding of the key generic elements ('enablers') that are necessary to develop and sustain the strategic innovation capability of an organisation, including the necessary interplay between and within them, as well as with the external environment, in order to achieve the organisation's vision and goals. From a practical perspective, it provides the basis for conducting assessments of these elements (e.g. maturity levels), guiding their configuration, development and management within the context of a Strategic Innovation System (SIS).

Figure 2.1 shows a high-level view of the holistic system framework, which is comprised of the external environment and six enabling elements: *strategy*, *processes*, *structures*, *people*, *culture* and *networks*. The role of the 'processes element' to drive the creation of new sources of value is highlighted by expanding it into a model with seven subsystems that provide the functions to make all system elements interrelate and interact to achieve outcomes. Unlike a traditional fixed and linear sequence, the behaviour in a HiFFi system is intended to be flexible, non-linear and iterative, where activities in the processes are configured and triggered on a 'needs' basis, according to strategic drivers and emerging information and events. This behaviour is represented through a model with a central subsystem configuration that orchestrates and supports the dynamic interaction between the subsystems of the SIS, thus, the interplay between perception, thinking, decision-making and action.

At this level, the framework represents a generic representation that can be used to obtain a 'snapshot' of the current situation of an organisation in terms of its particular internal and external context. Every element in the snapshot represents a 'state' that is a consequence of the current system configuration (e.g. of the enterprise and the SIS configuration), which is susceptible to development and fine-tuning according to changing environment and strategic demands over time.

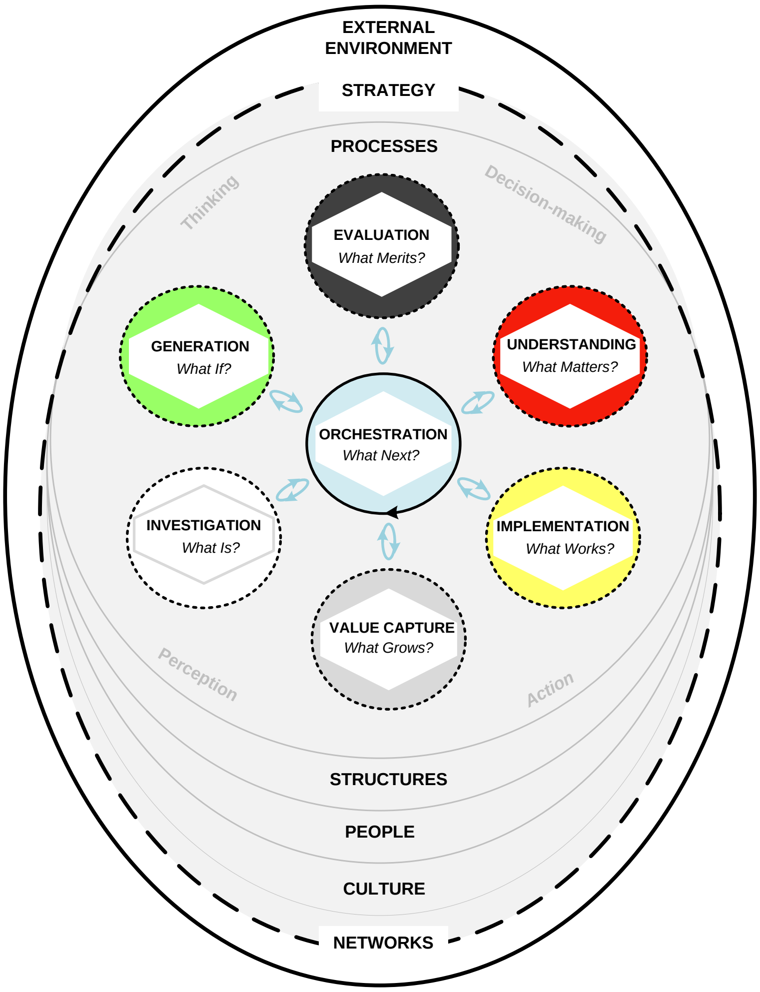

Figure 2.1 HiFFi system framework with six enabling elements, expanding the 'processes element' to show the dynamic interaction between the subsystems of the SIS so that everything is brought together to produce outcomes.

2.1 Definitions

Before describing the framework in more detail, it is worth reviewing what it is meant by some key foundational terms. This will ensure consistency in the use of terms and facilitate a common basis for configuration, integration and application of components of a HiFFi system, as well as for benchmarking with other organisations (when possible and convenient for the parties in the future).

In HiFFi, the most basic device for practical implementation is a management *tool* (Shehabuddeen et al, 2000) – see Figure 2.2. As in other related management approaches (e.g. Phaal, 2012), *processes*, *procedures* and *techniques* guide the use of the *tools* in a *system*, governed by an underpinning conceptual *framework*. These interrelated approaches are defined as follows:

A *framework* supports understanding and communication of structure and relationship within a system for a defined purpose (Shehabuddeen et al, 2000). The HiFFi framework was designed to facilitate the development and sustainment of a Strategic Innovation System (SIS) in an organisation.

A *system* is a collection of interrelated parts (elements and resources) that work together by way of some driving processes (Pidwirny, 2006). An SIS is a holistic system that allows an organisation to continuously understand its current reality, environment and customers, explore emerging futures, and use the insights gained to identify high impact business opportunities, as well as to generate, prioritise and implement new ideas and concepts with the purpose of capturing significant value from the resulting innovations. A HiFFi system is an SIS based on the HiFFi framework and principles.

A *process* in the context of a HiFFi system represents either a continuous or a finite arrangement of value-creating tasks/activities (for learning or execution). A continuous process is related to the 'routine' activities of the SIS (e.g. market and technology surveillance, and system 'health' check/audit/assessment), while a finite process is related to the 'non-routine' activities of a specific opportunity (i.e. innovation project). The latter delineates the *immediate path planned*[2] in a transformation cycle from 'opportunity-to-innovation'. Since innovation is a complex and uncertain phenomenon, especially when pursuing radical and disruptive outcomes in a fast-changing environment, the design of a fixed end-to-end 'value chain' of activities is not suggested (nor would it be realistic). Instead, evolutionary depictions that allow for fast adaptation are used. In Section 3, the term 'project process' is introduced and used to emphasise the finite nature of this type of process, as well as its dynamic and unique creation.

A *function* is a purposeful operation of a subsystem that is carried out as part of a process and is intended to produce a specific outcome.

A *procedure* is a means to operationalise functions through concrete tasks/activities of perception, thinking, decision-making and action. It is comprised of a series of 'steps' (or 'micro-sequences') configured to achieve outcomes efficiently. In a collaborative environment (e.g. workshops), flexible steps may be used in order to maximise the cognitive, social and emotional benefits given the constraints in time, people and other resources. These steps may include tasks/activities such as clarifying aims, performing a function, sharing ideas and feelings, reflecting on the experience and outcomes, capturing learning points and information/knowledge gaps, and deciding on the next step and responsible people.

A *technique* is a structured way in which a particular function or task/activity is performed. Several complementary techniques may be used to carry out a procedure. These techniques may include from general purpose techniques such as facilitation techniques used in workshops (e.g. *Clustering* [Tassoul & Buijs, 2007] for making sense of information, *Six Thinking Hats* [de Bono, 2000; Myers, 2012] for ensuring focus and efficiency of collaboration, or *Storytelling* [Hensel, 2010, The Ariel Group, 2011] for engaging people) to more specialised ones such as *Roadmapping* techniques (e.g. Phaal, 2010) for aligning markets, strategy, products and technology.

A *tool* supports decision-making (Kerr et al, 2013) by facilitating the practical application of one or more techniques (Shehabuddeen et al, 2000) that intend to link technological

[2] It represents what Ilevbare (2013) describes as "concrete plans [tasks/activities] extended into the future in relatively short bursts, only as far as available knowledge allows".

resources and organisation objectives (Keltsch et al, 2011). In the case of workshop-based activities, tools are typically represented in the form of structured templates or wall charts, which participants interact with using repositionable notes and pens (Kerr et al, 2012). These charts are supplemented by simple electronic representations (e.g. presentation slides, word processing documents and spreadsheets that are projected or distributed as handouts). Thus, a tool makes techniques tangible and enables them to perform functions guided by a procedure that steers participants towards the subsystem outcomes.

The HiFFi framework was designed to allow the configuration and integration of tools and toolkits appropriately and efficiently as well as the development and setup of the conditions and resources that enable their application (e.g. structures and people). This way subsystems can be operationalised and interconnected, bringing elements and resources together, facilitating their interaction, and giving life to a productive and evolving HiFFi system.

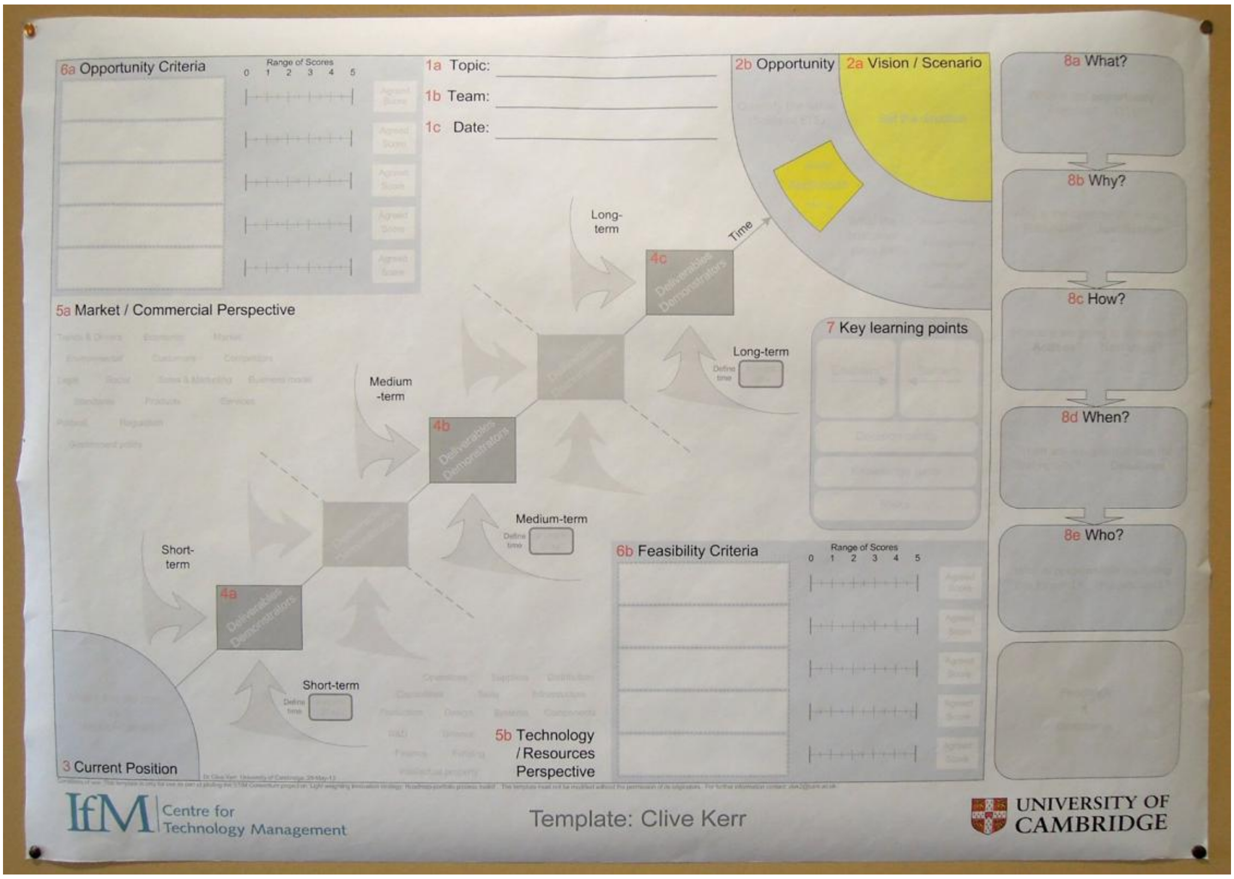

Figure 2.2 Example of a management tool: Opportunity exploration roadmap (workshop template). Source: Farrukh et al (2014).

2.2 Challenges

The HiFFi framework has been designed to develop and sustain strategic innovation systems that address key innovation management challenges according to a number of interrelated themes:

Complexity

Effective innovation requires the orchestration of a complex web of components and interactions (internal and external). HiFFi allows the customisation and combination of the necessary tools and resources to carry out all functions of the SIS in an orchestrated manner. To facilitate this, it uses *roadmapping* (Phaal et al, 2010) and other techniques in a collaborative and visual setting (the HiFFi 'Touch Room' explained in Section 2.5), which provides the necessary structure and supports communication.

Opportunity and feasibility

Successful innovation requires making sense of what is needed by the market, what is important for an organisation, and what is feasible and viable to develop. HiFFi uses the roadmapping approach as a core integrator device, which ensures alignment of market and organisational needs with resources and technology knowledge over time, supporting strategic thinking and decision making (Phaal et al, 2010). Continued cross-functional and multi-disciplinary collaboration is facilitated by a 'Touch Room'.

Ambidexterity

The process of innovation requires managing the inherent contradiction between exploiting and exploring (Reeves et al, 2013). Challenges in this theme are especially significant for established organisations (O'Reilly & Tushman, 2004; Smith et al 2010). On one hand, organisations need to cut costs and drive efficiencies in their current business operations and on the other, they need to learn how to create new business avenues so that growth can be sustained. HiFFi integrates key enabling elements that guide the acquisition and development of the right structures and mindsets, as well as the configuration and integration of engaging spaces for creation and learning, such as the 'Touch Room'.

Fertility

Successful innovation requires a fecund ground in order to flourish, bearing in mind that the SIS is embedded in a larger system (or 'super system'): the organisation. There are a number of elements that have the potential to enable or inhibit strategic innovation (e.g. Cooper & Edgett, 2009; Goffin & Mitchell, 2010). HiFFi has grouped them in six generic and interrelated elements (strategy, processes, structures, people, culture and networks) that can be integrally assessed, developed and managed.

Uncertainty

Innovation is concerned with the future, which requires taking risks and managing uncertainty and change appropriately and continuously (Courtney et al, 1997, 2000; Bryan, 2009). This is important not only when planning with a long-term horizon where information is never sufficient and conclusive, but also when creating radically new products, services or businesses which pose conditions of extreme uncertainty (Ries, 2011). HiFFi allows the configuration and integration of tools for continuous surveillance and management of environmental, market and technology intelligence (e.g. Kerr et al, 2006; Mortara, 2010), as well as facilitates an experimentation and user-oriented approach that enables transparency, inspection and adaptation (Satpathy, 2013), especially useful in the case of radical or 'new-to-the-world' solution development.

Speed

Innovation in today's world requires accelerated processes and agile decision making, especially in fast-paced industries (Bascle, 2012). HiFFi enables increased efficiency and effectiveness by incorporating a lean, agile and experimentation philosophy, techniques and tools. Team focus and engagement as well as constant user/customer feedback and facts are instrumental in avoiding waste and creating value fast (Sehested & Sonnenberg 2011; Ries, 2011). HiFFi enables these features by building on other approaches such as Six Thinking Hats (de Bono, 2000), Design Thinking (e.g. Liedtka & Ogilvie, 2013; IDEO.org, 2015), Agile Development (e.g. Satpathy, 2013) and Lean Startup (Ries, 2011; Maurya, 2012; Blank, 2013). It also provides a way to nimbly apply unique configurations of tools that enable activities both in a series or parallel fashion as needs and context demand; and allow evaluation points (or 'gates') to be flexibly configured and integrated with strategic portfolio management.

2.3 Principles

The HiFFi framework was designed to address the challenges of innovation in a number of ways, drawing on a set of underpinning principles (see Table 1) that collectively guide the design and application of a Strategic Innovation System (SIS) and its practical approaches.

The HiFFi principles stress the importance of focusing an innovation effort to strategic and shared aims (e.g. purposeful principle), and taking a complete and systemic approach to address them (e.g. holistic principle). An initiative should be designed according to the specific context and particular needs of an organisation (e.g. flexible principle) and carried out in a way that is not only effective but also efficient (e.g. scientific, lean and agile principles). And everything should be done in an engaging and rich learning environment (e.g. social and cognitive principles).

Although in general the term *efficiency* means making better use of resources (e.g. money, materials and time) and the term *effectiveness* means being able to achieve a desired result, it should be recognised that their meanings differ between an innovation perspective and that of production/operations. The common ground in both perspectives is to eliminate waste, that is, all that does not contribute to value creation; which is a core imperative of the *lean* approach originated in Toyota corporation, which led to improved effectiveness and efficiency not only in production environments but also in innovation (Ward et al, 1995; Sobek et al, 1999). Since then, some organisations have adopted lean approaches to improve their innovation processes. For example, Philips Shaving and Beauty (S&B), a high-tech business unit of the Dutch electronics company Philips (van der Duin et al, 2013).

Perhaps the most important difference between *lean innovation* and *lean production* can be appreciated by recognising that innovation is about 'learning' and that operations are about 'execution'. Value creating activities in innovation are those that contribute to discover who the users/customers are, what is of value for them, and how to produce and deliver that value; whereas in operations they are those that contribute to optimise and ensure the delivery of actual value to the customers; anything else is waste (Ries, 2011). When a valuable solution has become known and validated by a set of customers, the operational processes can take the 'front seat' in order to reproduce it and ensure its consistency.

Variation in routine operations is, by definition, non value-creating (i.e. waste) because the more accurate the solution can be reproduced, the better. In contrast, in an innovation process the end result is unknown to a greater or lesser extent so that flexibility is important. Thus, there is value-creating and non value-creating variation in innovation. On one hand, some variation is valuable as a necessary prerequisite for creating something novel. On the other hand, non value-creating variation such as making collaboration more difficult, creating misunderstandings and unproductive confusion represent waste and should be eliminated (Sehested & Sonnenberg, 2011).

			Principle	**Meaning**
← From a Macro perspective	← (Top-Down) Design	Goal	*Purposeful*	Strategic approach that allows alignment of stakeholders and innovation efforts towards high-impact goals.
		Features	*Holistic*	Complete approach that comprises all key elements, components and relationships (internal and external) involved to make it effective and efficient.
			Flexible	Modular and scalable approach that can be configured according to particular context and needs.
			Scientific	Empirical approach that seeks to uncover fundamental assumptions of market, business and technology and uses experiments to validate or change direction fast.
			Lean	Light approach that maximises value for stakeholders (user/customer and organisation) and minimises waste (non value-creating activities and resources).
			Agile	Iterative and concurrent approach that involves stakeholders and nimbly adapts in response to emergent knowledge, events and conditions.
		Setting (e.g. Touch Room)	*Social*	Human-centric, multidisciplinary and collaborative approach that facilitates interactions and engagement through field/desk and workshop settings that are visually instrumented and encourage reflection and contribution from all.
From a Micro perspective →	Application (Bottom-Up) →		*Cognitive*	Learning approach that allows for divergent-convergent virtuous cycles of perception, thinking and action conducing, as much as possible, to early, fast and inexpensive knowledge.

Table 1. HiFFi principles.

In HiFFi, the lean innovation approach is adopted and strengthened by the compatible agile and experimentation (scientific) philosophies. An agile development philosophy, developed by the software industry, highlights the importance of individuals and interactions, working products, customer collaboration, and responding to change quickly and nimbly (Beck et al, 2001; Satpathy, 2013). It uses short time-boxed increments in which a deliverable is something that can be continuously demonstrated to stakeholders (rather than documentation) (Cooper, 2014), which fits neatly with the experimentation approach that seeks to gradually validate with stakeholders the fundamental business assumptions behind an envisioned solution concept.

The HiFFi principles reinforce each other and are intended to provide a basis for setting up a lean SIS. Therefore, they must be applied in 'sync' in order to accelerate the learning needed for a timely and successful execution (i.e. to ultimately achieve a scalable and profitable business operation).

Since management tools play a key role in a HiFFi system, the principles have been designed to be compatible with those set out by Kerr et al (2013), which provide a conceptual underpinning for the development of practically relevant tools/toolkits, namely:

1. *Human-centric*: A tool should provide the opportunity for individuals to participate and engage with one another leading to a co-created solution which embodies their meaningful collaboration and generates a useful product from the result of their social interaction.
2. *Workshop-based*: The recommended mode of engagement for deploying/applying a tool/toolkit should be through workshops.
3. *Neutrally facilitated*: The workshop within which the tools are to be applied should be facilitated from a position of neutrality.
4. *Lightly processed*: The process for using the tools within the workshop should be applied in a lightweight manner based on the premise of 'start small and iterate fast' and also have a degree of flexibility by not being too prescriptive.
5. *Modular*: Toolkits should be built in a modular fashion with their constituent tools being readily integrated with one another (see Figure 2.3) and that the combined final output or product of using the tools should also be able to have a composite form (see Figure 2.4).
6. *Scalable*: the tools should have the ability to be employed at the different levels both within and surrounding an organisation. For instance, a tool should be able to be used at the firm level and then move up in scale to relate the organisation to the market/sectors or move down in scale to relate the organisation to its portfolio, products and technologies.
7. *Visual*: the tools should have a visual form for both their application (see Figure 1.2) and their resulting output (see Figure 2.4) with the ideal being a single page format.

In order to illustrate the integration and deployment of the seven principles above, Kerr et al (2013) provided an example (see Figure 2.5) drawn from an actual commercial engagement with a multinational chemical company: "This organization consisted of 19 business units with activities in 80 countries and annual revenues in the order of 15 billion Euros. The corporate strategy was to accelerate the growth in revenue to 20 billion Euros by 2020. One of the business units was given the target of increasing its revenue by 1 billion Euros, of which half would come from growth in existing markets and the other half from new markets. The toolkit shown in Figure was deployed to develop a plan for this business unit to achieve its growth target across their 14 value streams. The time horizon out to 2020 equated to four cycles in their new product development process".

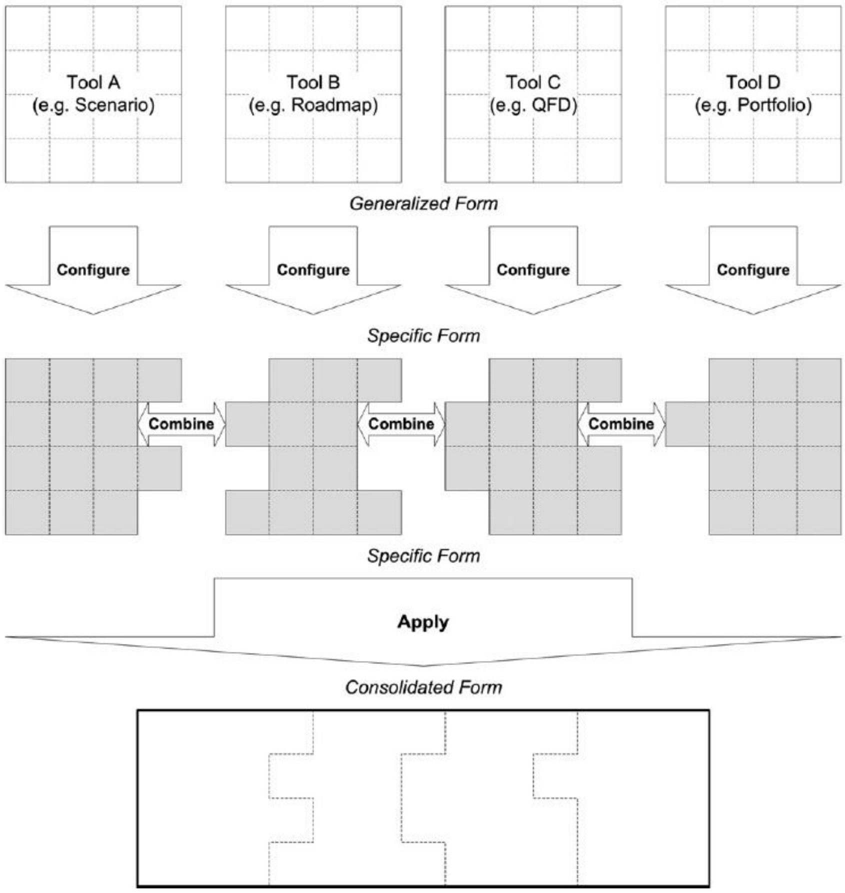

Figure 2.3 Modular toolkit. Source: Kerr et al (2013).

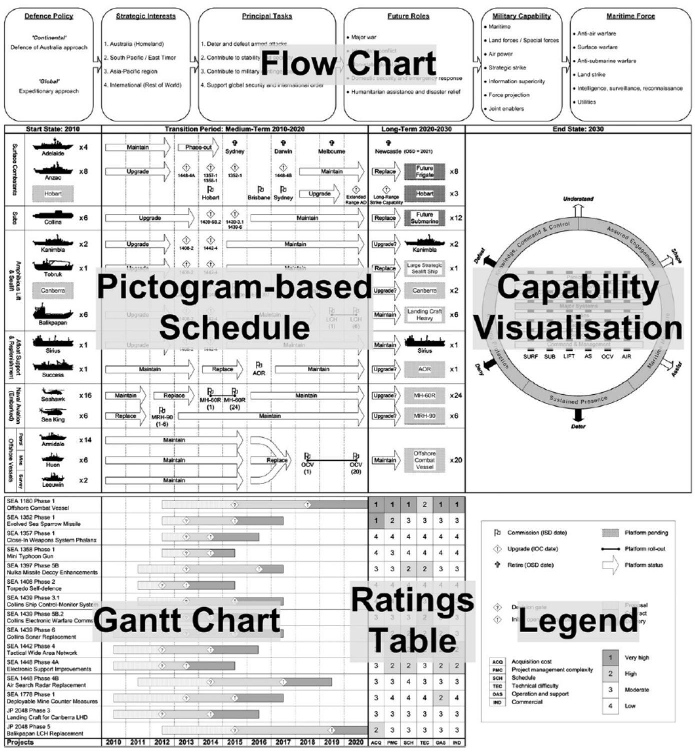

Figure 2.4 Modular visual output. Source: Kerr et al (2013).

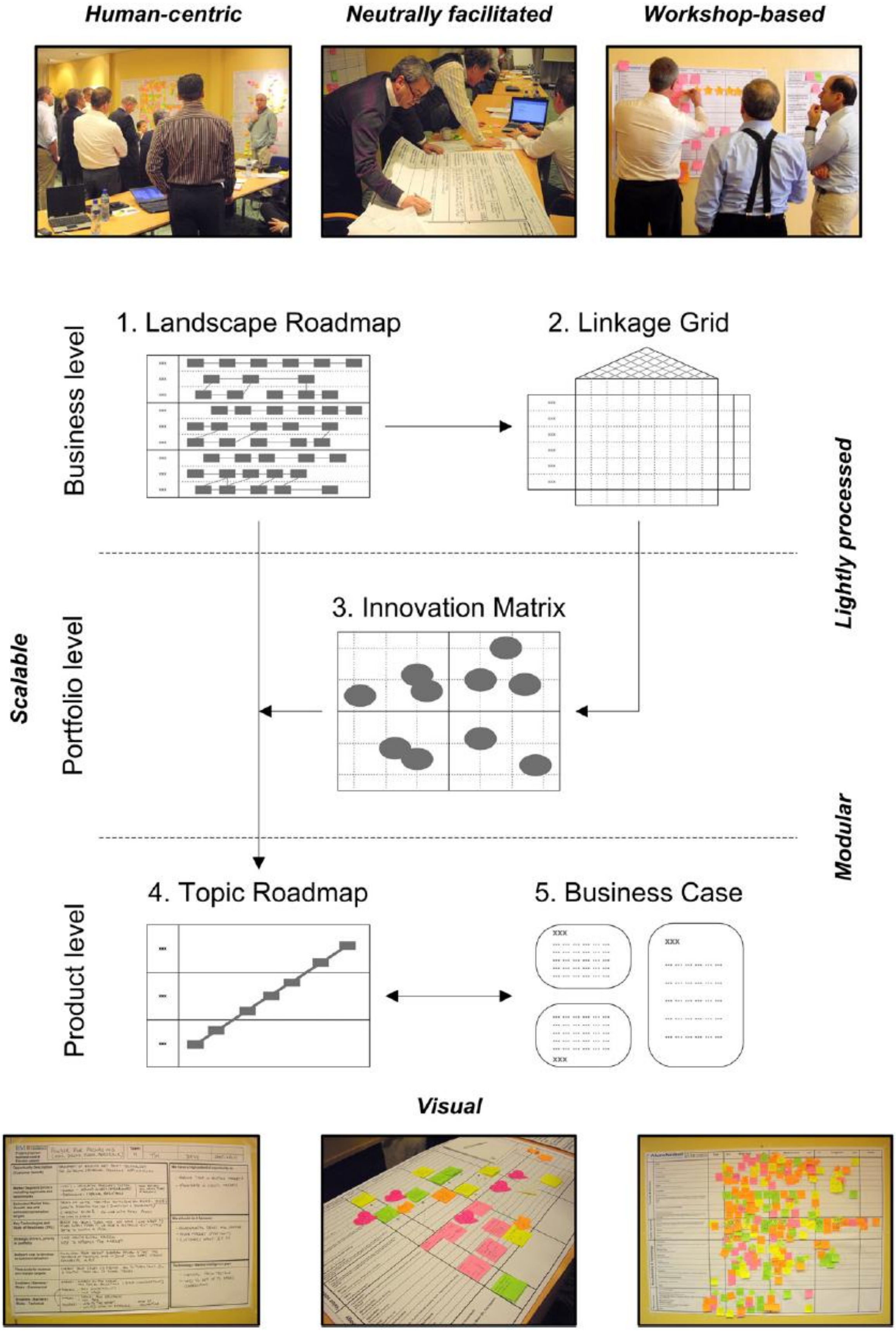

Figure 2.5 Example of integration and deployment of tool/toolkit principles.
Source: Kerr et al (2013).

2.4 Enabling elements

All the elements depicted in the framework (see Figure 2.1) need to be regularly assessed and tuned accordingly (e.g. changed or further developed) in order to manage the innovation challenges appropriately and to achieve the strategic goals. Each of the elements is briefly described below and a brief example of an assessment is also provided.

Strategy

The strategy element of the HiFFi framework is concerned with innovation strategy in the context of the overall business strategy that it supports or in which it is embedded. Innovation strategy determines broadly what is to be done (including where and when) to fulfil the vision and aims of the organisation (Cooper, 2009; Goffin & Mitchell, 2010). In general, the strategic intent is driven by the needs of customers combined with the demands of investors for growth and profitability and the requirements or ambitions of other stakeholders. Transparency on this allows leadership to allocate resources to the total and individual innovation efforts through a portfolio comprised of the right areas and development projects. Thus, the strategy element gives purpose to the SIS, shaping and influencing all the other elements, which in turn influence the strategy over time through feedback mechanisms.

Processes

The processes element of the HiFFi framework is concerned with multiple SIS functions, and their links within the organisation and to the environment that are needed to achieve high-impact innovations. For organisations that aim to grow significantly in a sustained fashion, this element represents the systematic way of bridging the gap created by ambitious long-term goals (Johnston & Bate, 2003; Torres-Padilla, 2008). The functions of subsystems allow to define and carry out activities that bring everything together (other elements and key resources, including information technology), enabling the transformation of inputs (e.g. abstract knowledge in the form of opportunities, ideas and concepts) into outputs (e.g. embodied knowledge in the form of innovative products and services). Processes are actual deployments of subsystems in the form of innovation projects[3] or 'value-chains' that connect to: a) decision-making processes such as strategy and portfolio management; and b) support processes such as capital, workforce, acquisition, legal and project management; which might be necessary to develop and enable new value in the form of new or improved business models.

Structures

The structure element of the HiFFi framework is concerned with the way people are organised and empowered. The ways in which an SIS and business operations are arranged are usually different, so they represent fundamentally different ways of working. To the extent that stakeholders recognise this phenomenon, an innovation development structure begins to realise its full potential (Clark & Weelwright, 1992). How successfully an organisation can implement its innovation projects depends significantly on selecting the appropriate structures, as well as on developing the necessary leadership skills within them (Goffin & Mitchell, 2010), and on sponsorship at a senior management level (O'Reilly &

[3] It should be recognised that, ideally, subsystems are previously deployed as a continuous/periodic activity of an SIS, which give rise to projects. For example, when continuously identifying and generating ideas that are evaluated and selected by appointed decision makers so that they can become formal projects.

Tushman, 2004; Reeves et al, 2013). Structures can be defined at system and project levels. At the system level, an innovation structure that helps to manage a stream of projects should be considered (e.g. innovation sponsor and manager, advisory committee, facilitator). At the project level, team structures of different types can be used in order to bring together different perspectives from a variety of areas and disciplines within the organisation, and even from external networks. Structures can vary from lightweight to heavyweight (cross-functional) and autonomous (or 'tiger'), or even virtual teams can be deployed depending on innovation strategy needs, each with its strengths and weaknesses.

People

The people element of the HiFFi framework is concerned with the emotional, social and intellectual 'assets' of people. These involves aspects such as motivation, style, knowledge, skills and experience. The character of an innovation system is largely determined by the interdependence of these assets. A good mix and interconnection of people allows teams to think and do the 'right thing' fast in novel situations (Weick & Roberts, 1993). Thus, the SIS should be supported by human resource processes to recruit, train, monitor and reward people in alignment with the innovation strategy (Goffin & Mitchell, 2010; Dornberger & Suvelza, 2012). Depending on the particular case, dedicated people in the right amount and profile should be allocated to lead and/or perform roles in structures and processes. Unlike a business operation that is typically associated with authoritative managers with an operational excellence track that rewards people for the achievement of margins and productivity (e.g. predominantly measured with quantitative targets), an SIS needs to select visionary leaders with an entrepreneurial spirit, and reward people for learning from failures and for achieving of milestones and growth (e.g. measured with both qualitative and quantitative targets), especially when more radical approaches to innovation are required.

Culture

The culture element of the HiFFi framework is concerned with the overall pattern of behaviour of people in the SIS as part of a greater organisation system. This involves aspects such as shared symbols, habits, norms, values, beliefs and assumptions that make it possible for individuals in the system to interpret and act upon their environment. Thus, it is important to understand how a culture has come to be what it is and how it could be changed if strategic aims are to be achieved (Schein, 1984). However, change may not be simple because culture often reflects the imprint of earlier periods in a persistent way (Marquis & Tilcsik, 2013). Additionally, the ideal 'ambidextrous' character of an organisation makes it necessary to deal with at least two broadly different 'sub-cultures': an innovative culture and an operational. While an operational culture typically values things such as precision, efficiency, low risk, control and quality, an innovation culture values things such as flexibility, novelty, risk taking, agility and experimentation.

Networks

The network element of the HiFFi framework is concerned with formal and informal collaboration links with outside organisations as well as with internal and external communities of practice. This allows organisations to fully explore and exploit their possibilities (Chesbrough, 2003). Generally the main motivations for creating these links are the better management of risk and uncertainty; the acquisition of particular resources and activities; and/or optimisation and economies of scale (Osterwalder & Pigneur, 2010). Formal collaboration links may range from simple subcontracts, through joint development projects and licensing, to joint ventures, equity participation and acquisition (Chatterji, 1996; Goffin & Mitchell, 2010). The more extensive a potential collaboration is, the more necessary to rigorously assess its strategic fit and potential conflicts (e.g. cultures integration). The influence that an organisation can exert is important. In a network, its position reflects and is a source of power and control imbalances (Tidd, 2001). Sources of power may include technology, expertise, trust, economic strength and legitimacy. Thus, the ability of an SIS to appropriately manage all aspects of collaborations overtime is key for value creation (Doz & Hamel, 1998).

Example - A SME organisation that commercialises and integrates software.

Let us consider the case of a real medium-sized organisation referred to as 'ITCo' in this document. ITCo is an Information Technology (IT) integrator company founded in 2002, specialised in software and related services for the telecommunications market. The company had a difficult start but managed to survive and eventually achieve a low but stable growth until 2009 when the company started to enjoy a significant growth in sales and profitability. However, by the end of 2014, the company started to experience a decline that made the top management team wonder how they could meet their ambitious goals in spite of the turmoil in the economic landscape in the region and the world.

The top management then turned to 'strategic innovation' as a possible means to improve the situation. An assessment (as a starting point) was conducted in order to understand their current state in regards to each one of the elements explained in this section. Individual interviews with a semi-structured questionnaire were conducted. A maturity scale from 1 to 5 was used to measure key aspects of each enabling element, based on generic descriptions of what each aspect on a particular level means (see Figure 2.6). The evaluation yielded some interesting results. A snapshot of its current state at that time can be seen through the assessment profile shown in Figure 2.7. A brief description of the results can be summarised for each element as follows:

– *Strategy*. ITCo had a low differentiation in its commercial offerings, which were based on third party software and professional services for support and implementation. The software products were mature and competition was mainly on the basis of price. Although the professional services had an important weight on buyer's decisions and the organisation maintained a strong position there, its growth had depended historically on sales driven by software products. There was no formal innovation strategy in place yet and a significant growth was expected in the long term. Some managers had recently started to understand innovation as a means to fulfil the expectations of the stakeholders and had recently started some innovation initiatives. However, such explorative capability was still incipient and unarticulated, and was finding some resistance from the operational side of the business, which was still dominated by a traditional exploitative mindset engrained for many years.

–*Processes (innovation practices)*. ITCo did not perform formal activities for macro-environment intelligence. However it showed some level of maturity in activities related to market-industry intelligence, as well as activities to know itself (e.g. strengths and weaknesses). The organisation had made significant progress in learning and applying creativity tools although rather informally and knowledge had not been spread to the whole organisation. Additionally, the approach to take an original idea to reality was fragmented and incomplete.

–*People*. ITCo had been training heavily a small group of people in creativity tools. However, there was not yet a clear leadership and direction on innovation activities, especially with a holistic view of the subject and the commitment to drive it across the whole organisation.

–*Structures*. ITCo did not have formal innovation structures/teams in place and only a small innovation team had been exploring areas of interest sporadically. However, the chairman of the board seemed to be very keen to support the establishment of a formal innovation structure and sponsor, support and integrate it from the top level.

–*Culture*. ITCo had values compatible with an innovation culture in a moderate degree (e.g. values of the kind of risk-taking and flexibility were mixed with those of precision and control, without clarifying the arenas where they would apply). Operational priorities were clearly a major concern at the time, leading people to give low importance to innovation.

–*Network*. ITCo had a long history of partnerships and joint ventures for commercial purposes but very limited in regards to research, development and innovation.

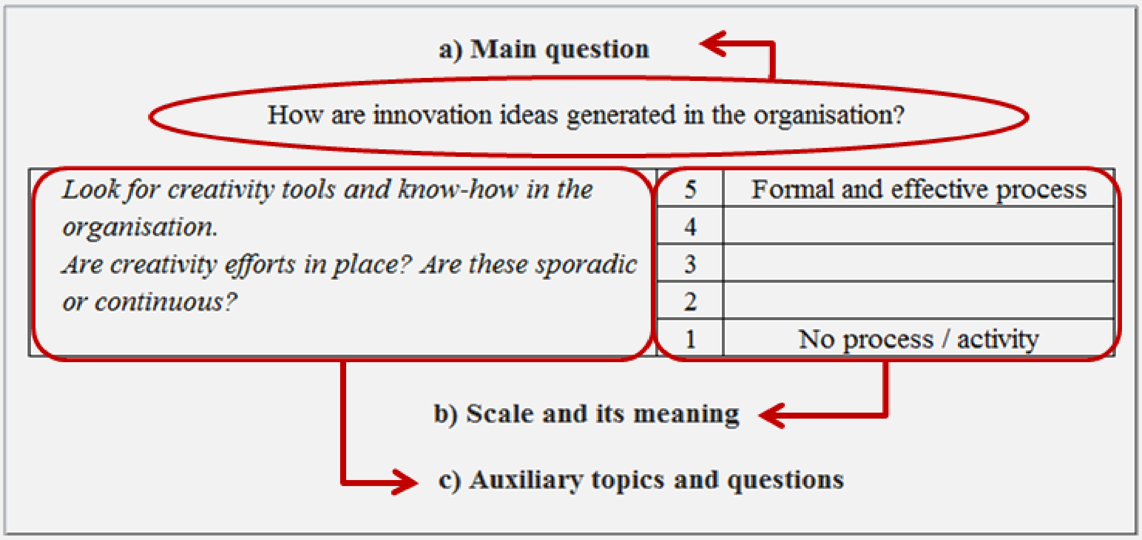

Figure 2.6 Example of an interview question.

Strategy & Innovation		Differentiation	1
		Historical Growth	1
		Future Growth	4
		Innovation Intentions	2
		Exploration / Agility	2
		Formal Innovation	2
Processes	*Perception*	Environment Intelligence	1
		Market-Industry Intelligence	3
		Organisational Intelligence	2
	Thinking	Creativity tools	3
		Ideas collection	1
		Selection tools	1
		Resources assignation	1
	Action	Ideas Testing	1
		Idea to reality	2
People		Innovation Champions	3
		Innovation training	3
Structure		Innovation Structure	1
		Sufficient Hierarchy	3
Culture		Time Devoted (CXO)	2
		Organisational Values	3
		Priorities	1
		Adaptability to Change	2
Network		Capture External Ideas	2

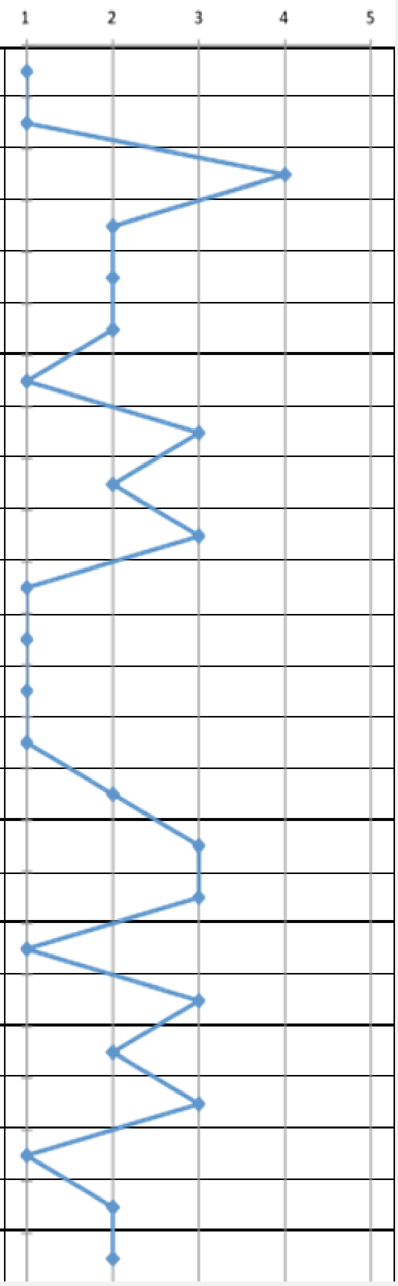

Figure 2.7 Assessment profile of ITCo.

2.5 The ‘Touch Room’

The HiFFi ‘Touch Room’ is a vital component of the HiFFi SIS framework. It is intended to be an actual space where collective perception, thinking, decision-making and action are continuously promoted and accelerated towards aims and goals with the aid of visual devices (e.g. management tools) and a conducive environment (physical and/or virtual). The ‘Touch Room’ facilitates the application of HiFFi principles ‘bottom-up’, aiming to bring together all key elements in a people-centered formula: the right people (internal and external), in the right place, at the right times, with the right tools and resources.

Right people

Participants are brought together to work in teams that are formed according to need, considering the benefits that each configuration might bring (Cohen & Bailey, 1997). Multidisciplinary team structures of an appropriate size and combination of authority, drive, knowledge and skills are commonly used (see Figure 2.8). These types of structures are associated with faster development rates (Stalk & Hout, 1990; Eisenhardt & Tabrizi, 1995) and enhanced performance (Brown & Eisenhardt, 1995). The use of teams has also been associated with improvements in organisational efficiency and quality (Applebaum & Batt, 1994), and ultimately, with financial performance (Macy & Izumi, 1993). They also provide the flexibility needed to respond effectively and efficiently to the constantly changing demands in the organisation's environment (Zaccaro et al, 2001) and to facilitate the development of different human dimensions involved during strategy-related activities: cognitive, emotional and social (Roos & Victor, 1999; Kerr, Phaal & Probert, 2012).

Right place

Assigning a special space to the SIS and projects completely changes the perspective of people, putting shared goals front and center. It facilitates the development of the necessary strategic conversations and trust (Webber, 1993) by providing individuals and teams with an energising space to focus, think, act, share, reflect and decide throughout the whole innovation cycle (see Figure 2.9). It signals a change in people's mindset towards exploratory behaviors, away from the paradigms, rules and routines of operations in the exploitation arena (Hendry & Seidl, 2003; Lewis & Moultrie, 2005). The layout of the space where a particular activity takes place is configured to foster the kind of behaviours and interactions needed (Doorley & Witthoft, 2012). It is a special space that continuously reminds senior management of the importance of innovation investment for survival and growth.

Right times

The Touch Room is intended to facilitate continuity by tuning activity cadence so that the system and projects do not overcool or overheat, and outcomes and aims are fulfilled in a timely manner (Sehested & Sonnenberg, 2011). Although many activities can take place in the Touch Room, it is also necessary to 'go out there' (i.e. into the field) where the 'truth' can be found, that is, where direct observations can be made and customer and partners feedback and facts can be obtained (Liedtka & Ogilvie, 2011; Ries, 2011). As learning occurs and knowledge accumulates, it is also necessary to build and test actual components and whole new systems in the right places at the right times. An oscillation with the right rhythm in obtaining data in the field and making sense of this information back in the Touch Room enables accelerated knowledge and value creation.

Right tools and resources

Most of the management tools, which are the most basic devices of practical implementation (Shehabuddeen et al, 2000), are brought to life in the 'Touch Room'. Actual configurations and integrations of tools, as well as related techniques, are used by participants to facilitate concrete outcomes along an innovation cycle. Since tools are the basic foundation for results, their development must bear in mind sound principles such as those set out by Kerr et al (2013), which are described in more detail in Section 2.3: 1)‘human-centric’ so that everyone involved participates fully; 2) activity-based using workshops and small-group activities with structured tasks; 3) if the activities are to be facilitated then the facilitators must be neutral (focused on process not on content); 4) as ‘lightweight’ as possible so that they can accommodate a degree of flexibility and not be overly prescriptive; 5) modular so that they can be readily integrated with one another; 6) scalable so that they can be used at different hierarchical system levels both inside and outside the organisation; and last but not least, 7) visual, both when they are being used, as in workshop charts and templates, and when communicating the outputs, as in reports or summaries.

Having resources, materials and knowledge – pictures, posters, data, ideas, workflows, pictures and prototypes – related to a project on display in this shared space, allows project participants to be constantly stimulated by them. The use of flexible furniture in the space can also help: sofas, chairs, tables on wheels, and moving whiteboards (See Figure 2.10). While it is not always possible to replace the furniture in a space (due to cost, among other reasons), it is something to take into account. However, the most important part is going beyond just putting everything wheeled to think on what kinds of behaviors one wants to encourage with a given configuration. The configuration sends a message that tells people how to behave, even if people are often unaware of it (Doorley & Witthoft, 2012; Britos Cavagnaro, 2013).

The basic concept of visual management behind the ‘Touch Room’ is not new and has been implemented under different names and for different specific purposes: From the ‘Chart Rooms’ of the early twentieth century (e.g. Yates, 1985), through the ‘War Rooms’ of the second world war, until the more recent ‘Obeya Rooms’ (e.g. Warner, 2002), ‘Pulse Rooms’ (e.g. Kaya, 2012), ‘Design Studios’ (e.g. Britos-Cavagnaro, 2013), ‘Creative Spaces’ (e.g. Doorley & Witthoft, 2012), and ‘Innovation Labs’ (e.g. Stevens & Moultrie, 2011); the common ground is sharing knowledge and experiences in a focused, agile and visual way so to improve decisions and outcomes.

Figure 2.8 Multidisciplinary teams in a ‘Touch Room’.

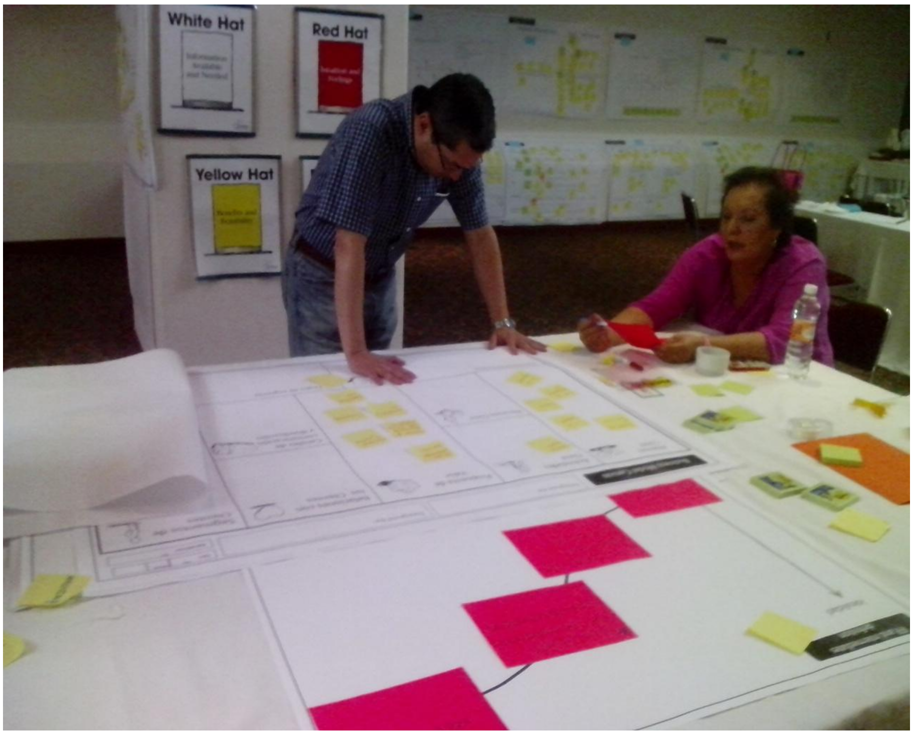

Figure 2.9 The ‘Touch Room’: A space for strategic thinking and dialogue.

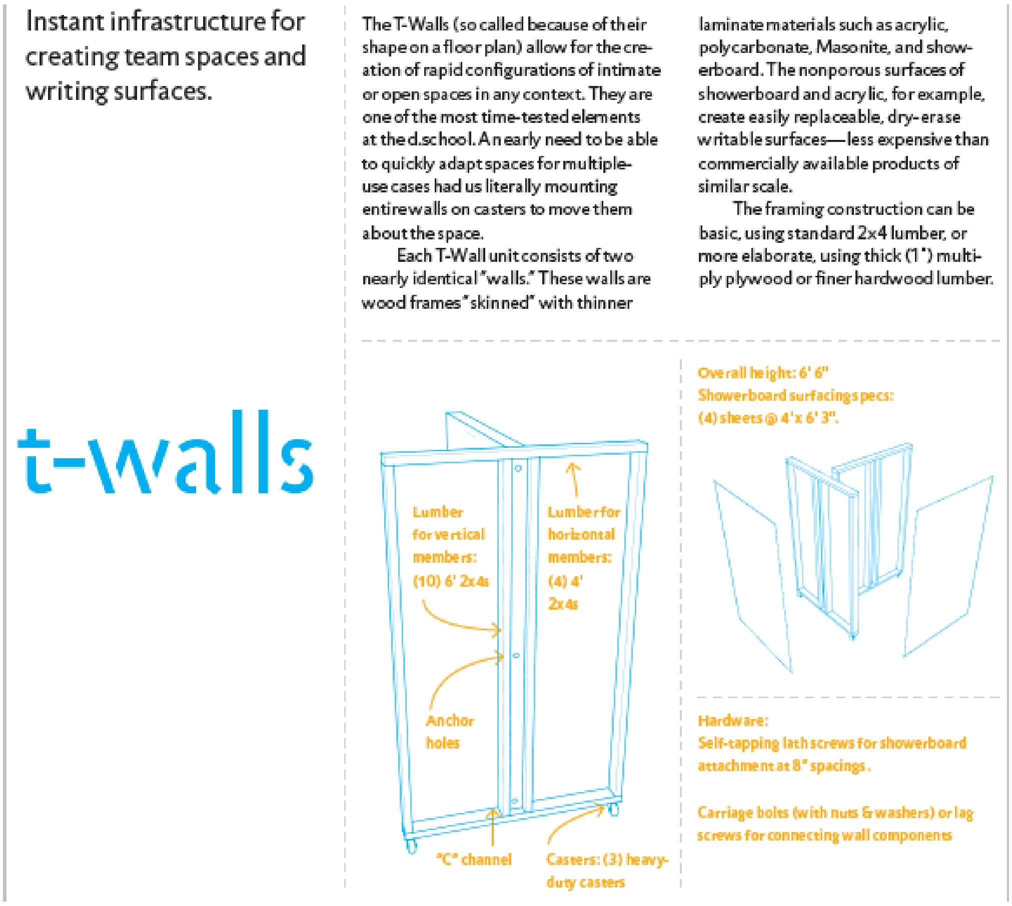

Figure 2.10 Flexible furniture.
Source: Doorley & Witthoft (2012).

The HiFFi 'Touch Room' seeks to tap into the experience of the innovation-oriented approaches to provide a strengthened approach. For example, while the 'Pulse Room' is mainly focused in the effective and efficient management of multiple projects and maintaining a regular cadence ('pulse') in product development (e.g. Sebestyén, 2006; Kristofersson & Lindeberg, 2006), the HiFFi 'Touch Room' takes a broader approach and is intended to also host other kinds of innovation activities along an innovation cycle (supporting the holistic principle of the HiFFi framework). Thus, the HiFFi 'Touch Room' not only contemplates the monitoring and review activities typical in a 'Pulse Room' (see Figure 2.11) but a wider range of activities, even to the point of incorporating activities to actually create physical things when appropriate in order to enhance communication and knowledge building (Bradshaw, 2010) – see Figure 2.12. In this sense, some creativity work might be carried out in the 'Touch Room' to come up with conceptual prototypes that might eventually be built and tested in a specialised laboratory or field environment with a higher fidelity/resolution.

Figure 2.11 Example of a ‘Pulse Room’ meeting (above) and a board (below).
Source: Kaya (2012).

Figure 2.12 Examples of teams creating concepts through physical means in a 'Touch Room'.

However, although the value of principles drawn from these experiences is well established and has been incorporated in HiFFi to help to accelerate innovation development, it should be recognised that challenges and limitations exist to date. A low-tech approach is sometimes criticised as childish and weak. Regarding the critique of being childish, this would represent a misunderstood perception because the process is quite serious. Problems are openly discussed, and decisions and responsibilities are exposed to everyone (e.g. Sehested & Sonnenberg, 2011). Regarding the critique of being weak, there are several aspects that have been raised as drawbacks of using a low-tech approach such as the one used with 'Pulse' boards (Kaya, 2012):

- Since they are physical, it is challenging for organisations with several offices to share information with managers that are scattered around the world.
- The increased complexity of the solutions (e.g. products) being developed increases the volume of information that has to be included and managed. Several challenges are associated with this:
  - Since the information is worked manually, detailed information (e.g. report about a particular deviation) has to be tracked down manually, which may be troublesome and time consuming in some cases.
  - Since there is limited space in a board, they are not flexible to considerable expansions. Adding a totally new project without deleting another may cause problems.

Some solutions have been proposed that make use of low and high technology (e.g. video conference and software applications) which can replace or complement the above approach, resulting in hybrid approaches. Even digital visual management technology is being offered recently (see Figure 2.13). In general, these hybrid approaches seek to overcome the apparent challenges and issues of physical settings such as: collaboration among multi-site teams, surface cost of physical spaces, and security and reuse of knowledge. However, it is important to bear in mind to what point this would actually improve the overall benefit without undermining important cognitive, social and emotional benefits that come with face-to-face, high-touch approaches.

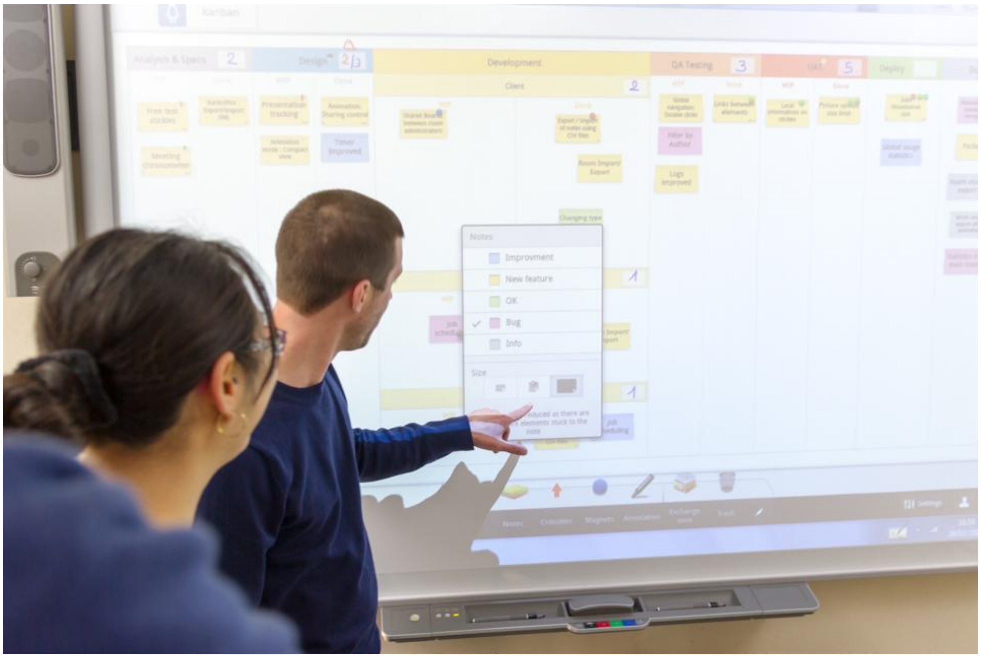

Figure 2.13 Example of a digital board.
Source: iObeya company website (www.iobeya.com)[4]

[4] iObeya is a software solutions provider that claims to have launched in 2012 the first *Digital Visual Management* platform for lean and agile practices.

The ‘Touch Room’ should be designed and implemented according to the needs and constraints of an organisation, based on the HiFFi principles. Generally, a physical space that is ‘High-Touch’ (e.g. highly collaborative) and ‘Low-Tech’ (e.g. predominantly manual, supported by wall-charts and sticky notes) is advocated in lean approaches in order to strengthen closeness and commitment (Sehested & Sonnenberg, 2011). However, the ‘Touch Room’ should be scaled as needed (e.g. through a corporation and its various geographies) and allowed to incorporate information technology and other technologies when appropriate (e.g. visual management and collaboration software). Further research in this area is envisioned to be carried out within the broader HiFFi research and development programme; allowing deeper understanding of ‘good practices’ and key factors involved in a variety of business/organisational contexts and thus providing additional guidance for practitioners.

3. HiFFi innovation cycle

The 'innovation system' of an organisation is often represented as a funnel-like process (see Figure 3.1), where many opportunities/ideas are explored, assessed and transformed through a series of phases and filters (e.g. Wheelwright & Clark, 1992; Phaal, 2010) until only a few of these opportunities are put in the market successfully in diverse forms or types and varying degree of novelty: from marginal or radical improvements on a process, product or service to whole new and disruptive business models enabled by a combination of elements (e.g. technologies, capabilities, channels, markets and/or revenue schemes).

Many of these depictions also recognise the open nature of an innovation system and the increasing use of open innovation approaches (Chesbrough, 2003; Mortara et al, 2009; Mortara & Minshall, 2014) to enhance the exploration and exploitation of ideas and technologies. The open innovation nature is represented in Figure 3.1 by a dotted line that outlines the funnel, thus representing the boundary of the organisation. This implies the possibility of using "purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough, 2003b).

The funnel representation can be useful as a basis for discussions on typical phases of innovation and rates of success (Goffin & Mitchell, 2010). However, it must be recognised that this is a simplification of the phenomenon since the funnel is a high-level view that hides much of the complexity of the system (e.g. non-linear flows caused by uncertainties).

An important point to be noted is that some mechanism should be in place for opportunities/ideas to be identified in the first place. From there, looking at how each opportunity/idea might make its way through the funnel, one should recognise that iterations are necessary and depend on the needs and context, so that a unique 'opportunity-to-innovation' path ends up being created for every case (Nieto, 2012). In this sense, it is essentially about a flexible risk-management approach, where the risk, uncertainty and need for information determine what steps should be next (Cooper, 1994). Thus, the process of turning an opportunity vision into reality (i.e. leaps of faith into facts along the way) is a unique experience that must be treated as a project (Goffin & Mitchell, 2010) and should allow managerial flexibility (Pender, 2001) to an appropriate degree (Barnett, 2003). As Ilevbare (2013) identifies, relevant approaches such as 'options thinking' and 'rolling-wave planning' help to retain managerial flexibility to adapt to knowledge and information as it emerges (which helps to clarify uncertainty).

The term 'project process' is used to convey the notion of a unique and finite path that is built of interrelated HiFFi subsystems which are represented by arrangements of tools configured and integrated to transform ideas/knowledge and other resources into useful outcomes that may ultimately lead to a high-impact innovation. At this point, the project process would be complete, matching an innovation cycle.

Managing a project process of an opportunity/idea appropriately, considering its evolutionary nature, translates into managing its innovation cycle effectively and efficiently; that is, achieving outcomes while minimising waste (i.e. eliminating non-value creating activities and resources). Thus, the management of a 'project process' may benefit to a greater or lesser extent from approaches such as *real options* (e.g. Faulkner, 1996; Pender, 2001; Barnett, 2003), *decision trees* (e.g. Faulkner, 1996; Wright & Goodwin, 2008; Mitchell et al, 2010), and *agile development* (e.g. Satpathy, 2013).

As shown in Figure 3.1, an 'innovation system' (the SIS) may have several 'project processes' ('transformative' projects) that need to be managed. These projects present different conditions to the left of the funnel compared to those on the right, ranging from uncertain and creative exploration to more controlled implementation (Phaal, 2010). As conditions change (e.g. new knowledge), projects must continuously prove their merits to move forward. Otherwise, they should be 'killed', 'put on hold' (Cooper et al, 2002b), or 'pivoted' (Ries, 2011; Blank, 2013). A concept/project that is 'killed' does not meet the requirements of the organisation so that is filtered out of the funnel. A project that is 'put on hold' may be a decent project on its own but it is no longer active because it does not impact the portfolio positively (Cooper et al, 2002b). However, it may be resumed in the future if it recovers strategic relevance. A project that is 'pivoted' remains active but is 'looped back' in order to change the logic of the business concept/model, which implies identifying and testing new fundamental assumptions (Ries, 2011; Blank, 2013). Each project always represents to some extent a journey of discovery with new things being learned along the way (Goffin & Mitchell, 2010).

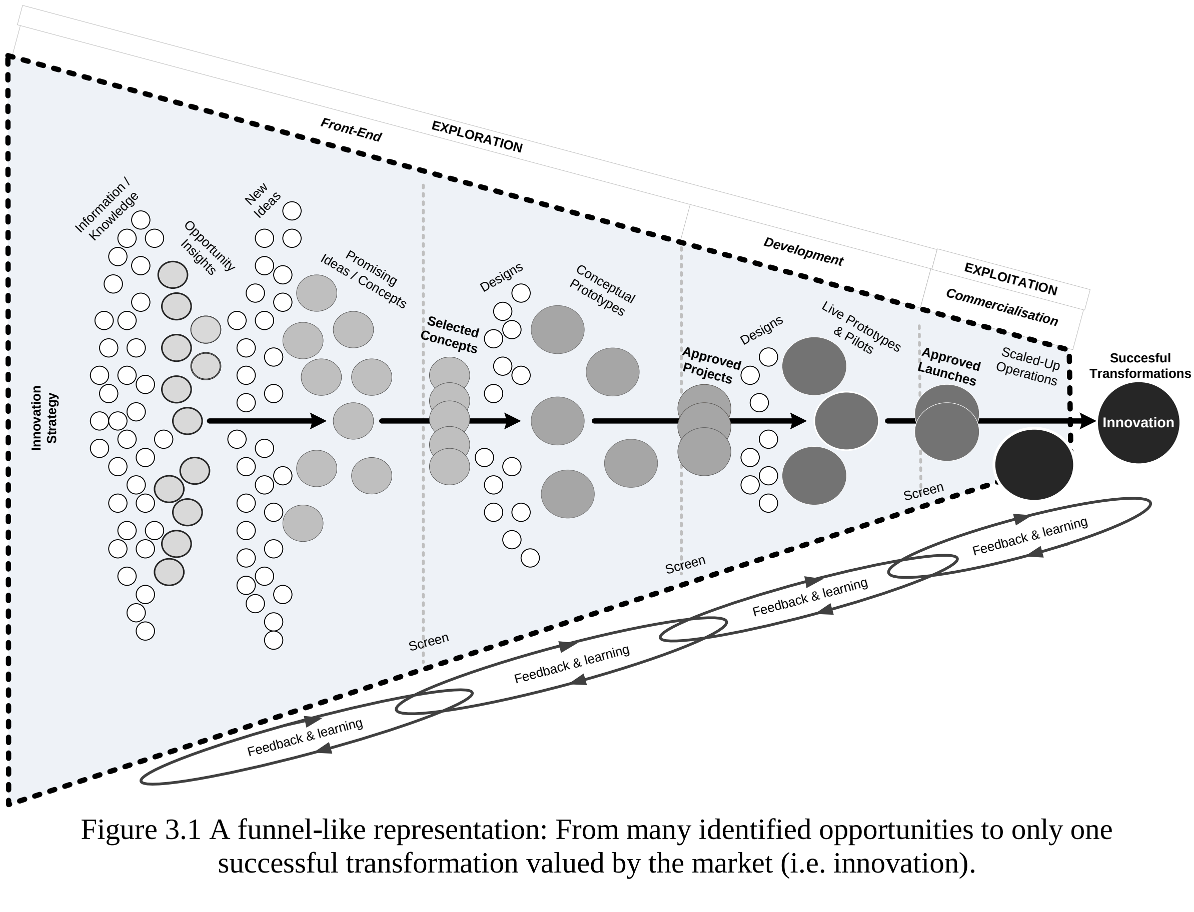

Figure 3.1 A funnel-like representation: From many identified opportunities to only one successful transformation valued by the market (i.e. innovation).

3.1 Staged model

Although a project process is unique, a reference model with four stages can help to understand and guide an innovation journey, namely: *Strategic Fit*, *Problem-Solution Fit*, *Product-Market Fit* and *Business Model Fit* stages (see Figure 3.2). The former allows to explore and identify opportunities in the external environment and envision solution options that can potentially match them in the marketplace, while fulfilling the strategic priorities of the organisation. The latter three stages represent the ‘stepping stones’ to turn an envisioned solution into actual value for a market and for the organisation (e.g. Osterwalder et al, 2014; Maurya, 2012). Any kind of fit that is gradually achieved must be maintained along the journey. A change in any kind of fit ‘status’ previously achieved should lead to a decision whether to ‘kill’, ‘put on hold’ or ‘pivot’ the project/concept. A change in a fit ‘status’ may be caused by many factors such as those related to changes in customer or organisation priorities.

As illustrated in Figure 3.2, innovation activities within stages are linked, on one side to the external environment (e.g. users/customers and suppliers/partners), which facilitate obtaining key information/knowledge along the journey; and on the other, to the necessary support processes of the organisation (e.g. human resources, procurement, legal/IP protection, etc.), which allow the flow of knowledge and other resources between the Strategic Innovation System (SIS) and the rest of the organisation.

In order to ‘leap’ into a next stage, it is necessary to obtain *evidence* of the achievement of fit in the current one. Evidence is proof of the validity of certain hypotheses/assumptions related to a concept, which can be drawn from tacit (unarticulated) or explicit (codifiable) positions from or related to relevant stakeholders; taking the form of feedback, responses or facts and thus, measured as either qualitative or quantitative information/knowledge (Ries, 2011; Maurya, 2012). Evidence is facilitated by *demonstrators* (Bradshaw, 2010), which embody such hypotheses/assumptions and enable designers to test them (Hartmann et al, 2006) with stakeholders (e.g. potential users/customers) in the quest for *validated learning*[5] (Ries, 2011).

While the ‘strategic-fit’, ‘problem-solution fit’, and ‘product-market fit’ stages are more about *learning* (e.g. research/observation, ideation/hypotheses and experimentation), the business model fit stage is more about *execution* (e.g. optimisation/scaling-up and selling/growing). Demonstrators support learning by providing evidence during both building (e.g. feasibility validations) and testing/demonstrating (e.g. desirability and viability validations). When favourable evidence is found, the demonstrators can also facilitate the ‘buy-in’ from other key internal stakeholders (e.g. top-level decision makers) (Bradshaw, 2010). Demonstrators support execution by facilitating understanding of the benefits and advantages of the innovation to the target market.

Thus, a demonstrator is essentially a communication device that facilitates innovation development and adoption; which is instrumental in HiFFi for knowledge creation (e.g. to learn from experiments and develop the solution) and concept promotion (e.g. to achieve management’s commitment during evaluations/screens at system/portfolio level and to support customer’s awareness and acquisition during launch); while improving team understanding, collaboration and motivation throughout an innovation cycle (Bradshaw, 2010).

[5] The term *validated learning* emphasises the notion that evidence should be backed up by empirical data/information/knowledge collected from real stakeholders (e.g. potential users/customers).

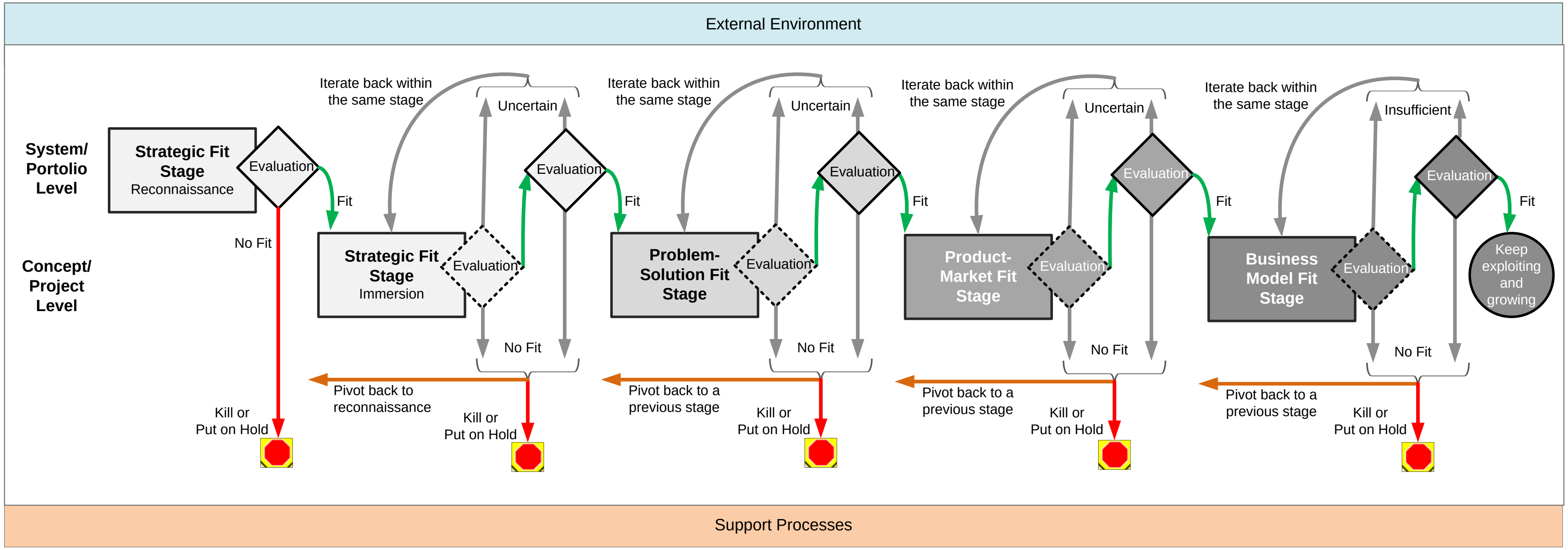

Figure 3.2 Staged Model of Innovation Cycle.

A demonstrator in HiFFi should be designed considering the purpose of the stage and the type of innovation project (aspects that imply a certain degree of uncertainty and risk), as well as the characteristics of the target stakeholder (internal or external). For example, a radical innovation project implies higher ambiguity and poses an unfamiliar context to stakeholders (to a lesser or greater extent), which may require richer or higher fidelity/resolution demonstrators[6] (as far as possible and viable) so that stakeholders can better understand the message and are able to interact with the demonstrators at an appropriate level. A range of 2D, 3D or 4D/live 'objects', 'artifacts', 'deliverables' or 'work products' can be designed, built and used, such as drawings, sketches, mock-ups, models and prototypes depending on the needs (Liedtka & Ogilvie, 2011; Hasso Plattner Institute of Design, 2013; Osterwalder et al, 2014; IDEO.org, 2015). Generally, the fidelity/resolution is increased as progress is made because there is increasingly more need to approximate reality so that the outcomes are meaningful (the richness of a demonstrator reflects its ability to convey the end-use benefits of the concept (Bradshaw, 2010)).

Given the lean and agile approach of HiFFi, demonstrators are something that should be built in short-time box increments and continuously demonstrated to stakeholders (Satpathy, 2013; Cooper, 2014). For example, aspects of a new product/service can be demonstrated to a sample of potential customers in order to gain knowledge to guide project decisions and subsequent activities.

Strategic Fit stage

The purpose of this stage is to explore the environment in order to identify stakeholder's problems/needs that the organisation can potentially solve by devising solution concepts that might incorporate new or existing technology and capabilities. Strategic fit happens when a solution concept aligns with the business and innovation strategy of the organisation and can impact the innovation portfolio positively. As illustrated in Figure 3.2, this stage comprises two parts or sub-stages, one that operates at system/portfolio level ('reconnaissance'), and another that operates at concept/project level ('immersion').

The *reconnaissance* part concerns to those exploratory activities of the Strategic Innovation System (SIS) that aim at identifying and creating strategic opportunities, such as market and technology intelligence (Kerr et al, 2006) and creativity and problem solving, which can be strengthened by integrating open innovation approaches (Mortara et al, 2009; Mortara, 2010) and maintaining them in a regular or continuous mode. This type of activities represents a key feature in relation to other innovation approaches, such as design thinking (e.g. Liedtka et al, 2014) and lean startup (e.g. Ries, 2011; Blank, 2013) in which an opportunity is assumed to be identified somehow before starting an innovation endeavour. Therefore, this part is especially important for established organisations if they wish to keep abreast of relevant market and technology developments and be responsive and proactive in pursuing high-impact opportunities. From a start-up perspective, the vision of the

[6] Bradshaw (2010) points out that richness is not the same as fidelity, as richness defines the information carrying capacity of a medium (demonstrator) whereas fidelity is a measure of closeness to the final product. The author identifies that fidelity does not account for the interactive ability of the demonstrator. However, other authors refer to a kind of demonstrators, such as "live" prototypes that allow real-world experiences, as being of high fidelity (e.g. Liedtka & Ogilvie, 2011). Thus, the terms are used interchangeably in this document.

entrepreneur/founder would lay the foundation to define the opportunity concept (Blank, 2013), which can be explored and enriched by immersing in the opportunity in a structured way.

The *immersion* part concerns to the initial activities for each of the opportunities identified, which allows to explore an opportunity in more depth, aiming to define a promising concept (e.g. preliminary business model) that fulfil strategic needs. Thus, this part represents the start of a 'project process' in its journey towards marketplace.

From a technology ('push') perspective, the quest for 'strategic fit' is also supported by activities at both system and project levels. The approach could be generally described by drawing on the two initial steps of a process for building a business case for new technology investment proposed by Probert et al (2013), where potential markets or industries that could benefit from the technology can be first identified (which involves actively seeking problems for which the technology can produce a benefit), and then a list of potential customers that fulfil a strategic criteria can be selected for further understanding.

Demonstrators, as a means to facilitate the evidence of fit at this stage, are usually in the form of 2D lean and rapid artifacts or prototypes enabled by workshop-based management tools (e.g. structured wall-charts), which elicit the necessary knowledge and responses from key stakeholders. A core set of standarised tools/toolkit might be used as a basis and other tools might be integrated as necessary. For example, the popular and widely tested S-Plan ('Strategic Landscape') approach for roadmapping (Phaal et al, 2007) can be used as a basis. Activity at the system level in HiFFi should be implemented as a regular/continuous activity revolving around roadmaps (the roadmap tool is the central device of the HiFFi system, as explained in Section 4.1). Keeping such a system alive is a challenging task that should be effectively addressed by means of the appropriate approaches to implementation (e.g. Gerdsri et al, 2009).

It should be recognised that most of the elements described by the demonstrator are usually very raw at this point and an accurate 'picture' of details (e.g. size of market) may not be possible due to the uncertainty involved. Thus, when it comes to evaluation, qualitative approaches would be more appropriate at this stage. 'Gut feel' or expert judgement would expected to take place to an important extent due to the complexity of the situation, which would not mean a lack of rigour (Dissel et al, 2005). Even in cases where the concept is based on an already existing technology which feasibility can be measured by facts, market-related factors might be highly uncertain and impossible to assess at this point. For example, when a concept is based in a potentially disruptive technology, a business model depiction (i.e. a low-fidelity 'demonstrator') might contemplate a new and relatively small market, betting on a future entrance into the mainstream market when the technology is further developed (Christensen, 1997), all of which represents a highly uncertain landscape.

Once the obtained knowledge has been validated as satisfactory *evidence*, 'strategic fit' is considered to have been achieved (*for the time being*). However, at this stage there would be no evidence yet that an envisioned solution would actually be desired by the market, feasible to be built[7], and viable for the organisation, which is addressed in the next stages.

[7] Except for individual technologies that have already been tested, although the new concept may integrate other technologies and capabilities that affect the feasibility of the envisioned value proposition and business model.

Problem-Solution Fit stage

The purpose of this stage is to better understand the need that a potential market is presumably facing (as defined in the opportunity concept) and the ability of an envisioned solution to fulfil that need. The solution at this stage should be defined in terms of the business need that intends to meet (e.g. through a value proposition or benefits) rather than how it will meet the need (e.g. technically). The focus is on the characteristics of the problem rather than the specific features and functionalities of the solution. Problem-solution fit happens when there is *evidence* that the identified problem is actually important for a set of customers (as a proxy of a particular market) and that the envisioned value proposition of the solution can address it. Although evidence is mainly aimed at market *desirability* aspects of the concept at this stage, preliminary evidence of solution *feasibility* and business *viability* can also be obtained.

Some authors emphasise the importance of understanding a market in terms of its specific problems/needs as instrumental in achieving 'problem-solution fit'. For example, Osterwalder et al (2014) proposes that specific customer profiles should be used to understand a market segment, in which, the most important, painful and essential problems/needs can be identified, and thus, 'great solutions' (value propositions) can be matched. Andreesen (2007) also gives special importance to the market (and thus, to the associated problems/needs) when he discusses its contribution to the success of a start-up in comparison to product and team quality. As the author puts it: "In a great market – a market with lots of real potential customers –the market *pulls* the product out of the startup. The market needs to be fulfilled and the market *will* be fulfilled, by the first viable product that comes along". Maurya (2012) uses the term 'problem-solution fit' for the initial stage in his lean startup approach as follows: "...is about determining whether you have a problem worth solving before investing months or years of effort into building a solution. While ideas are cheap, acting on them is quite expensive". According to the author, once the fundamental questions at this stage have been clarified, a minimum viable product (minimum set of features) to address the right problem(s) can be derived and developed (in the next stage: the *Product-Market Fit* stage).

Given that an opportunity concept may be fundamentally based on market-related assumptions, it is important to identify, test and validate those of critical importance as early as possible. Thus, this stage is predominantly about experimentation as an early mechanism to mitigate the risk of significantly wasting resources later (e.g. developing an actual 'solution' that is not wanted/needed, which might lead to costly and time-consuming activities to solve the situation).

Demonstrators, as a means to facilitate the evidence of fit at this stage, can take diverse forms in order to elicit the necessary feedback and responses (e.g. observed behaviours) from key stakeholders. Since users/customers cannot often articulate what they want beyond current experience and practice (Ries, 2011; Cooper et al, 2002), demonstrators with the appropriate degree of richness (i.e. the extent of physical representation, scope, refinement and interactivity (Bradshaw, 2010)) would enable key insights/evidence to emerge. For example, in the case of newly envisioned concepts, low-fidelity demonstrators (e.g. rapid and inexpensive 2D or 3D prototypes) would be usually expected to fulfil the purpose at this stage because the aim is not to test specific features, functions and/or appearance of a potential solution but to facilitate understanding of the real problem/need and its importance to the stakeholder (user/customer). In contrast, for some technologies that have been already developed at some point of maturity (so that possible applications/problems are being explored), higher fidelity demonstrators (e.g. with the appropriate interactive capability) might be appropriate. Bradshaw (2010) states that "most authors agree that low-fidelity demonstrators/prototypes are more suitable during the early stages when the emphasis is on understanding requirements and specification development, whereas high-fidelity prototypes are thought to be required for more rigorous testing and uncovering usability problems in the later design stages. The exception appears to be designs which include a physical manipulation or interaction where some element of feel is involved".

From a technology ('push') perspective, the potential applications/markets of a technology can also be better understood at this stage by testing and validating 'problem-technology' combinations (Dissel et al, 2009). In other words, by conducting experiments and paying careful attention to what potential users/customers say and do in order to find out whether their problems/needs might be solved by an envisioned technology-based application. Again, it should be recognised that is more important at this stage to obtain a deep understanding of a prospective customer's problems rather than the technological details or features (Probert et al, 2013).

Although the specific term 'problem-solution fit' is not extensively used across literature, the underlying notion of building of a 'bridge' between the problem space and the solution space by the identification of a key concept is relatively well established. Dorst and Cross (2001) explain that creative design does not seem to be a simple matter of first defining the problem and then searching for a satisfactory solution concept but more a matter of developing and refining together both the formulation of a problem and ideas for a solution, with constant iteration of analysis, synthesis and evaluation activities between the two notional design 'spaces', namely *problem space* and *solution space*. The authors describe this pattern of development in their experiments based on a 'co-evolution' model proposed by Maher et al (1996): "A rough description of what happened in this case is that a chunk, a seed, of coherent information was formed in the assignment information, and helped to crystallise a core solution idea. This core solution idea changed the designer's view of the problem. We then observed designers redefining the problem, and checking whether this fits in with earlier solution-ideas. Then they modified the fledgling-solution they had". In HiFFi, this 'co-evolution' may happen through iterations within and between the stages of 'strategic fit' and 'problem-solution fit', facilitated by demonstrators/prototypes. For example, evidence of lack of 'problem-solution fit' in this stage might lead to pivoting back to the 'strategic fit' stage in order to redefine the market or problem and redesign the solution/opportunity concept.

Once the obtained knowledge has been validated as satisfactory *evidence*, 'problem-solution fit' is considered to have been achieved. However, at this stage there would be no *evidence* yet that the customers would actually care about the value proposition of the solution and would pay for it (Osterwalder et al, 2014), which is a concern of the next stage: 'product-market fit'.

Product-Market Fit stage

The purpose of this stage is to develop solution's features and functionalities, as well as the necessary capabilities (e.g. manufacturing/production and service delivery), so that user/customer benefits (i.e. the value proposition) can be created, delivered and validated. The development is carried out in short-time increments so that market and business assumptions can continuously be tested and changes or refinements can be made nimbly (i.e. experimentation and development are done concurrently)[8]. Product-market fit happens when there is evidence that the value proposition of the solution (built in actual products and/or services) can actually deliver value to a set of customers representing a market.

The term ‘product-market fit’ is widely used, especially in literature related to lean startup approaches (e.g. Ries, 2011; Maurya, 2012; Blank, 2013). The term is often attributed to Marc Andreesen and popularised by Sean Ellis; both high-profile entrepreneurs, investors and advisors. Andreesen (2007) defines ‘product-market fit’ as “being in a good market with a product that can satisfy that market”. Ellis (2009) places ‘product-market fit’ as a precondition for effectively scaling the business in his ‘Startup Pyramid’.

The term was further popularised by the Lean Startup movement initiated with Steve Blank’s approach for startups (Blank, 2013), where he explains the usefulness of his methodology to achieve ‘product-market fit’: “[It] proves that you have found a set of customers and a market who react positively to the product: By relieving those customers of some of their money”. However, as Ellis (2009) states: “Product/market fit has always been a fairly abstract concept making it difficult to know when you have actually achieved it. Yet many entrepreneurs have highlighted the importance of creating a product that resonates with the target market”. The more newness of the development, the more likely that the initial set of customers would be found within the technology enthusiasts and early adopters categories, as some literature suggests (e.g. Rogers, 2003; Moore, 2014). Technology enthusiasts (also called the ‘innovators’) are typically the first people to appreciate and adopt an embryonic innovation for its own sake, whereas early adopters (also called the ‘visionaries’) are people who have the insight and temperament to match up the innovation to a strategic opportunity; thus, both are willing to adopt an unrefined/incomplete ‘solution’ and support its evolution.

In HiFFi, the use of demonstrators, such as physical 3D or 4D/live (real time) prototypes or minimum viable products of ever increasing fidelity (e.g. which allow to experience the functional and emotional features), should facilitate the evidence of fit. For example, evidence that users/customers are having a good experience may be measured by qualitative feedback but most importantly, by quantitative facts such as users coming back and even paying for a (demonstrator) product/service.

As demonstrators/prototypes are developed and tested, so does a product/service and capabilities, as some authors explain. Miller (1995) states that “participatory research with stakeholder testing of prototypes is coupled with a new business process that concurrently develops capability and architecture [including product platforms]”. Bradshaw (2010) draws on this view and explains that “physical prototype development also helps to build new capability by providing a mechanism to simultaneously test organisational capability, market assumptions and technical feasibility, thereby allowing a new form of concurrent learning to develop”.

[8] This approach is aligned to principles of *Agile Development*, such as those proposed in the *Scrum* method (Satpathy, 2013). For example, to the principle of ‘empirical process control’, which prescribes making decisions based on observation and experimentation rather than detailed upfront planning.

Once the obtained knowledge has been validated as strong *evidence*, ‘product-market fit’ is considered to have been achieved [9]. However, at this stage there would be no evidence that value could also be captured by the organisation as it is expected (Osterwalder et al, 2014), which is a concern of the next stage: ‘business model fit’.

Business Model Fit stage

The purpose of this stage is to deploy and scale the necessary resources and capabilities (e.g. marketing and sales channels) to acquire and retain customers in a way that the expected value for the organisation can be captured. Transition to operations allows an innovation to be launched/introduced in a market and be regularly monitored to ensure that the expectations of the organisation are met. Business model fit happens when there is evidence that the value proposition of the solution is embedded in a profitable and scalable business model (Osterwalder et al, 2014). However, even when this kind of fit is reached, it should be recognised that any market and related competitive forces drive improvements (e.g. incremental innovations) so that further innovation development cycles would likely be needed. In order to maintain business model fit it is important to pay attention to the lifecycle and progression of markets for the solution and their associated needs (e.g. from the needs of a small early market to the needs demanded by a potential mainstream market) (Moore, 2014).

From an organisation’s *success* perspective, the ‘early adopters’ market and the ‘early majority’ of a mainstream market (also called the ‘pragmatists’) are critical. The first category would allow the initial traction necessary to keep momentum and obtain the additional funding/resources to improve the innovative solution, while the early majority not only represents a great part of the market volume (Moore, 2014) but also the ‘battle field’ where dominance can be earned towards fulfilling the organisation’s expectations in the long term. Indeed, ambitious expectations of growth might only be achieved if a dominant design status (Utterback & Suarez, 1993) is achieved early in the growth phase of an innovation, which would allow the organisation to exploit the mainstream market significantly (i.e. not only the early majority could be favourably exploited but the innovation-related growth could be sustained by exploiting beyond the early majority, that is, to the late majority, also called the ‘conservatives’, and even to the laggards, also called the ‘skeptics’). Conquering each of these markets poses different challenges and the transition from a market of the early adopters to a mainstream market (starting with the early majority) is not straightforward[10].

Demonstrators at this stage are mainly about selling (in contrast to learning in previous stages). Communicating the benefits of the solution effectively is an imperative across the different customer categories in the innovation lifecycle. Thus, rich demonstrators should be used (Bradshaw, 2010) such as high-fidelity prototypes or even an instance of the actual innovation. However, it should be recognised that different type of marketing messages may be appropriate along the timeline of an innovation in the marketplace. For example, for a radical innovation aiming to create a new market, the concept behind may need to be first understood by a bulk of a market before it can be converted into significant growth for an organisation.

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[9] For a start-up seeking funding, this is a key achievement since most investors require initial traction to be evidenced (Maurya, 2012; Dee et al, 2015). As Maurya (2012) puts it: “Even though you may need to raise seed funding sooner, the ideal time to raise your big round of funding is after product/market fit, because at that time, both you and your investors have aligned goals: to scale the business”.

[10] This transition is what Moore (2014) calls “crossing the chasm”.

Let us consider the video games industry. When video games were introduced more than three decades ago (e.g. 'Pac-Man'), advertising focused on building the generic idea: "buy a video game, a novel home entertainment concept" (Benett & Cooper, 1984). Even when some players entered the scene offering different 'colours and flavours' of products, their main concerns were not really about their competitors but about gaining credibility and customers. As Utterback (1996) explains: "In the early days of an industry, when products are unique in design and capabilities, competition has more to do with winning over customers to the winning technology embodied in an unrefined product than in crossing swords with rival innovators". Later, when the concept was understood, advertising highlighted the unique features and differences among brands (i.e. a more 'features-oriented' strategy) within a context of battle to become the dominant design.

Evaluation points

Evaluation points can be flexibly configured throughout the journey so that risk and resource management can be optimised (Cooper, 2014). Evaluation activities support decision making at two levels: at project and system/portfolio level. At the individual project level, evaluations may be instrumented as necessary by the project team along the innovation journey (i.e. self-managed evaluations). For example, to evaluate and select from a range of options (which may be organised as a list of ideas and/or depicted as 2D prototypes, models, designs and/or roadmaps); or to evaluate the desirability, feasibility and/or viability of the business/solution concept based on learning from experiments (such as thought experiments; 2D, 3D or 4D/live prototypes tests; or even full 'market-ready' pilots) and make decisions on what would follow, namely: a) additional research and/or experiments if 'fit' is still uncertain (e.g. key unknowns or assumptions remain); b) 'kill', 'put on hold' or 'pivot' the project/concept if 'no fit' is evidenced; or c) move it to the next stage if 'fit' has been achieved, point at which a formal evaluation and approval at project portfolio level might be needed so that its strategic relevance can be reassessed and new resources can be committed (e.g. by senior management).

At the project portfolio level, evaluation activity might be organised periodically to assess and prioritise all projects together in order to focus on the best ones (i.e. the best portfolio investments); and as mentioned earlier, it would also be organised at a convenient time in order to decide whether an individual project should indeed be moved forward and the requested resources allocated. At this level, projects are assessed relative to other projects (even to the ones 'on hold') and on their impact to the total portfolio.

In any case, a concept/project should be moved to the next stage when there is evidence of the pursued fit. Otherwise, a project should be 'killed', 'put on hold' or 'pivoted'. For example, if new knowledge (learning) from experiments invalidates a key business model assumption, this could definitely lead to the decision to 'kill' or 'put on hold' the concept/project altogether but alternatively it could also lead to a 'pivot' (i.e. loop back to a previous stage) in order to change the direction of the project (e.g. in the search of new customers with important and unfulfilled problems/needs where the solution can fit and prove that can actually create value for them and the organisation).

Once an innovative solution has been officially introduced in the market (i.e. business model fit stage), evaluation activities would still be useful to measure that the value proposition remains valid but equally importantly, that value is being captured for the organisation according to the expectations (e.g. revenue growth rate and profitability margins). Otherwise actions should be triggered to optimise the operation; to improve the value proposition or business model elements (e.g. by pivoting in order to improve the business model for incursion in the mainstream market); or to retire the solution from the market (e.g. when its lifecycle has come to the 'decline' phase and the solution itself has proved not to be sufficiently profitable anymore).

Staged Model with HiFFi subsystems

Although this staged model may well serve as a basis to setting up a Strategic Innovation System (SIS) that resembles the behaviour of some of the traditional approaches such as the well established Stage-Gate™ approach (Cooper, 1990), which is suitable for relatively stable environments; the model would be best associated with more progressive approaches (e.g. Liedtka & Ogilvie, 2011; Maurya, 2012; Blank, 2013; Osterwalder et al, 2014), which are designed to address higher-risk endeavours (e.g. radical innovation projects) in highly uncertain and fast-changing environments; since the core activities and deliverables in each stage are being dynamically defined based on the critical unknowns that must be researched and the critical assumptions that must be validated (Cooper, 2014).

In practice, the innovation activities in each of the stages are defined and carried out in the context of HiFFi subsystems (Figure 2.1) which are operationalised by procedures, techniques and tools. Figure 3.3 shows the notion of the Staged Model with the relevant HiFFi subsystems according to the particular stage.

In the *Strategic Fit* stage, the *Investigation* subsystem facilitates the exploration of the internal and external context in order to obtain different types of insight (e.g. organisation, market, customer and technology insights), the *Generation* subsystem facilitates envisioning new possibilities in order to generate solution concepts that can fit with the strategy of the organisation, and the *Evaluation* subsystem facilitate the selection and prioritisation of concepts/projects in order to maximise the value of investments. As in any stage, the *Orchestration* subsystem is concerned with the overall management of the SIS where the key knowledge integration and synchronisation is facilitated.

In the *Problem-Solution Fit* stage, the previous subsystems can be used iteratively on a needs basis to support the *Understanding* subsystem that takes the most prominent role. While the *Investigation* subsystem supports in researching key unknowns and the *Generation* subsystem supports in generating ideas of experiments, the *Understanding* subsystem facilitates the articulation of ideas or needs of potential customers by conducting experiments designed to validate (or invalidate) key business concept assumptions related to the customer problem, its level of importance, and how the envisioned solution addresses the problem. The *Evaluation* subsystem may be used at project level to select among a range of experiment ideas, and at system/portfolio level to assess whether a concept/project should be approved to move forward to the next stage (e.g. ensure that it maintains *Strategic Fit* and have actually achieved *Problem-Solution Fit*) and if so, then to allocate the appropriate resources.

In the *Product-Market Fit* stage, the subsystems work in a similar fashion except for the *Understanding* subsystem which is replaced by the *Implementation* subsystem that takes the most prominent role. The *Implementation* subsystem facilitates the transformation of a concept into value for users/customers by building and measuring/testing the solution gradually, supported by experiments designed to validate (or invalidate) key business concept assumptions related to the value proposition of the solution. As in the previous stage, the *Evaluation* subsystem may be used at both, project level and system/portfolio level.

In the *Business Model Fit* stage, the nature of the activities changes since uncertainty has been minimised and the focus is on growing by executing what was learnt (e.g. which are the appropriate marketing and sales channels). Thus, the *Implementation* subsystem is replaced by the *Value Capture* subsystem which aims to enlarge the customer base, and very importantly, the revenue and profitability of the organisation. The *Investigation* subsystem supports by facilitating all key information necessary for planning, deploying and scaling the operation. In this stage, the *Evaluation* subsystem ensures that a solution have reached the appropriate fit and maintains it.

A detailed description of the subsystems is provided later, in Section 4.

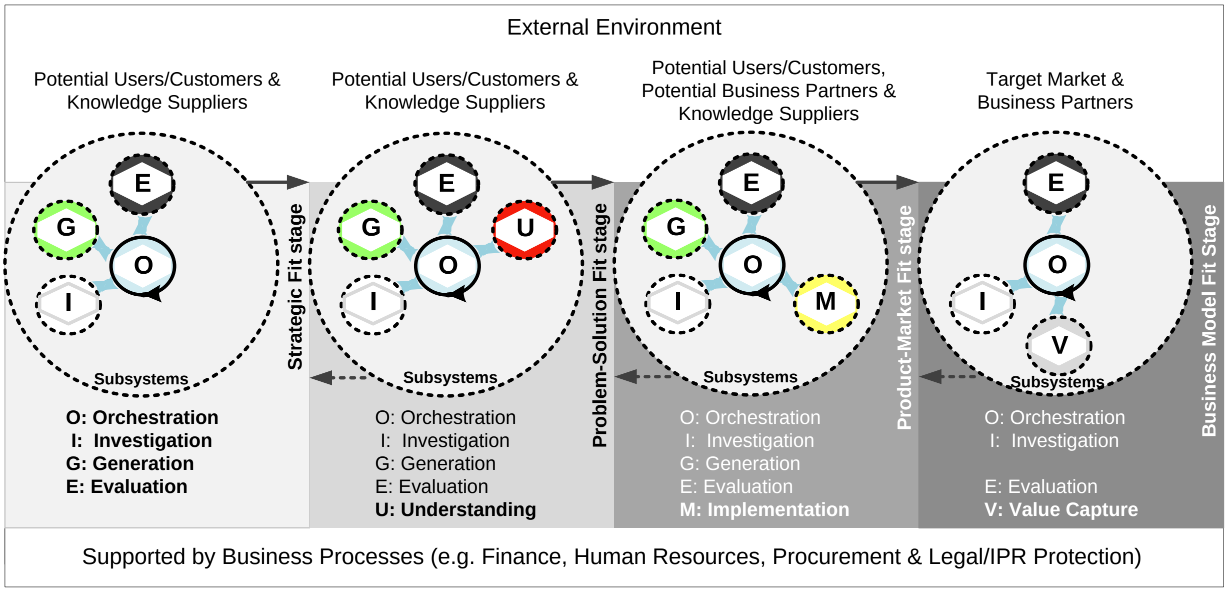

Figure 3.3 Staged Model of Innovation Cycle with HiFFi Subsystems.

3.2 HiFFi funnel

A particular funnel-like depiction can be useful to relate key HiFFi concepts at system and project levels, and illustrate how a project process might run along an innovation cycle. Figure 3.4 depicts a HiFFi system in action through a simplified example. It attempts to convey the notion that many opportunity insights can be systematically obtained and lead to a range of solution concepts that are gradually transformed, evaluated and filtered until only a few are fully turned into reality and create value for all stakeholders. To highlight this situation, in this example, only one of the selected concepts/projects is fully transformed and comes out of the funnel, which is illustrated by slightly magnifying its 'opportunity-to-innovation' path (as represented by the bigger circles with letters representing HiFFi subsystems linked by bold arrows). In this example, the HiFFi subsystems in the path (which in practice are operationalised with procedures, techniques and tools) are directly related to a particular project with the exception of the evaluation subsystem which relate to other projects as well. As mentioned earlier, evaluation points may not only be integrated as selection mechanism at the individual project level, for example, when using set-based concurrent approaches (e.g. Ward et al, 1995; Sobek et al, 1999) or options thinking (i.e. different development paths or the branching out of alternatives from a baseline concept) (Kerr & Phaal, 2015; Phaal et al, 2015) but may also operate at a higher level as an overall prioritisation and selection mechanism linked to portfolio management so to ensure that balance on investments is maintained. This will depend on the particular implementation of an SIS, which must be configured to particular needs and context.

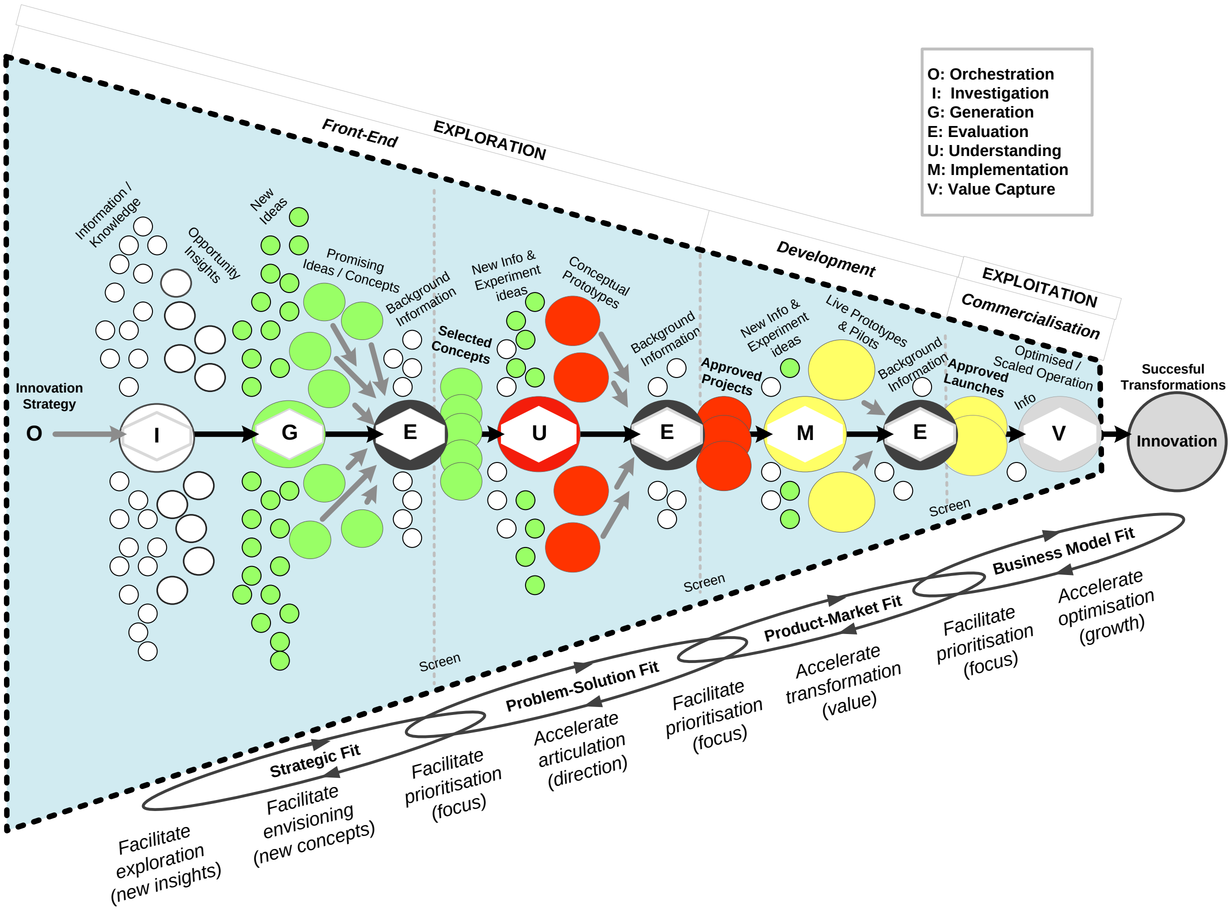

Figure 3.4. An example of a HiFFi funnel-like depiction for innovation development.

Another aspect that should be recognised is that an another ‘funnel’ system might be needed in the case of technology-intensive organisations (Cooper, 2006). This approach helps to manage technology uncertainty and risk, relieving pressure on the innovation development funnel (e.g. time to market) when technologies are embryonic and uncertain (see Figure 3.5). Thus, an appropriate level of technology maturity should be achieved before moving a technology into the application-oriented innovation development funnel. For example, Högman & Johannesson (2010) discuss the experience gained from developing, implementing and using a process model for technology development that incorporates the well-established Technology Readiness Levels (TRL) maturity scale (Mankins, 1995; Nolte, 2003; Collins & Pincock, 2010). The authors state that the model was closely linked to TRL and was decided that a level of 6 should be reached prior to application in product or process development.

The separation and interlinking of two funnels also implies that not all seven HiFFi subsystems are involved in the technology development funnel. Two of them (i.e. implementation and value capture) come into play later in the innovation funnel where technologies are to be embedded in capabilities and/or embodied in the products/services they support so that value can be delivered in the market. Although it should be recognised that technologies may be also exploited via other routes (e.g. by licensing-out) towards the end of the technology development funnel (Chesbrough, 2003).

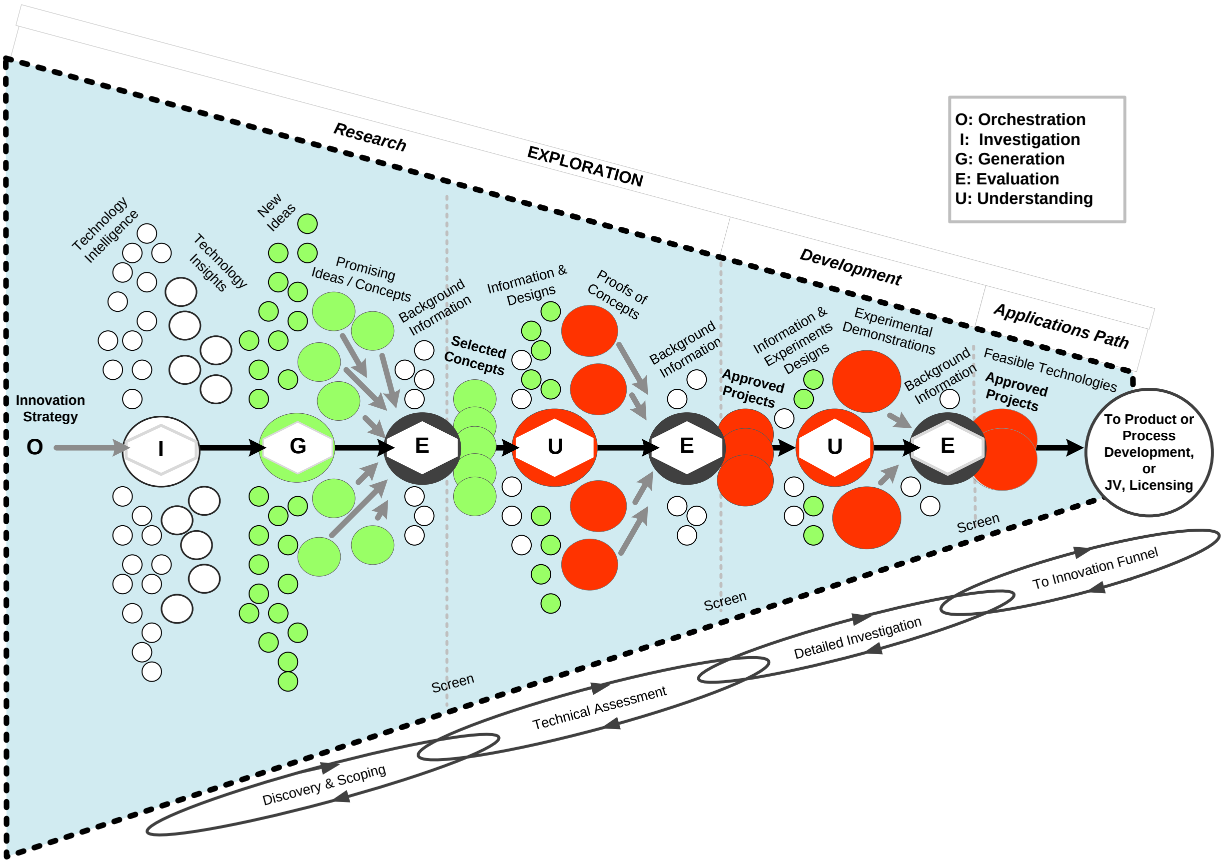

Figure 3.5. An example of a HiFFi funnel-like depiction for technology development.

In this context, a HiFFi system must also be configured to operate essential technology management processes, namely: identification, selection, acquisition, exploitation and protection of technology (Gregory, 1995; Phaal et al, 2004a). These processes are not always very visible in organisations, with relevant activities typically distributed within business processes that span strategy, innovation and operations (Phaal et al, 2010). Thus, a HiFFi system must be linked to the relevant strategy and operation processes in place. For example, the identification, selection and the ultimate form of exploitation (i.e. new products/services) could be directly carried out through the investigation, generation, evaluation and value capture subsystems of HiFFi, while the acquisition, protection and other forms of exploitation (i.e. selling or licensing out intellectual property) would be supported by operational support processes such as those related to human resources, procurement and legal matters.

3.3 HiFFi subsystems framework

In order to facilitate a flexible 'universal' framework that can be configured and applied by a whole range of organisations and stakeholders, a common language was designed which combines words, shapes and colours into two types of 'building blocks': subsystems and enablers. The generic set of building blocks is conformed of seven subsystems and six enablers (see Figure 3.6). The subsystems, when interlinked, build innovation 'value-chains' that are operationalised by procedures, techniques and tools. The enablers build the conditions that subsystems need to perform appropriately and create value. Thus, appropriate combinations of particular instances of these building blocks (e.g. a multidisciplinary team structure interacting with the right subsystem tool) must be deployed and fine tuned along an innovation cycle.

Subsystems building blocks are instantiated through the customisation of specific tools (i.e. the most basic practical devices) whereas enablers building blocks through the acquisition or development of specific human and organisational aspects (i.e. the necessary conditions). Simple to complex arrangements of subsystems tools and enabler attributes can be gradually deployed according to strategic needs and particular circumstances. This way, the SIS takes a lean, agile and empirical approach that allows it to deal with uncertainty and change more appropriately. The system will most likely exhibit more complex behaviours than the ones depicted in the development funnels (Figures 3.1, 3.4 and 3.5), with iterative, non-linear and unique activity trajectories that cannot be accurately predicted in advance.

Thus, we propose that at the system level, the model depicted in the HiFFi system framework (Figure 2.1) is useful to assess and establish the basis of an SIS; and at project level, particular arrangements of subsystems tools should be configured, integrated and applied as necessary following the guidelines of the HiFFi subsystems framework (Figure 3.6). At both levels, the underlying HiFFi principles must serve as the foundation for any configurations (Table 1).

3.4 Common aspects

Before any of the subsystems in the framework is described, a few aspects common to all of them are explained here:

- Divergence-convergence
- Thinking modes
- Enablers

Divergence-Convergence

All the subsystems incorporate a divergent–convergent construct (illustrated in each of the subsystems). The use of sequential divergent-convergent phases originated from early work on creativity (Osborn, 1953; Parnes, 1967) and psychology (Guilford, 1967). Divergent thinking can be defined as producing a diverse collection of responses to an open-ended question or task in which the outcome is not completely determined by the information available. It concentrates on generating a large and diverse number of alternative responses including original, unexpected, or unusual ideas. Thus, it is commonly associated

Subsystem Name	O ORCHESTRATION	I INVESTIGATION	G GENERATION	E EVALUATION	U UNDERSTANDING	M IMPLEMENTATION	V VALUE CAPTURE
Why is it needed?	**What Next…** ...in light of events and outcomes? To configure, integrate & manage subsystems/ processes, procedures, techniques, tools and enablers according to context and needs	**What Is…** ...our state and out there? To learn about the enterprise and the external environment	**What If…** ...there are new, better ways? To devise possible solutions	**What Merits…** ...further investment? To decide on what concepts/projects to work on & allocate resources	**What Matters…** ...really to our potential customers? To learn about potential users/ customers of a solution, including how important is a problem (Achieve Problem-Solution Fit)	**What Works…** ...for our potential customers and us? To learn about the value of a solution for potential users/ customers & other stakeholders (Achieve Product-Market Fit)	**What Grows…** ...sustainably as expected? To optimise the operation in order to achieve fast and profitable growth. (Achieve Business Model Fit)
What does it do?	**Facilitate perception, thinking and action towards vision and aims**	**Facilitate exploration activity towards new insights**	**Facilitate envisioning activity towards new concepts**	**Facilitate prioritisation activity towards investment focus**	**Accelerate articulation activity towards solution direction**	**Accelerate transformation activity towards value for customers**	**Accelerate optimisation activity towards value for organisation**
Knowledge Outcomes	Concept/Project brief(s), Roadmap(s) & Experiments board(s)	Enterprise/organisation, market, customer & technology insights	Solution concepts & Experiment ideas	Investment/divestment decisions	User/customer problem & solution insights	Solution & market facts	Business model facts

How does it do it?

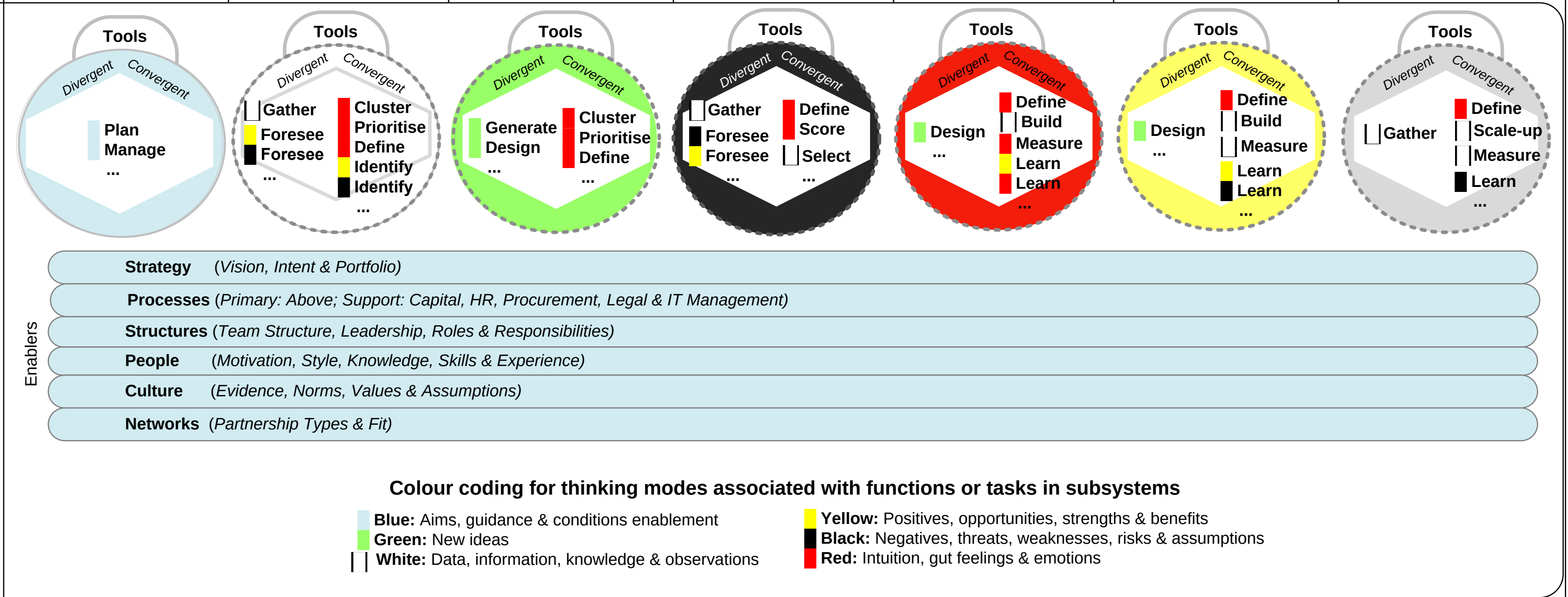

Figure 3.6 HiFFi subsystems framework (detailed view).

with *creativity or generative thinking.* Convergent thinking involves finding the correct or best answer, conventional to a well-defined problem or question. Many facts, information or ideas are examined or judged for their logical validity, within a set of rules, guidelines or paradigms. Thus, it is commonly associated with *critical thinking*. In the context of HiFFi, the fundamental idea is to first have a timeframe for generating as many new information pieces, insights or ideas as possible (i.e. divergence) and then making sense of them so to focus on the best one(s) (i.e. convergence), and iterating as necessary. Thus, the divergence–convergence cycle promotes exploration and learning.

Today such a scheme has been broadly established, not only among authors and practitioners in the field of creativity but also in related fields such as innovation and entrepreneurship. From methods such as Creative Problem Solving (CPS) that pioneered its practical and explicit use within a structured process and toolkit (e.g. Isaksen & Treffinger, 2004) or the Lateral Thinking and Six Thinking Hats techniques that facilitate the instrumentation of creative processes conformed of both phases (called 'expansion' and 'contraction') (de Bono, 2005) to design thinking approaches that clearly recognise its usefulness for understanding and structuring an innovation process (e.g. Liedtka & Ogilvie, 2011; IDEO.org, 2015) to hybrid or proprietary approaches incorporating the concept. Thus, organisations around the world have instrumented their innovation processes in some degree around divergence–convergence, whether explicitly or implicitly, since it seems to be an efficient way to structure thinking to produce a range and quality of outcomes. For example, as in Toyota's set-based concurrent approach for innovation development where implicit divergence occurs when many variations of concepts are generated and explicit convergence allows to move towards the best options (Ward et al, 1995; Sobek et al, 1999).

It should be recognised that the divergent–convergent concept can be applied with different levels of granularity in the context of a project process. One could characterise a process with only a few sets of divergent–convergent cycles, or break it down in much detail so as to comprise many sets (e.g. at the tool level, where team interactions with every tool in the process may be organised in a divergent–convergent fashion). For example, when using roadmapping tools in the context of a strategy or innovation process, as in the sequence of a strategic landscape roadmap followed by topic roadmaps (Phaal et al, 2007), named the 'S-Plan' and recently referred as the 'R1 (Roadmap 1) – R2 (Roadmap 2) sequence' (Kerr & Phaal, 2015), which has been depicted as consisting of two sequential divergent–convergent sets, each corresponding to each type of roadmap (Kerr et al, 2013) – see Figure 3.7. While during the first cycle strategic opportunities are identified and prioritised at high level, during the second cycle, the opportunities are explored in more depth.

Considering that the roadmap approach is flexible and can embed other tools (e.g. STEEP for Socio-cultural, Technological, Economic, Environmental and Political trends), this arrangement of two types of roadmaps (the tools) could also be designed with more divergent–convergent sets within each of them. The use of more sets of divergent–convergent phases would potentially increase clarity and efficiency to the process but may also add some management complexity. The HiFFi framework provides the flexibility to apply the concept at an appropriate level according to needs, from a macro perspective of subsystems along an innovation cycle (i.e. spanning weeks, months or years) to a micro perspective of tools in a workshop setting (i.e. lasting a few hours or days). While the macro perspective can be useful for understanding and communicating at a high level how a particular innovation cycle will be carried out, the micro perspective supports its operationalisation to achieve actual outcomes.

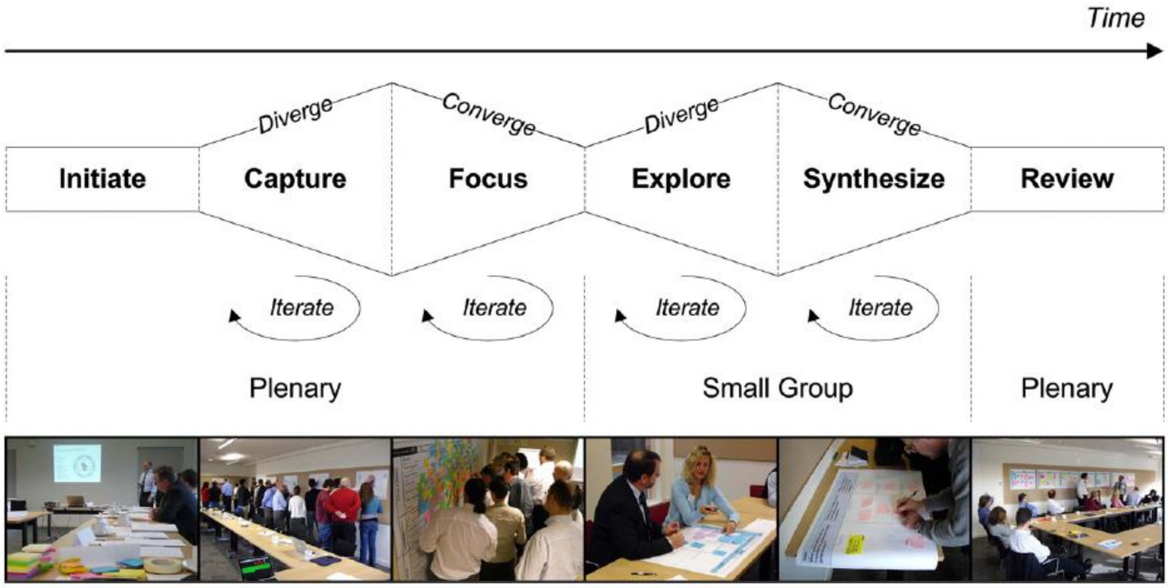

Figure 3.7 'R1–R2 sequence' using two Divergent–Convergent cycles.
Source: Kerr et al (2013).

Thinking Modes

The concept that the human brain can be deliberately challenged to concentrate in only one mode of thinking (as represented by a colour) for a determined time frame when carrying out a particular task, lays the foundation of the approach. It draws on the *parallel thinking* technique, also called, the *six thinking hats* (de Bono, 2000; Myers, 2012) which aims to improve the effectiveness and efficiency of a thinking activity (e.g. in a meeting or workshop setting). By making people aware of the 'rules' and facilitating the same mode of thinking at the same time, adversarial positions are substituted by collaborative behaviours that speed up outcomes. This contributes to focus on value and minimise waste (e.g. waste in the form of confrontations and misunderstandings). An analogy is borrowed from Myers (2012) to illustrate the technique: "When you play golf, you have several different clubs in your bag. You have a driver for long shots and a putter for hitting the ball into the hole on the green. In a similar way, each of the six hats has a specific function. Just as you select a golf club, so you would select a thinking hat".

Thus, a team/group 'activates' one of the six following thinking modes ('hats') at a particular time so that a task (e.g. a particular interaction with a tool during a workshop) and associated outcomes are significantly enhanced:

- *Blue.* The blue mode is concerned with managing the thinking process, that is, with 'metacognition' (thinking about the thinking). Just as the conductor of an orchestra tries to maximise the quality of sound of the instruments, this thinking mode encourages the best thinking from all participants.
- *White.* The white mode is concerned with data and information (even including someone else's feelings if available and relevant). It responds to questions such as: What do we know? What information is missing? What do we need to know? Where can we get the information? How accurate and relevant is the available information?

- *Yellow.* The yellow mode represents the strengths or positive aspects of thinking. It looks for benefits and value. It responds to questions such as: What are the benefits? What are the positives? What is the value here?
- *Black.* The black mode represents the weaknesses or negative aspects of thinking. It looks for risks, caution, difficulties and problems. It responds to questions such as: What are the challenges, both existing and potential? What are the risks? What could be the possible problems? What could be some of the difficulties? What are points of caution?
- *Red.* The red mode is concerned with intuition, feelings and gut instinct. It responds to questions such as: What does my intuition tell me? What is my gut reaction? What are my feelings right now?
- *Green.* The green mode represents creativity. It challenges the status quo and generates new ideas. It responds to questions such as: Are there any other ways to do this? What are the possibilities or alternatives? What could overcome our difficulties?

A sequence of thinking modes can be used in order to explore a subject thoroughly. Each thinking mode may be used as many times as required in the sequence but only one at a time. An example of a sequence for idea generation and selection is shown in Table 2.

Thinking Mode ('Hat')	Description
Blue	Focus statement: Generate new ideas about [a particular matter].
White	Share background information.
Green	Generate ideas.
Red	Converge on the best ideas.
Blue	Focus statement: Set up and manage the evaluation process. Evaluate one idea at a time.
Yellow	Identify the benefits of the idea.
Black	Identify the weaknesses, difficulties or risks of the idea.
Green	Generate ideas to overcome the weaknesses, difficulties or risks of the idea.
Blue	Summarise the evaluated ideas.
Red	Select ideas to move forward.
Blue	Plan next steps.

Table 2. Example of a 'Six Thinking Hats' sequence for idea generation and selection.
Source: Adapted from Myers (2012).

In the context of HiFFi, as shown in Figure 10, the thinking modes are summarised as follows:

- *Blue*: Aims, guidance and conditions enablement
- *White*: Data, information, knowledge and observations
- *Yellow*: Positives, opportunities, strengths and benefits
- *Black*: Negatives, threats, weaknesses, risks and assumptions
- *Red*: Intuition, feelings and emotions
- *Green*: New ideas

This example of a 'Six Thinking Hats' sequence can also be illustrated with HiFFi 'language' as shown in Figure 3.8. In a practical sense, this could be instrumented by using wall charts and sticky notes, or electronic means if convenient, which would allow dynamic changes as required during workshops/activities. From the perspective of thinking modes, this visual planning approach aims to help configure more productive innovation workshops/activity not only by means of the 'parallel thinking' sequence itself but also by the mix of skills/traits that could be incorporated in the team (in addition to domain-specific knowledge required), which are associated with each mode of thinking (e.g. creative skills are associated with the green thinking mode). From a broader perspective, this visual planning approach can potentially offer a variety of benefits that will be explained in more detail in Section 5. In this section, the example in Figure 3.8 helps to put together and illustrate some of the basic concepts of the HiFFi framework.

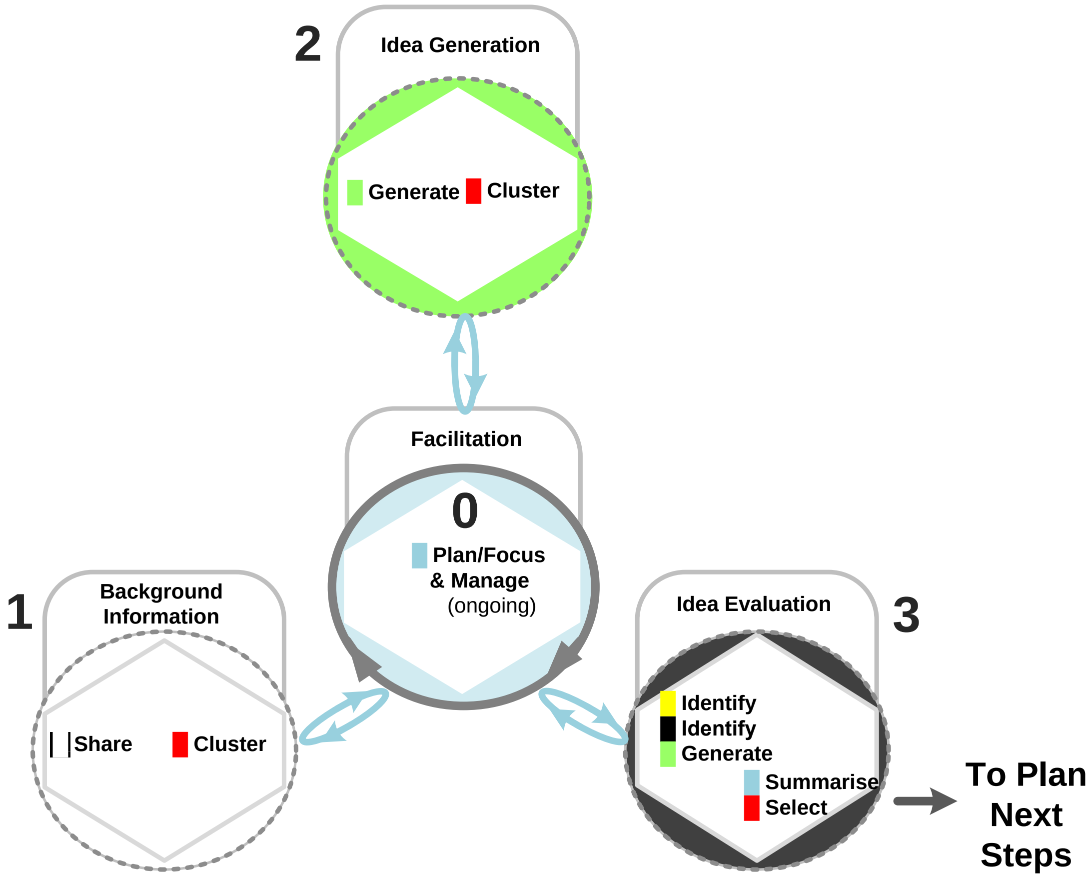

Figure 3.8 Example of 'Six Thinking Hats' sequence converted into HiFFi 'language'.

As it can be seen in the example, three HiFFi 'tools' have been configured, each one corresponding to a different HiFFi subsystem, namely: 'Background Information' to the *Investigation* subsystem, 'Idea Generation' to the *Generation* subsystem, and 'Idea Evaluation' to the *Evaluation* subsystem. Organising the effort as an arrangement of subsystem 'tools' aims to facilitate a better understanding, management and communication (transparency) of what is to be done step by step (i.e. which tools), its nature and purpose (e.g. what subsystem is associated with a tool and what is the focus), and how outcomes are to be achieved (i.e. what functions/tasks/activities and thinking modes are to be performed).

Moreover, the configuration of a tool using this type of depiction makes explicit the likelihood of divergence-convergence cycles, which helps to configure the appropriate functions and associated thinking modes, thus, supporting a better planning and management of both, individual thinking and group interactions (e.g. interactions among team members and with the tools). For example, the HiFFi 'sequence' depicted in Figure 12, in comparison with the 'Six Thinking Hats' sequence of Table 2, makes explicit the continuous operation of the orchestration subsystem and its facilitation role ('Blue' mode thinking) as well as clarifies opportunities to fine tune and adapt innovation activity. In this sense, the 'Cluster' function/task ('Red' mode thinking) was added in the convergent part[11] of 'Background Information' and 'Idea Generation' considering that many ideas could be generated during divergence and therefore, some mechanism to synthesise and/or group ideas according to a similar, underlying, or related notion might improve the velocity/rhythm of the workshops/sessions and the quality of outcomes[12].

Enablers

The subsystems operate within a context of resources and conditions that must be tuned to facilitate an innovation effort appropriately. The HiFFi framework can provide the basis for this through the assessment, configuration and development of the six enabling elements described earlier: *strategy*, *processes*, *structures*, *people*, *culture* and *networks*. Together, they represent the potentially 'fertile soil' that enables the subsystems to produce 'fruits' (see Figure 3.6).

[11] As identified by Tassoul and Buijs (2007), the verb 'to cluster' is defined by some as "to bring together groups of items on the basis of shared characteristics or attributes". Although this activity has been traditionally associated with a convergent type of thinking, possibly due to the influence of concepts in the long-established CPS method (Isaksen & Treffinger, 2004), Tassoul and Buijs (2007) argue that clustering is neither a form of divergence (you do not add new ideas) nor a form of convergence (you do not discard any ideas). For the authors, it is a transition step between divergence and convergence, which is more about making connections and building a shared understanding, in other words, about 'making sense' of a seemingly random collection of independent ideas or suggestions. In this document, the focus is in the potential of clustering to connect ideas and provoke new, additional ones by iterating back and forth within a divergence-convergence cycle, some of which are expected to be original, unusual or radical. Thus, for simplicity and familiarity, the 'Cluster' function/task is maintained within the traditional, convergent, notion.

[12] Although the quality of outcomes depends on a variety of factors such as the quality and complementarity of the individuals in the team, the configuration of tasks/activities such as *Clustering* might help in this example to make the most of the collective knowledge of the team, depending on how many iterations of the divergent-convergent cycle can be carried out within the time allocated, especially during 'Idea Generation'.

4. HiFFi subsystems

Before describing how a 'project process' and associated tools can be managed along an innovation cycle, it is first necessary to provide an account of the individual subsystems.

4.1 Orchestration subsystem

As shown in Figure 2.1, a subsystems model with a central hub arrangement is at the heart of the HiFFi system framework. The orchestration subsystem acts as the 'hub' that interconnects all the subsystems and facilitates the planning, setup and iteration of any activity that may be necessary within and between them.

The purpose of the orchestration subsystem is to configure, integrate and manage subsystems/processes and their associated procedures, techniques, tools and enablers according to the context and needs (Figure 3.6). Every other subsystem is 'called' on need basis in light of events and outcomes. At a the highest level, this subsystem is associated with the management of the Strategic Innovation System (e.g. supported by an senior sponsor, a manager and an advisory committee). At the project process level it is associated with the management of a particular innovation endeavour (e.g. supported by an appropriate team leadership). Thus, the mode of thinking in this subsystem tends to be managerial (i.e. blue colour), making decisions about management approaches (e.g. tools) and next steps, keeping stakeholders focused on aims and facilitating them guidance, and enabling favourable conditions.

This subsystem facilitates the synchronisation of information/knowledge flowing within and between subsystems tools, enabled by the time dimension of roadmaps (Kerr & Phaal, 2015); and the engagement of team members by keeping interactions alive and momentum going at the right pace. In order to achieve outcomes, the hub performs functions that allows it to manage other subsystems to perform their own functions. Functions must be clear to everyone and congruent with the purpose of the subsystem, the aims of the project and the particular task, and even with the divergent or convergent type of outcome pursued. During divergence, the key function is to capture data and information whereas in convergence, the key functions include to plan and agree on activity and investment. Other functions performed during procedures related to this subsystem include to communicate procedures and outcomes, and facilitate project management and decision-making (e.g. by facilitating stakeholder alignment and engagement).

In practice, the hub is implemented with the support of a few key interrelated tools and techniques, namely:

- Roadmap
- Concept/Project brief
- Experiments board

These tools help to link the innovation effort to the established project management practices and structures of the organisation. They support the management of a project process by systematically capturing the key knowledge from each subsystem activity and making decisions visible.

Roadmap

The roadmap is the primary tool in the hub arrangement, providing an integrative device to which other management tools can readily connect (Kerr & Phaal, 2015), acting as the focal point for strategy and planning activities (Phaal, 2006a). It can provide at all times a visual representation of innovation strategy in a single chart that seeks to lay out the key aims, the means it will use to deliver them, and the resources needed to make it all possible through time (Goffin & Mitchell, 2010; Phaal, Farrukh & Probert, 2010). Thus, roadmap visualisations can be deployed as communication devices to promote multidisciplinary dialogue and coordinate action (Kerr et al, 2012). Given its framework (see Figure 4.1), the tool can be flexibly configured and integrated according to need and context; and scaled to be used at both business/system/portfolio and opportunity/option/project levels of an organisation (Phaal et al, 2010; Farrukh et al, 2014).

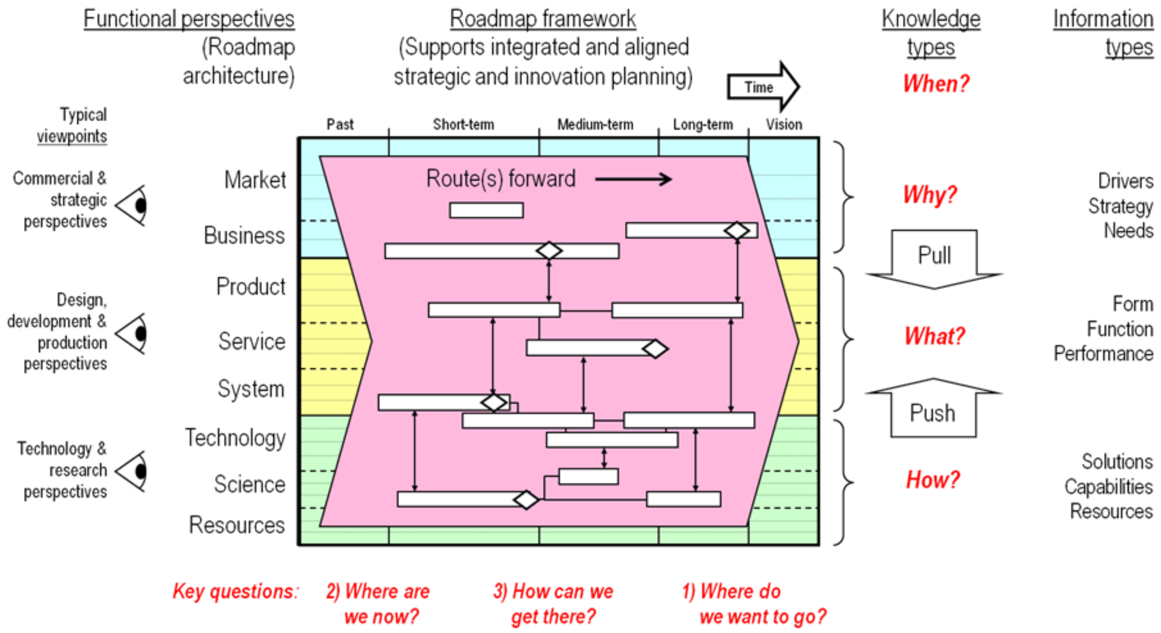

Figure 4.1 Generic Roadmap Architecture. Source: Phaal et al (2008)

Concept / Project Brief

The concept/project brief facilitates the integration of key knowledge that needs to be considered to support the management and communication of a formal innovation project (Liedtka & Ogilvie, 2011). It is intended to be an evolving device, thus its content will be enriched, changed and/or adjusted as progress is made. For some organisations, this brief could be considered the formal business case and may eventually lead to an actual plan.

As any tool in HiFFi, its configuration is flexible according to needs and context of the endeavour. The format may vary but it should in some form include information elements such as the following:

- Opportunity Vision / Scenario / Description
- What is it about?
    - Purpose / Goal / Intent / Scope
    - Target Users / Potential Market
    - Requirements / Constraints / Design Criteria
- Why is it important?
    - Rationale / Justification (e.g. Need, Quantified Value, Potential Benefits)
    - Potential competitors
- How can it be done?
    - Resources (e.g. People, Time, Money)
- When should it be done?
    - Plan / Actions / Next Steps
    - Milestones / Deadlines
    - Expected Outcomes
    - Success Metrics
- Who is interested? Who is responsible?
    - Stakeholders / Ownership
- Key Assumptions and Risks

It should be recognised that given the holistic architecture of a roadmap, most (if not all) of the key available information might already be there. Thus, depending on the case (e.g. communication style or needs of the organisation and team), the project brief could be integrated directly in the opportunity/option level roadmap (possibly by adding a vision and summary sections) (e.g. Farrukh et al, 2014; Phaal et al, 2015).

Experiments Board

The experiments board supports the management of the uncertainty of a concept by defining what must be learnt, how can it be learnt and when should it be learnt. Thus, it includes a prioritised list of the assumptions that must be true for an opportunity concept to work (i.e. validated desirability, feasibility and viability) and the experiments that could be done to validate each of the assumptions, including success metrics and the resources that would be needed to conduct them (Ries, 2011; Liedtka & Ogilvie, 2011; Osterwalder et al, 2014).

The analysis of the outcomes related to an assumption facilitates the learning needed to take one of the following routes: a) conduct further experiments if something remains uncertain; b) validate the assumption, which would support making further progress in the planned direction; c) invalidate the assumption, which should lead to a ‘pivot’ (Blank, 2013; Ries, 2011) translated in subsystems’ iterations in search of the right fit (e.g. problem-solution fit, product-market fit or business model fit) (Osterwalder et al, 2014). Any fundamental change in the logic of the business concept (e.g. a different customer segment) would be reflected in the roadmap and project brief, and may lead to new assumptions to be tested.

4.2 Investigation subsystem

A Strategic Innovation System (SIS) should be able to provide a means to identify potential opportunities and threats by exploring market, competitive and technology developments from internal and external sources (Kerr et al, 2006); and support the framing and development of a particular opportunity/project by facilitating insights about current reality

(Liedtka & Ogilvie, 2011; Cooper et al, 2002a); so that timely and relevant information can be provided to stakeholders.

Thus, the purpose of the investigation subsystem is to learn about the enterprise and the external environment (Figure 3.6). It facilitates exploration activity leading to new insights, responding to questions such as the following:

- External environment (intelligence): what are the main trends affecting the organisation (e.g. STEEPLE)? What are the forces governing competition (e.g. Porter analysis)? How is the market and what is it demanding (e.g. user / customer and market research)? What technologies are out there that might be of particular interest?
- Future (foresight): how the environment might be in the short, medium and long term (as seen from current reality)? What are the main certainties and uncertainties about the future aspects that are relevant to the organisation?
- State of the organisation: what are the current capabilities and resources of the organisation? What is its business model (i.e. how it creates, delivers and captures value)?

In order to answer these kind of questions, the subsystem performs a variety of functions. During divergence, the key functions include to gather and capture pieces of data and information, as well as to foresee possible negative aspects (e.g. risks, difficulties and/or assumptions) and/or positive aspects (e.g. benefits and value) associated with pieces of information; whereas in convergence, the key functions help to make sense of all data/information by clustering it into meaningful insights that can be assessed and prioritised. Thus, the mode of thinking during divergence should be predominantly oriented towards data, information, knowledge & observations (i.e. white colour) but allowing the exploration of negatives (i.e. black colour) and positives (i.e. yellow colour) when appropriate; whereas during convergence should mainly alternate between identifying positive and negative aspects (i.e. yellow and black colours correspondingly), with the right 'doses' of intuition at times (i.e. red colour). This way the intellectual effort can be efficiently directed towards the desired type of knowledge outcomes: enterprise, market, customer and/or technology insights.

In practice, this subsystem can be implemented with the support of tools and techniques such as the following:

- STEEPLE (e.g. integrated within Roadmap) (More, Probert & Phaal, 2015) for the purpose of identifying social, technological, economical, ethical, political, legal and environmental trends and drivers.
- Scenario planning (e.g. Ringland, 2006) for the purpose of comprehending possible futures by interpreting today's signals in the environment.
- Porter's forces (competitive analysis) (Porter, 1979, 2008) for the purpose of comprehending the level of competition and factors involved within an industry which may affect the ability of an organisation to serve a market and make a profit.
- Interlinked grids (QFD-like) (Phaal et al, 2001; Kerr & Phaal, 2015) for the purpose of analysing customer needs, establishing design criteria, and visualising implications.
- LEGO Serious Play (e.g. Frick et al 2013) for the purpose of comprehending values, interests, motivations and emotions of stakeholders (even unconscious or hidden drivers) and their roles, relationships and potential impacts within a team, environment or system.

- Business model canvas (Osterwalder & Pigneur, 2010) for the purpose of comprehending a current business model through its key elements and interrelationships.

4.3 Generation subsystem

A Strategic Innovation System (SIS) should be able to provide a means to systematically generate new possibilities and build an understanding of what holds strategic meaning, and hence new value for the organisation and its customers, suppliers, employees and other stakeholders (Stevens & Moultrie, 2011; Johnston & Bate, 2003; Cooper et al, 2002a).

Thus, the purpose of the generation subsystem is to create possible solutions (Figure 3.6). It facilitates envisioning activity leading to new concepts, responding to questions such as the following: what unique competitive advantages might the organisation create, given the external landscape and the reality of the organisation (capabilities and limitations)? What new products, services and business models might be developed to fulfil the expected growth and profitability?

In order to answer these kinds of questions, the subsystem performs a variety of functions. During divergence, the key functions include to generate new ideas and foresee possible negative aspects associated (e.g. risks); whereas in convergence, the key functions help to make sense of all ideas by clustering them into solution options that can later be elaborated and refined into business concepts. Thus, the mode of thinking during divergence should be predominantly oriented towards new ideas (i.e. green colour) but allowing the exploration of risks (i.e. black colour) when appropriate; whereas during convergence, experience and intuition (i.e. red colour) could be predominantly used. This way the intellectual effort can be efficiently directed towards the desired type of knowledge outcomes: solution opportunities/options and also experiment ideas.

In practice, this subsystem can be implemented with the support of tools and techniques such as the following:

- Lateral thinking (e.g. De Bono, 1990; Myers & Thompson, 2007) for the purpose of generating novel, unusual, or more radical, ideas.
- TRIZ (e.g. Ideal Final Result) (Altshuller, 1994; Savransky, 2000; Gadd, 2011) for the purpose of designing evolved or transformed systems (e.g. product, service, application or equipment) aiming to deliver increasingly more value to stakeholders.
- Business model canvas (Osterwalder & Pigneur, 2010; Osterwalder et al, 2014) for the purpose of envisioning new business models from the identification of customer needs and other insights.

4.4 Evaluation subsystem

A Strategic Innovation System (SIS) should be able to evaluate every single concept/project as necessary, as well as to look at an entire portfolio of projects in order to prioritise them and focus resources on the 'best bets' so that the potential value for the organisation can be maximised (Cooper, 1994; Cooper et al, 2002b; Mitchell et al, 2014).

Thus, the purpose of the evaluation subsystem is to decide on what concepts/projects to work on and allocate resources (see Figure 3.6). It facilitates prioritisation activity leading to investment focus, responding to questions such as the following:

- Risks: what can go wrong? What can help the organisation to manage the risks? What is the criteria for decision-making?
- Selection: what are the best ideas and concepts? What concepts/projects can give a viable answer to what is happening or will happen in the environment, thus ensuring the survival and growth of the organisation over time?

In order to answer these kind of questions, the subsystem performs a variety of functions. During divergence, the key functions include to gather background information on the project(s) as well as to foresee risks/difficulties and/or benefits/value of options; whereas in convergence, the key functions are to evaluate and prioritise concepts/projects so that decisions can be made and communicated, and the next evaluation criteria can also be defined. Thus, the mode of thinking during divergence should be predominantly oriented towards information (i.e. white colour) but allowing the exploration of negatives (i.e. black colour) and positives (i.e. yellow colour) when appropriate; whereas during convergence expert judgement and 'gut feel' (i.e. red colour) take much relevance. It is necessary to recognise the importance of experience and intuition in complex situations (e.g. evaluation of potential innovations), which does not necessarily dictate a lack of rigour (Dissel et al, 2005). This way the intellectual effort can be efficiently directed towards the desired type of knowledge outcomes: investment/divestment decisions.

In practice, this subsystem can be implemented with the support of tools and techniques such as the following:

- Scoring methods (e.g. Mitchell, Phaal and Athanassopoulou, 2014) for the purpose of evaluating early stage innovation projects.
- Opportunity-Feasibility matrix (e.g. Mitchell et al 2014; Farrukh et al, 2014) for the purpose of prioritising and selecting innovation projects.
- Financial methods (e.g. Cooper et al, 1997) for the purpose of evaluating late stage innovation projects.

4.5 Understanding subsystem

A Strategic Innovation System (SIS) should be able to provide a means to find out who the users/customers are for a solution (i.e. business or technology-based concept) and whether the problem that is intended to solve is important to them (Blank, 2013), as well as to identify unmet needs and even unarticulated needs (Cooper et al, 2002a; Ries, 2011) as early, rapidly and inexpensively as possible (Liedtka & Ogilvie, 2011; Ries, 2011; IDEO.org, 2015). At this point, it should facilitate a deep understanding of a prospective customer's problems rather than the technological details or features (Probert et al, 2013). The quest is to efficiently achieve what is known as 'problem-solution' fit, that is, evidence that customers care about certain problems and that the solution designed addresses them (Osterwalder et al, 2014).

Thus, the purpose of the understanding subsystem is to learn about potential users/customers of a solution, including how important is a problem or need (Figure 3.6). It accelerates articulation activity leading to solution direction, responding to questions such as the following: who is the right customer for our envisioned or actual technology/solution? How important is the problem actually to a user/customer?

In order to answer these kind of questions, the subsystem performs a variety of functions. During divergence, the key functions include to design conceptual models, demonstrators or rapid prototypes; whereas in convergence, the key functions include planning/defining, building and measuring the outcomes so that learning takes place and decisions can be made. Thus, the mode of thinking during divergence should be predominantly oriented towards experiment design (i.e. green colour); whereas during convergence the mode of thinking is varied. For example, using intuition (i.e. red colour) supported by reliable information (e.g. facilitated by roadmap and concept/project brief charts) may be useful to define/refine a plan for an experiment, which in turn could be used (i.e. white colour) to build a prototype and test/measure assumptions based on feedback (i.e. white colour) and experience (i.e. red colour). Focusing on the positive aspects (i.e. yellow colour) when a prototype does not work as desired could also be very useful for learning. This way the intellectual effort can be efficiently directed towards the desired type of knowledge outcomes: insights about user/customer problem and solution.

In practice, this subsystem can be implemented with the support of tools and techniques such as the following:

- TRIZ functional modelling (e.g. Gadd, 2011) for the purpose of ‘demonstrating’ and validating a possible solution system through a depiction (model or ‘2D prototype’) showing its components, relationships, and value creation.
- Rapid prototyping (e.g. Savoia, 2011; Hasso Plattner Institute of Design, 2013; IDEO.org, 2015) for the purpose of ‘demonstrating’ and validating early, inexpensively and quickly a concept (key assumptions) with stakeholders.
- Business model canvas (Osterwalder & Pigneur, 2010; Osterwalder et al, 2014) for the purpose of validating and learning with stakeholders about the ‘whole picture’ of value creation, delivery and capture of an envisioned business concept.

4.6 Implementation subsystem

A Strategic Innovation System (SIS) should be able to provide a means to effectively and efficiently transform a concept into a market-ready innovative solution by incorporating iterative development with short time-boxed increments to demonstrate something to stakeholders early, fast and often; allowing types of activities overlap as necessary (Cooper, 2014; Blank, 2013; Ries, 2011). The focus is on the gradual building and learning through deliverables, capabilities and prototypes of ever greater fidelity (Liedtka & Ogilvie, 2011) and thus, on the facts about the desirability, feasibility and viability of a solution (IDEO.org, 2015) rather than executing a marketing and sales plan (Blank, 2013), so that the existence of a market that reacts positively to an actual solution’s value proposition can be proven as fast as possible (i.e. a set of paying customers) before committing and scaling resources prematurely in the wrong route to market (i.e. wasting them). The quest is to efficiently achieve what is known as ‘product-market fit’, that is, evidence that the products and services offering is actually creating customer value and getting traction in the market (Osterwalder et al, 2014).

Thus, the purpose of the implementation subsystem is to learn about the value of a solution for potential users/customers (and other stakeholders such as suppliers and employees) (Figure 3.6). It accelerates transformation activity leading to value for customers, responding (as best as possible) to questions such as the following: what is actually feasible to be built? What attributes or features of the solution are actually valued by the user/customer (if any)? How good do they rate their experience with the solution? Are they coming back? Are they willing to pay in any particular revenue scheme? What should be sourced internally and what externally? What potential suppliers/partners are capable to deliver in terms of the required quality and scale? Which of them are willing to partner under certain financial (and other) conditions? What is actually viable that fits to the organisation's strategy? What should be the marketing and sales strategy, process and resources for a successful execution? In short, what should be the business model over time that fulfils the stakeholders expectations?

In order to answer these kind of questions, the subsystem performs a variety of functions. During divergence, the key functions include to design 'live' or market-ready deliverables or prototypes as well as full pilots, whereas in convergence, the key functions include planning/defining, building and measuring the outcomes so that learning takes place and decisions can be made. Thus, the mode of thinking during divergence should be predominantly oriented towards experiment design (i.e. green colour); whereas during convergence the mode of thinking is varied. For example, using intuition (i.e. red colour) supported by reliable information (e.g. facilitated by roadmap and concept/project brief charts) may be useful to define/refine a plan for an experiment, which in turn could be used (i.e. white colour) to build a prototype and test/measure assumptions based on facts (i.e. white colour). Focusing on both, the negative (i.e. black colour) and the positive aspects (i.e. yellow colour) of outcomes could also be useful for learning. This way the intellectual effort can be efficiently directed towards the desired type of knowledge outcomes: facts about solution (e.g. product/service value proposition, technology and capabilities) and market.

In practice, this subsystem can be implemented with the support of tools and techniques such as the following:

- Agile development methods (e.g. Satpathy, 2013) for the purpose of managing the development of potential innovations in a changing and uncertain environment.
- Make or buy methods (e.g. Probert, 1997; Canez, Platts & Probert, 2000) for the purpose of developing the make-or-buy strategy.
- 4D/Live prototyping (e.g. Liedtka & Ogilvie, 2011; IDEO.org, 2015) for the purpose of building and demonstrating an innovative component or system (e.g. product/service) in real world conditions with stakeholders (e.g. potential customers and partners), and validating and learning about its key assumptions.

4.7 Value capture subsystem

A Strategic Innovation System (SIS) should be able to build on initial/previous customer traction of an innovative solution and drive the desired market demand into the organisation's sales channel (Blank, 2013) by: executing the appropriate marketing and sales strategies and tactics; enhancing the solution or business model (e.g. by iterating to the implementation subsystem); and scaling up the production/operation capabilities as necessary; in a way that supports the achievement and maintenance of the innovative solution as the standard or dominant design in an industry (Utterback & Suarez, 1993). The marketing and sales strategies must account for the type of innovation (e.g. incremental or radical) and associated market (e.g. existing or new) (Blank, 2013); the types of customers in the progression throughout the adoption lifecycle (e.g. early or mainstream) (Moore, 2014); and the appropriate mechanisms to drive and monitor the growth (e.g. customer acquisition and referral) (Maurya, 2012). Commonly, the growth mechanisms are linked to elements in the business model so that changes on them may affect the business model and vice versa. For example, a change of mechanisms in order to seek faster or more profitable growth of customers may also require a change in the way that value is captured by the organisation (Ries, 2011) (e.g. the monetisation or revenue scheme). The quest is to efficiently achieve and maintain the 'business-model fit', that is, evidence that the value proposition of products/services is embedded in a profitable and scalable business model (Osterwalder et al, 2014).

Thus, the purpose of the value capture subsystem is to execute marketing and sales strategies and optimise the operation in order to achieve fast and profitable growth (Figure 3.6). It accelerates optimisation activity leading to value for the organisation, responding to questions such as the following: how do users/customers know about the solution? Are users/customers telling others about the solution? Is the solution having a sustainable and profitable growth at the expected rate?

In order to answer these kind of questions, the subsystem performs a variety of functions. During divergence, the key functions include to gather or capture any relevant information from previous activity (e.g. learning points); whereas in convergence, the key functions include planning/defining, scaling-up and measuring the outcomes so that learning about the new operation takes place and decisions can be made (e.g. optimise or pivot). Thus, the mode of thinking during divergence should be predominantly oriented towards information (i.e. white colour); whereas during convergence the mode of thinking is varied. For example, using intuition (i.e. red colour) supported by reliable information (e.g. facilitated by roadmap and concept/project brief charts) may be useful to define/refine the operations plan, which in turn would be used (i.e. white colour) to optimise/scale-up operations and measure results bases on facts (i.e. white colour). Focusing on the negative aspects (i.e. black colour) when everything seems to be working fine can be very useful for learning (e.g. to force thinking to find improvement opportunities). This way the intellectual effort can be efficiently directed towards the desired type of knowledge outcomes: facts about business model.

In practice, this subsystem can be implemented with the support of tools and techniques such as the following:

- Technology Adoption Life Cycle (Moore, 2014) for the purpose of deploying and maintaining appropriate marketing strategies and tactics that facilitate innovation adoption across market segments.
- Agile development methods (e.g. Satpathy, 2013) for the purpose of managing projects for scaling-up or optimising business operations in a changing and complex environment.
- Innovation/Growth Accounting (Ries, 2011) for the purpose of measuring the performance of an innovation (e.g. growth in terms of customers, revenue and profitability).

5. Managing a 'Project Process Expedition'

Although a traditional funnel depiction is inherently convergent (see Figure 3.1), several cycles of divergence-convergence characterise a transformation path towards an innovation, with each new divergence-convergence cycle getting an idea closer to a market-ready solution (IDEO.org, 2015). This can be better appreciated in the HiFFi funnel for innovation development where the existence of multiple divergence-convergence cycles is made more evident through the use of HiFFi divergent-convergent subsystems (Figure 3.4).

In practice, the use of HiFFi subsystems to explore, identify, create and transform an opportunity, is planned and managed through representations/arrangements of tools at the required level of granularity/detail (e.g. up to the level of 'tools within a tool'[13]). The HiFFi 'Project Process Expedition' (PPE) is a visual and dynamic planning approach that supports the configuration and integration of arrangements of tools along the innovation cycle, from opportunity/idea to innovation realisation and value capture. It facilitates the arrangement of tools that builds the path of knowledge transformation.

In order to illustrate the use of the PPE, the 'R1–R2' arrangement of tools mentioned earlier in the context of strategic and innovation workshops (see Figure 3.7) is now shown at two levels of granularity. Figure 5.1 shows an example of the conversion of the original 'R1–R2' sequence into HiFFi 'language' (i.e. into a PPE). As in the original depiction, the two divergent–convergent cycles can be appreciated. The first cycle corresponds to the 'strategic landscape roadmap' (R1) where opportunities are identified and selected, and the second cycle corresponds to the 'topic or option roadmaps' (R2), where each of the selected opportunities is explored in more detail. However, a more detailed procedure (e.g. a PPE) would be needed in order to operationalise this high-level sequence.

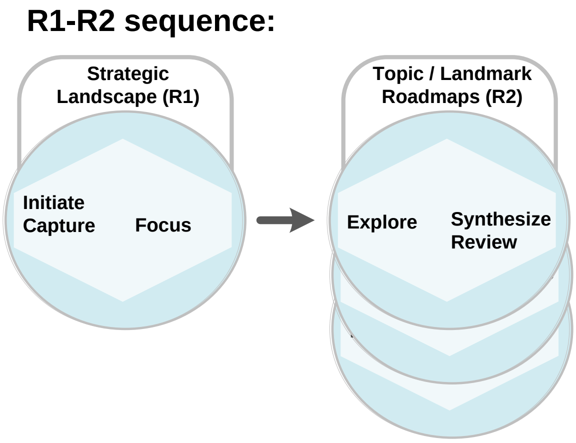

Figure 5.1 R1–R2 arrangement showing two sequential sets of divergent-convergent activity.

[13] A 'tool within a tool' may be considered a subtool since it is integrated in another one, which is the main tool. A subtool broadens the reach of the main tool, that is, the extent of the analysis that the main tool can cover (Keltsch et al, 2011). Several tools may be integrated or combined to form a single integrated composite visual for both application and communication purposes (Kerr et al, 2013).

Before illustrating how a detailed PPE arrangement could be configured, a brief description of the well-established S-Plan procedure (Phaal et al, 2007) is provided in Figure 5.2 as a basis to demonstrate the flexibility and other features of the PPE as a promising approach for strategic innovation planning and management. The S-Plan approach has the 'R1–R2' roadmaps arrangement embedded in it; the steps 'a' and 'b' are facilitated by the R1 roadmap (i.e. Strategic Landscape roadmap) whereas the steps 'c' and 'd' are facilitated by the R2 roadmap (i.e. Topic/Landmark roadmap).

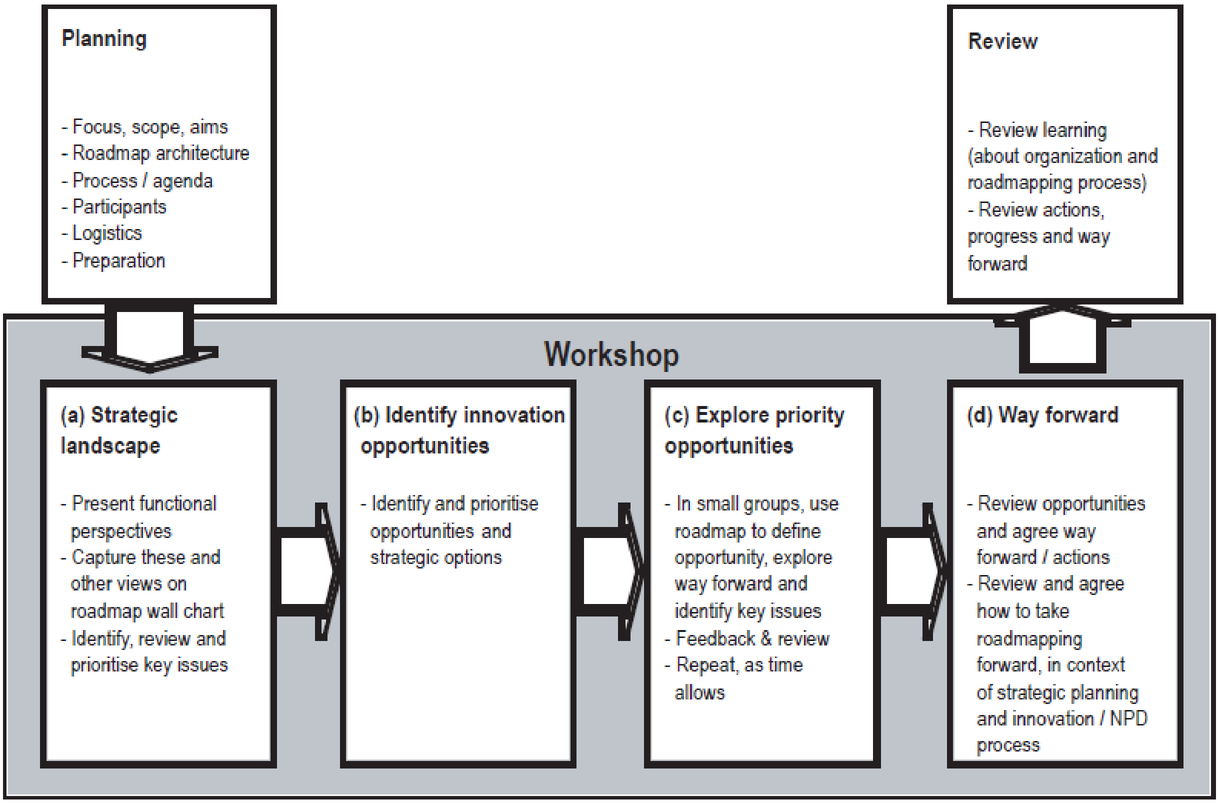

Figure 5.2 S-Plan workshop process for Strategic Appraisal (Identification and Exploration of Strategic Issues and Opportunities). Source: Phaal et al (2007).

Figures 5.3 and 5.4 represent a PPE granular arrangement for the 'R1–R2' sequence (i.e. the S-Plan), where the roadmaps are broken down in more detailed tools so that all the functionality of the HiFFi subsystems framework can be harnessed to achieve outcomes.

The illustration in Figure 5.3 (the R1 'zoom-in') is an example of a possible PPE for the Strategic Landscape roadmap. It consists of several 'steps', each which is instrumented with a tool planned to be used with a 'micro sequence' of functions (also called 'procedure'). Each function operates either in a divergent or convergent way and is supported by a particular mode of thinking as indicated by the colour (see Figure 3.6 to recall the meaning of colours). The steps can be briefly described as follows, each one with its illustrative micro sequence:

Planning and facilitating the workshop
(see initial step of Figure 5.2 translated into step '0' of Figure 5.3)

0) This step has been numbered as 'zero' because it is about managing/facilitating the activity and tools from start to end.

Blue	Plan and facilitate the activity, including the corresponding roadmap (as core integrating device) and tools (with their micro sequences of functions). In this case, all tools are integrated within the roadmap tool itself.

Presenting and capturing the different perspectives in the Strategic Landscape
(see step 'a' of Figure 5.2 translated into steps '1' to '6' of Figure 5.3)

1) Clarify the business drivers of the organisation and their relative importance.

⊓ White	Gather information about business drivers (e.g. goals and constraints).
Red	Cluster similar or closely related pieces of information.
Red	Prioritise business drivers so that their relative importance is clarified.

2) Obtain insights on market trends and drivers.

⊓ White	Gather information about market trends and drivers (e.g. socio-cultural, technological, environmental, economic and political).
Red	Cluster similar or closely related pieces of information.
Yellow	Identify possible opportunities for the organisation.
Black	Identify possible threats for the organisation.

3) Obtain insights on the current value proposition of products/services of the organisation.

⊓ White	Gather information about the current value proposition of the offerings (e.g. form, functions, features, performance, etc.).
Red	Cluster similar or closely related pieces of information.
Yellow	Identify possible opportunities for the organisation.
Black	Identify possible threats for the organisation.

4) Obtain insights on the current capabilities and resources of the organisation.

⊓ White	Gather information about the current capabilities and resources.
Red	Cluster similar or closely related pieces of information.
Yellow	Identify possible strengths of the organisation.
Black	Identify possible weaknesses of the organisation.

5) *Envision new possibilities of offerings/value propositions that can exploit the opportunities or inhibit the threats previously identified in the external environment through time.*

Green	Generate new ideas of offerings.
Red	Cluster similar or closely related pieces of information.

6) *Envision the capabilities and resources that may be needed to enable the new offerings/value propositions through time.*	
Green	Generate new ideas of capabilities and resources.
Red	Cluster similar or closely related pieces of information.

Identifying and prioritising strategic opportunities/options
(see step 'b' of Figure 5.2 translated into step '7' of Figure 5.3)

7) *Select the best opportunities/options based on their strategic fit.*	
Yellow	Foresee the value, benefits or positive impact of the concept to the stakeholders.
Black	Foresee the challenges, difficulties or negative impact of the concept to the stakeholders.
Red	Select the most promising options.

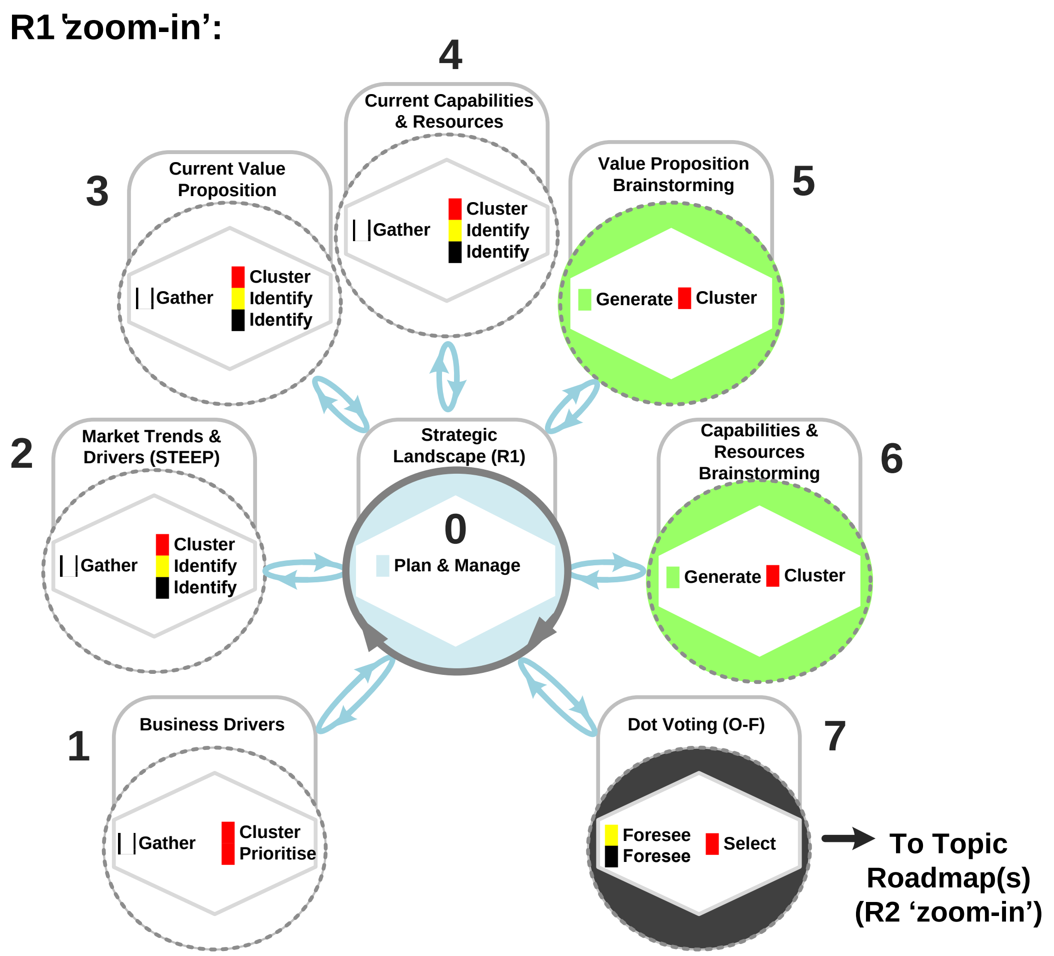

Figure 5.3 R1 arrangement with a more granular configuration.

The illustration in Figure 5.4 (the R2 'zoom-in') is an example of a possible PPE for the Topic/Landmark/Option roadmap. The steps can be briefly described as follows, each one with its illustrative micro sequence:

Planning and managing the small group activity
(e.g. team formation during step 'c' of Figure 5.2, which is translated into step '0' of Figure 5.4)

0) As in the R1 roadmap, this step has been numbered as 'zero' because it is about managing the activity and tools from start to end.	
Blue	Plan and manage the activity, including the R2 roadmap (as core integrating device) and tools (and their micro sequences of functions). In this case, all tools are also integrated within the roadmap tool itself.

Exploring priority opportunities/options
(see step 'c' of Figure 5.2 translated into steps '1' to '7' of Figure 5.4)

1) Define the opportunity vision or scenario.	
Green	Design the vision in enough depth and breadth by elaborating upon details and describing the scene, context or factors involved.
Red	Define the vision by synthesising the business concept (opportunity/option being explored) based on its key elements.
2) Obtain insights on the current state of the organisation.	
⊓ White	Gather information about the current capabilities and resources that are or might be relevant to the opportunity.
Red	Cluster similar or closely related pieces of information.
Yellow	Identify strengths.
Black	Identify weaknesses.
3) Envision a core path to the opportunity vision.	
Green	Design the application path by elaborating upon details of the deliverables or demonstrators along the way and describing milestones, decision points and other important elements involved.
Red	Define the path by synthesising it based on its key elements.
4) Obtain insights on market and business drivers.	
⊓ White	Gather information about market and business drivers.
Red	Cluster similar or closely related pieces of information.
Yellow	Identify possible opportunities and benefits.
Black	Identify possible threats and risks.

5) *Obtain insights related to technologies, capabilities and resources that may be needed.*	
Green	Design the enabling path by elaborating upon details of the possible technologies, capabilities and resources along the way.
Black	Foresee any challenges, difficulties or risks along the way.
Red	Define the path by synthesising it based on its key elements.
6) *Envision alternative paths/options to the opportunity vision*.	
Green	Design alternative application paths by elaborating upon details of the deliverables or demonstrators along the way and describing milestones, decision points and other important elements involved.
Red	Define the paths by synthesising them based on their key elements.
7) *Summarise the key knowledge.*	
⊓ White	Gather information about key learning points (e.g. enablers, barriers, decision points, risks, assumptions and knowledge gaps).
Red	Cluster similar or closely related pieces of information.
Red	Prioritise or highlight any critical learning points so that follow-up initiatives can be resourced and carried out in a timely manner.

Defining the way forward

(see step 'd' of Figure 5.2 translated into step '8' of Figure 5.4)

8) *Envision a core path to the opportunity vision.*	
⊓ White	Gather background information.
Red	Define the brief by synthetising the information based on the most important points that are required for resource approval (at portfolio level evaluation) and/or to guide the follow-up effort.

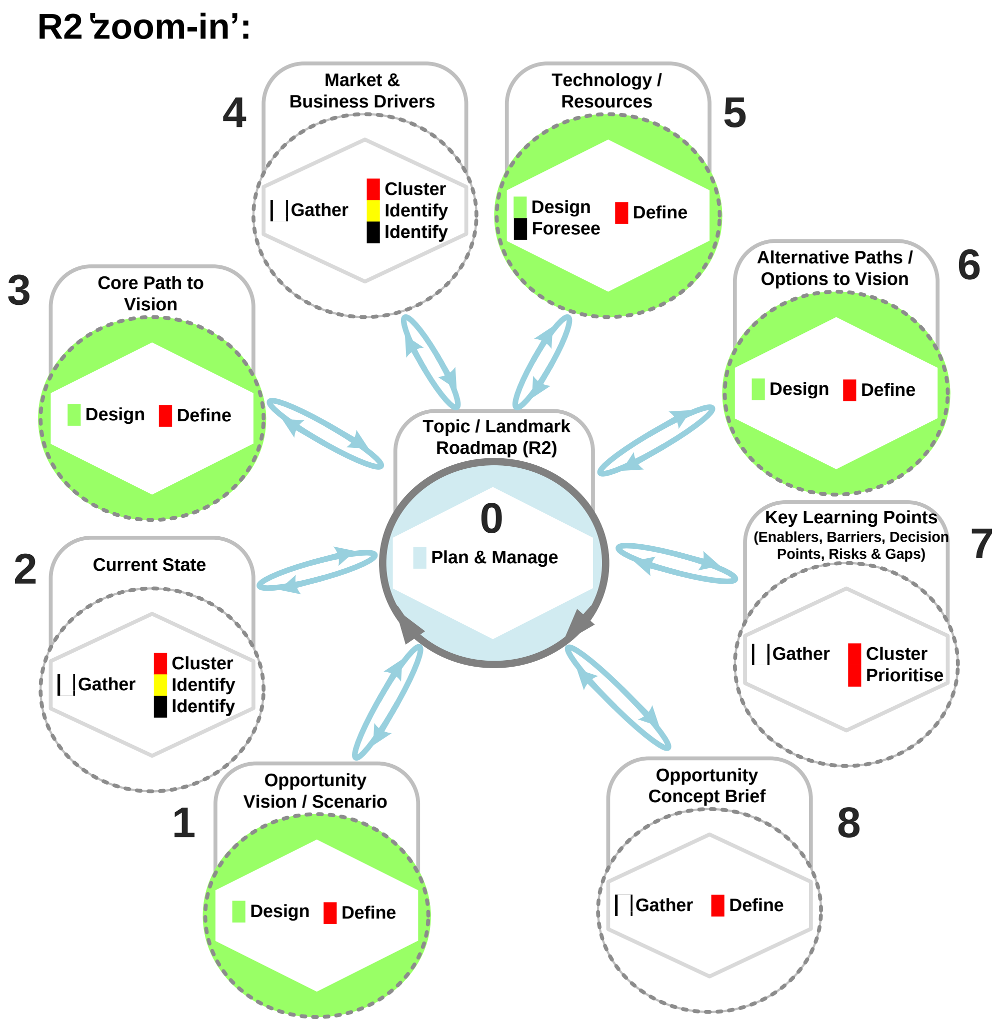

Figure 5.4 R2 arrangement with a more granular configuration.

5.1 Design considerations

Having illustrated how the HiFFi framework can be used to assess the overall innovation capability of an organisation (see Section 2.4) and 'unpack/describe/diagnose' innovation processes (as just described), the matter now turns to how it can be used to support 'design/configuration/customisation'. Thus, this section provides some guidance on how to determine a starting point and follow-up for an innovation endeavour, given a particular context.

Since the front-end of innovation (FEI) represents the part where an innovation cycle starts (i.e. where opportunities and ideas are identified and generated), a deeper look into the FEI is taken with the aim to provide a basis for system and project process design decisions within the context of HiFFi. The 'new concept development' (NCD) model developed by Koen et al (2002) can provide a good foundation for this purpose (see Figure 5.5) by deriving later a concrete logic based on the HiFFi framework.

The NCD model identifies three parts, namely:

- The *engine* at the center represents the leadership, culture, and business strategy of the organisation that drives the five iterative processes or activity elements in the FEI. In HiFFi, these aspects are taken into consideration when assessing and developing the enabling elements defined in the framework (see Figure 2.1 in Section 2), specifically, when considering *Strategy*, *Culture* and *Structures* (which includes leadership).
- The inner spoke area defines the five controllable activity elements of the FEI: *opportunity identification*, *opportunity analysis*, *idea generation and enrichment*, *idea selection*, and *concept definition*. In HiFFi, these activity elements are enabled through functions that HiFFi subystems provide, namely, *Investigation*, *Generation*, *Understanding* and *Evaluation*, supported by *Orchestration*.
- The *influencing factors* consist of organisational capabilities, the outside world (distribution channels, law, government policy, customers, competitors, and political and economic climate), and the enabling sciences (internal and external) that may be involved. These factors affect the entire innovation process through to commercialisation. In HiFFi, organisational capabilities are assessed as part of the innovation activities driven by the HiFFi *Investigation* subsystem; whereas the outside world is represented as external environment, which is also investigated according to the specific context, needs and constraints.

Although the *People* and *Networks* elements of the HiFFi framework (Figure 2.1) are not explicitly defined in the NCD model, some aspects of them are considered within the NCD engine and others are addressed when the authors make suggestions for methods, tools and techniques. They also make three basic definitions as a foundation for a common terminology that aims to improve communication and understanding, namely:

- *Opportunity*: A business or technology gap, that a company or individual realises, that exists between the current situation and an envisioned future in order to capture competitive advantage, respond to a threat, solve a problem, or ameliorate a difficulty.
- *Idea*: The most embryonic form of a new product or service [or any other form of potential innovation]. It often consists of a high-level view of the solution envisioned for the problem identified by the opportunity.
- *Concept*: Has a well-defined form, including both a written and visual description, that includes its primary features and customer benefits combined with a broad understanding of the technology needed.

A key insight of the NCD is the identification of two starting points for an innovation initiative. These are represented by the two arrows pointing into the model, which indicate that projects begin at either opportunity identification or idea generation and enrichment. There is also an exiting arrow representing how concepts leave the model and enter the new product development (NPD) (or any other type of innovation development).

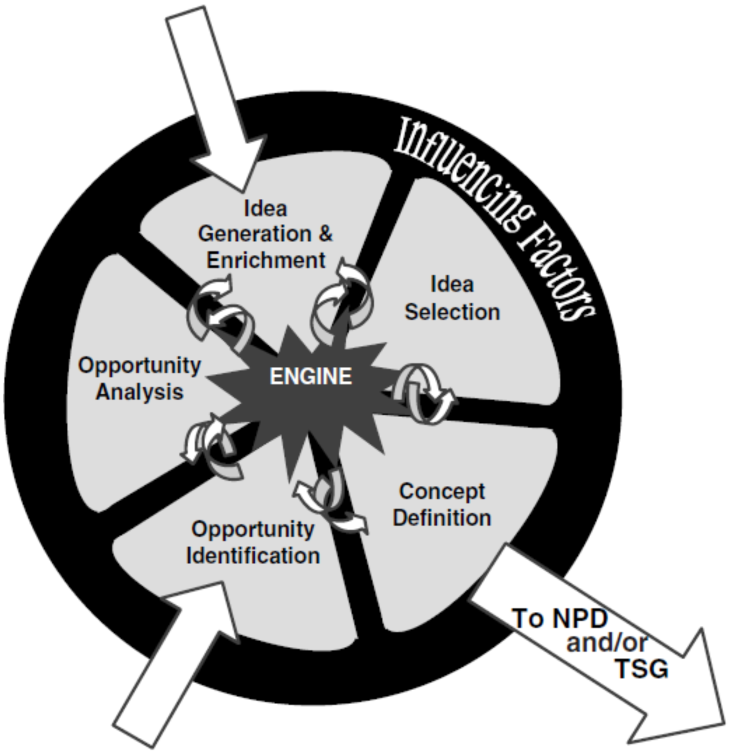

Figure 5.5 New concept development (NCD) model.
Source: Koen et al (2002).

In order to design a *starting point* (i.e. immediate activity) to develop a HiFFi system and 'project process expeditions' towards the fulfilment of strategic goals, an organisation should have a good understanding of the following aspects:

- Current state of strategic innovation capability (i.e. the enabling/inhibiting elements explained in Section 2.4, which include the key components in the NCD model, such as the 'engine').
- Types of events that trigger innovation explorations (e.g. a communicated strategy or an identified opportunity).
- Types of tools and techniques that facilitate the start of innovation explorations.

Understanding current state of strategic innovation capability

An initial (and periodic) understanding of the strategic innovation capability allows an organisation to design appropriate improvement initiatives to provide a conducive and resourceful environment for innovation projects. The *Strategy* element should be the starting point in the assessment since it allows to comprehend the long-term needs of an organisation and have a sense of the magnitude of a possible financial/commercial gap. This element provides direction for the organisation and thus, shapes the way in which the *Processes* element (i.e. project processes) and other process-driven elements are designed in a Strategic Innovation System (SIS). For example, a company that aims to grow exponentially in the long-term may need to consider an innovation portfolio with a significant proportion focused on radical/breakthrough projects, and may also need to consider new technology areas for development. These type of initiatives may require some basic conditions to be in place, such as an explorative culture and creative people, as well as autonomous (self-managed) structures/teams in order to be able to go beyond current paradigms and mindsets. Thus, an understanding of the goals and current level of capability maturity facilitates decisions on what enabling elements to develop, to what degree develop them, and when they should be in place. For some kind of organisations this is more challenging than for others. For example, for start-ups, a culture of creativity, experimentation and risk-taking is normally more natural than in established organisations, where a culture of precision and risk-avoidance, driven by short-term objectives, is more common (recall example in Section 2.4).

Understanding the types of events that trigger innovation explorations

Once the basic enabling conditions are set according to strategic drivers, a stream of innovation projects can flow more smoothly. However, it is important to recognise where such a stream can originate and the different types of triggering events involved, as well as how activities should be started and channeled. The first part require an understanding about the emergence of opportunities and ideas and the second part requires an understanding of the possible activity flows. These aspects are discussed next.

Initial impulses for innovation are triggered mainly by business interest and technological competence (Brem & Voigt, 2009). In the former, the impulses 'materialise' in the form of opportunities and ideas that may have the potential to be transformed in innovations that satisfy market needs while achieving business goals. In the latter, the impulses 'materialise' in the form of ideas for inventions (usually coming from R&D) that take advantage of a technology or capability without initial consideration of market needs. This reflects the common notion that there are two broad ways that innovation is driven, namely: market pull and technology push. Whereas in market pull a specific need or problem 'searches' for diverse technological potentials, in technology push a technological potential 'searches' for different needs or problems to be solved (Pfeiffer et al, 1997; Brem & Voigt, 2009). These two 'innovation ways' are not mutually exclusive and an appropriate balance should be pursued between market pull (requirements) and technology push (capabilities) (Phaal et al, 2010).

Figure 5.6 illustrates a HiFFi system logic where both market- and technology-driven opportunities and ideas have a place. The logic proposes three proactive starting points (i.e. O1, I1 and I2), two reactive starting points (i.e. O2 and I3), and a simplified activity flow for the HiFFi front-end of innovation. This depiction draws from key concepts of the research-based NCD model described earlier (see Figure 5.5), where two different generic types of starting points are recognised, which give rise to the five starting points (located in the *Reconnaissance* part of the *Strategic Fit stage*).

Starting points O1 and O2 are *Opportunity-oriented*, where the 'triggering event' is expected to be the communication of strategic drivers, interests or themes in an organisation. In O1, the opportunities are proactively searched and identified. This point implies the enablement of an SIS with market, business and technology intelligence capabilities that operate ideally in continuous way, but could also operate in a periodic or ad hoc fashion (e.g. Kerr et al, 2006; Mortara, 2010). In O2, opportunities are identified or recognised passively as people go about their regular work. Thus, in this case the starting point would be an early assessment of the opportunity (e.g. by an empowered individual) in regards to its strategic relevance. A satisfactory outcome from activities at these starting points would lead to *Idea*

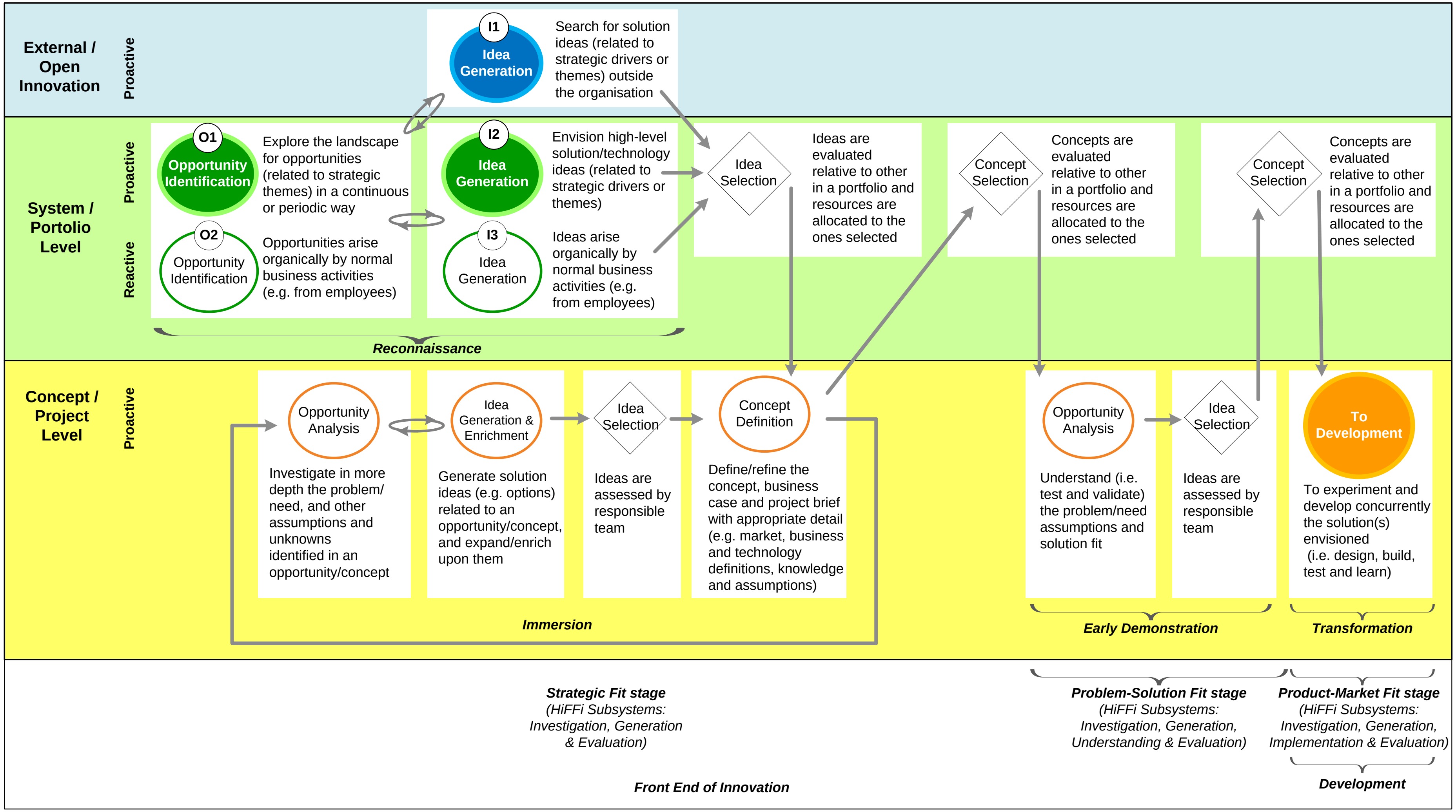

Figure 5.6 Starting points and a simplified activity flow in the HiFFi front-end of innovation.

Generation and Enrichment points I1 and/or I2, and possibly to I3 if the identified opportunities are shared with/among employees.

Two examples were borrowed and adapted from Koen et al (2002) in order to illustrate the activity elements in Figure 5.6:

- A market-driven example about the development of nonfat potato chips using a fat substitute (a substance that provides the same flavor as fat but is not absorbed in the body).
- A technology-driven example about the development of the 3M Post-it notepads.

Opportunity identification:

- Opportunity identification occurred in the nonfat potato chip example when the food company recognised the need to develop low-fat products to respond to developing consumer trends and the competitive threat in this area [e.g. Outcome of O1].

- Opportunity identification in the 3M example occurred when Silver, the inventor of the unusual glue, recognised that he had created something truly unique—a glue that was more tacky than adhesive [e.g. Outcome of O2].

I1, I2 and I3 are *Idea-oriented*, where the 'triggering event' is either a communicated strategy, an identified opportunity, or a 'sponsored' technology competence. In I1, solution ideas are searched proactively outside the organisation. This point implies the enablement of an SIS with open innovation approaches in place. In I2, solution ideas are also searched proactively but within the boundaries of the organisation, which implies the formation of teams to carry out deliberate creative efforts. In I3, solution ideas arise from normal business activities. In any case, viable solution ideas are generated by linking market needs/problems and technologies/capabilities in a way that can be profitable and/or strategically convenient for the organisation. However, it is important to recognise that when the 'triggering event' is market-driven, solution ideas (which may envision alternative technologies/capabilities) can be directly generated from the identified market problem/need, whereas when is technology-driven, solution ideas (i.e. technology application ideas in this case) can be generated by focusing the search on different market problems/needs that the technology can potentially solve. A satisfactory outcome from activities at these starting points would lead to *Idea Selection*, where a formal evaluation of the idea would be conducted in regards to its strategic relevance and ideally, according to its impact to a portfolio as well.

Examples

Idea generation and enrichment:

- Idea generation and enrichment occurred in the nonfat potato chip example when several methods of delivering nonfat potato chips were identified. Some ideas involved reducing the total fat content; others were about the development of a fat substitute that could provide the same flavor as fat but would not be absorbed in the body [e.g. Outcome of I2 and possibly I1 and I3].

- Idea generation and enrichment in the 3M example occurred when several product ideas (technology applications) were identified, such as the sticky bulletin board and notepads [e.g. Outcome of I2 and possibly I3].

Idea selection:

- Idea selection occurred in the nonfat potato chip example when a particular fat substitute molecule was chosen.

- Idea selection occurred in the 3M example when the notepad idea was selected for continued concept development.

All ideas making it through this early evaluation (*Idea Selection* filter/screen) are then elaborated into a concept to be further investigated (*Opportunity Analysis*), enriched and evolved (*Idea Generation & Enrichment*)[14]. As it can be seen in Figure 5.6, all these activities take place in the *Immersion* part of the *Strategic Fit stage* and would happen iteratively until a point where the concept/project brief and business case requirements are 'complete' and can be evaluated (in the first *Concept Selection* screen). If the outcome is satisfactory, then some early experiments (e.g. rapid prototypes) may then be carried out to test and validate key customer assumptions (which take place in the *Problem-Solution Fit stage*). Satisfactory evidence of these experiments would then lead to a pre-development evaluation (in the second *Concept Selection* screen) so that the concept can be evaluated as a promising candidate to be developed/transformed in the next stage (*Product-Market Fit stage*) into a new product, service, process or other type of business innovation.

Examples

Concept definition:

- In the nonfat potato chip example, a scientific program was defined (and refined/complemented iteratively) to develop the selected fat substitute molecule.

- In the 3M example, the concept for an entirely new manufacturing process to attach a 'nonsticking' adhesive to paper was defined.

Opportunity analysis:

- Opportunity analysis occurred in the nonfat potato chip example when the food company examined the trends in more detail. Did consumers really want a low-fat product, or did they want one that was low-calorie and/or low-cholesterol? How much taste would

[14] In contrast with the NCD model, in HiFFi the concept definition activity is not the final element in the FEI but an activity where a concept/project is defined and complemented iteratively until it fulfils the information requirements and criteria established (or it is 'killed' or 'put on hold'). If the outcome is satisfactory, then early experiments can be conducted to validate customer and problem assumptions, which, if confirmed, would lead to innovation development.

consumers give up? Was the market mainly a small niche? What were the regulatory issues? In this element the food company also examined the value of such an effort to their portfolio and the competitive threats if they did not develop such products.

- Opportunity analysis in the 3M case took place when Silver visited every division at 3M in his quest to understand better the potential application of the strange adhesive.

It should be recognised that the activity flow in FEI models is a simplification of a complex phenomenon where activities often proceed in a non-linear and iterative fashion, giving rise to new opportunities and ideas on the way (i.e. new ‘triggering events’), which should feed the appropriate starting points for new innovation initiatives. For example, *Opportunity Analysis* and *Idea Generation and Enrichment* at project level may feed *Opportunity Identification* at system level, and thus, increase the spectrum of possibilities to fulfil stakeholder expectations. However, the purpose of the model in Figure 5.6 is not to show all possible activity interconnections and iterations that might occur in a FEI but to provide a simple basis to support the design of ‘project process expeditions’ (e.g. tool selection, configuration and integration) within the logic of a HiFFi system.

Types of tools and techniques that facilitate the start of innovation explorations

As it has been described earlier in this document, the HiFFi framework can potentially integrate a wide variety of management tools. However, the recommended approach is to start with a small set of core tools/toolkits and incorporate additional (new) tools when the required knowledge breadth and depth cannot be obtained with current tools and the maturity in the use of current tools is reasonably high. However, an appropriate process to manage the tool lifecycle should be used (e.g. Keltsch et al, 2011), which covers from understanding the event or situation triggering the need for an additional tool, followed by a purposeful design, application and improvement.

The roadmapping approach is used as the focal device given its ability to support strategic alignment, decision making, planning and communication during different phases of the innovation effort (Phaal et al, 2010). Many authors have recognised the holistic nature of roadmaps as a key strength. As Koen et al (2002) states: “[the roadmap] is one of the few tools that can easily convey the complexity of real world projects to people who are not part of the project team”. Kerr et al (2015) argues that “roadmap should be deemed as being instrumental, and always considered for inclusion in any management toolkit, for the following crucial reasons:

- It embodies a flexible and powerful underpinning framework (Why-What-How-When-Where-Who);
- It can act as an integrative central hub to which other tools can easily connect;
- It provides a natural starting point, since it can be applied as a structured brainstorm for initiating group input and interactions;
- It can act as a strategic canvas, offering a broad visual means for communicating to different stakeholder audiences”.

The generalised roadmap form illustrated in Figure 5.7 enables the approach to be adapted for application in a wide range of contexts (for example, focusing on technology, product, or system), supporting the linkage of technological and commercial perspectives, and the balance between market pull (requirements) and technology push (capabilities) (Phaal et al, 2007, 2010).

Some forms of roadmaps are particularly suited to the front end of strategy and innovation processes, such as the S-Plan and the T-Plan (see Figure 5.8) designed to support general strategic appraisal, and the identification and exploration of new strategic, innovation and business opportunities (Phaal et al, 2007). They are complemented by portfolio matrices (e.g. opportunity-feasibility factors and matrix), which form part of the toolkits proposed by Kerr et al (2015), in order to support evaluation and prioritisation activities. Thus, these approaches have been established in HiFFi as core tools that facilitate starting points (see Figure 5.9). From there, other tools can be integrated as necessary. As Kerr et al (2015) states when explaining about the S-Plan approach, “the content on the landscape forms a repository of rich and broad information. Such information can then be directly drawn upon (i.e. explored, analysed, transposed, refined) by the other tools...”. These roadmap approaches facilitate interactive multi-stakeholder workshops that enable the HiFFi system to be applied rapidly in a ‘diagnostic’ mode, configured and scaled up in line with organisational requirements. They are intended as a starting point of a longer-term roadmapping mechanism embedded in a HiFFi system.

It should be recalled that activities in the FEI are iterative so that ideas and concepts are enriched as more research, ideation, and even experiments, are carried out. The challenges with rolling out and embedding roadmapping within an organisation should not be underestimated. It can take many iterations before full benefits are realised (Phaal et al, 2007). Appropriate approaches for roadmapping implementation should be used (e.g. Gerdsri et al, 2009) and additional techniques and tools that feed into a roadmap should be considered as the innovation initiatives evolve. For example, particular tools/toolkits provided by broad approaches such as open innovation and design thinking could be valuable in the front end of innovation at iterations of concept/project design in which outside support, ethnographic/observational/human-centered research, and prototyping can provide increasing breadth and/or depth of knowledge (see Figure 5.10).

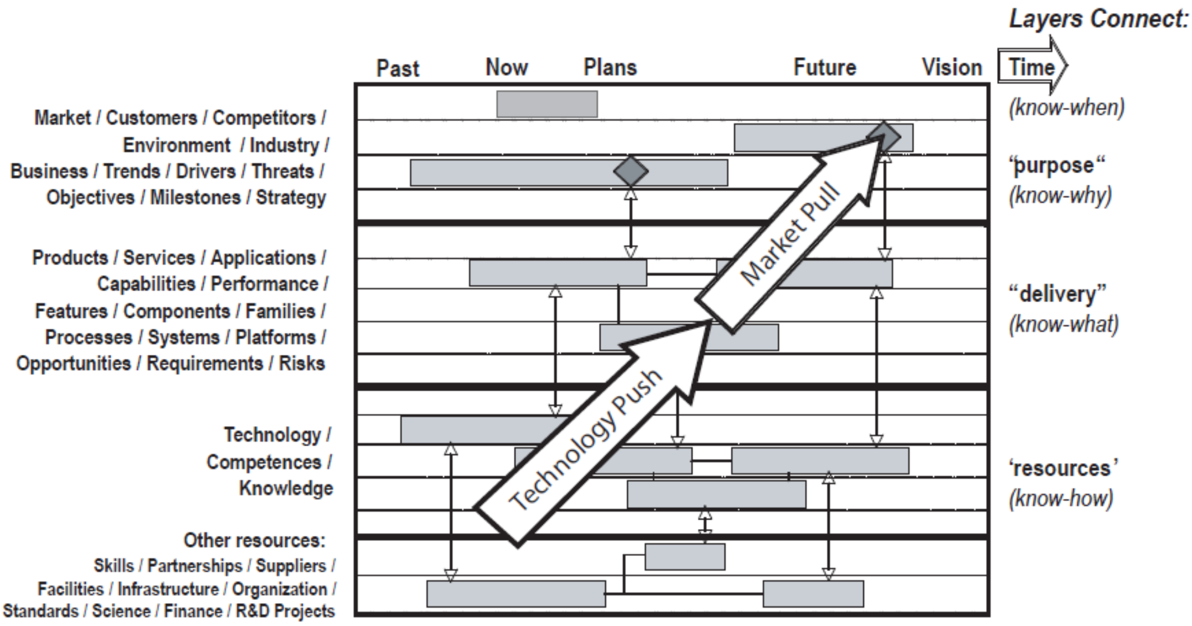

Figure 5.7 Generalised Roadmap: Enables the approach to be adapted for application in a wide range of contexts. Source: Phaal et al (2007)

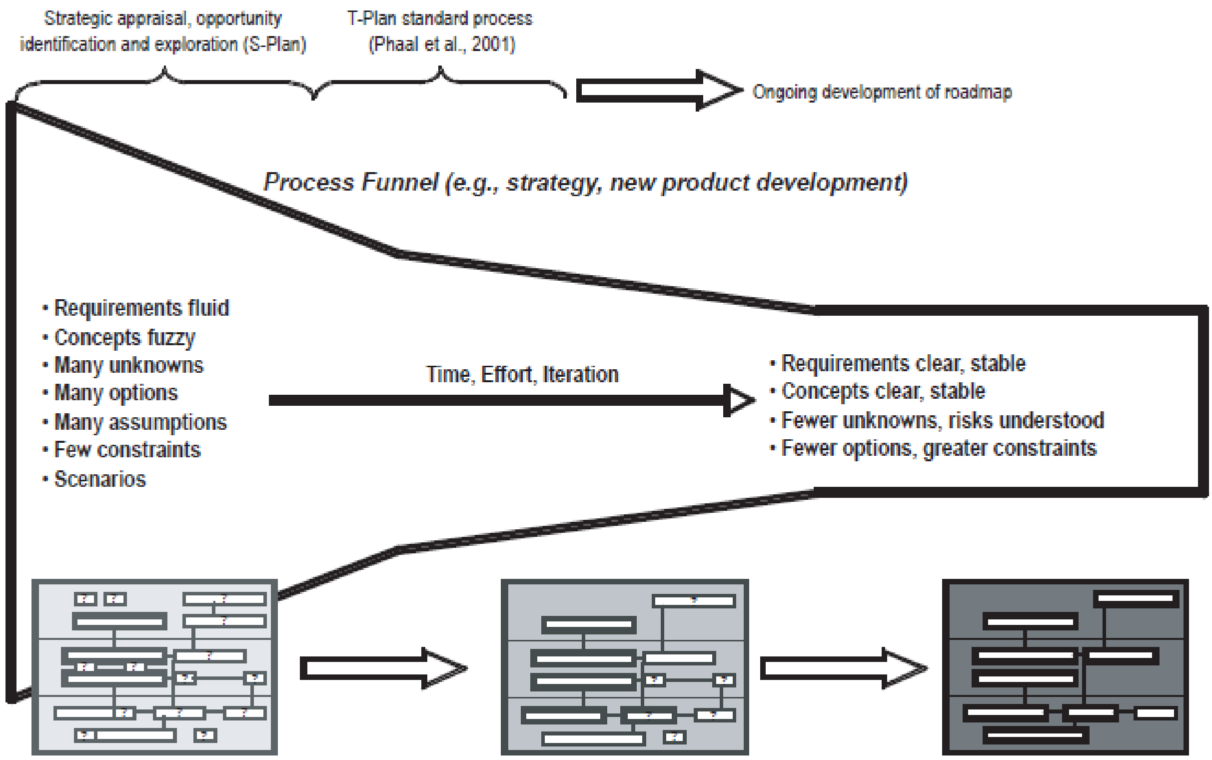

Figure 5.8 Roadmaps can provide a unifying structure and focus through strategic planning and innovation processes. Source: Phaal et al (2007).

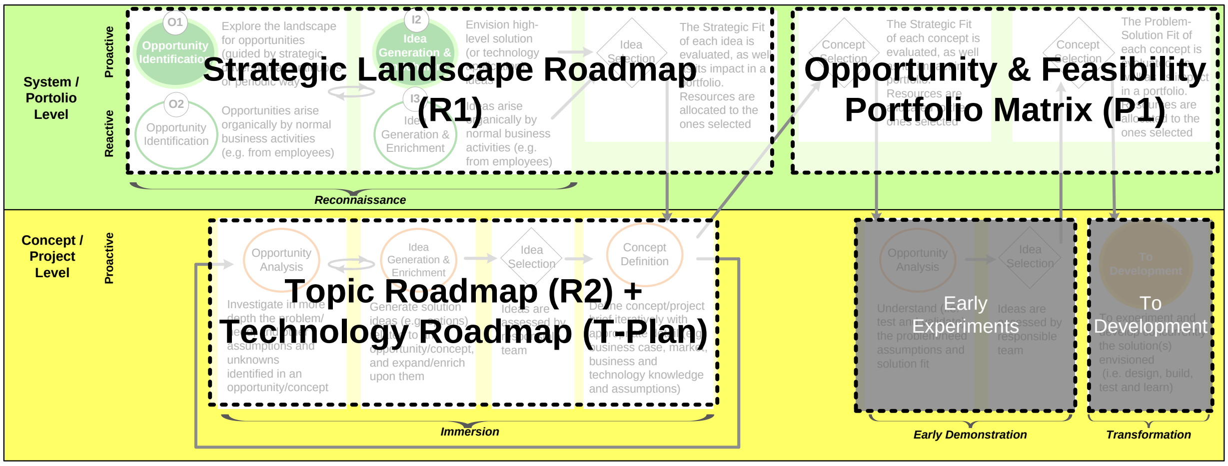

Figure 5.9 Example of core approaches to facilitate starting points
in the HiFFi front end of Innovation.

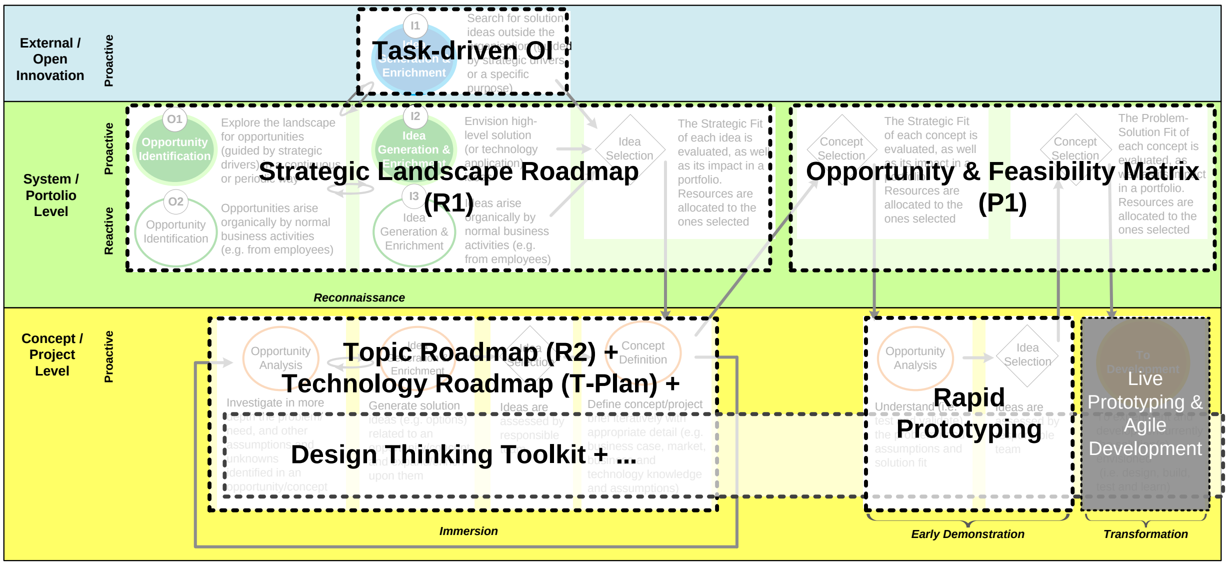

Figure 5.10 Example of core approaches complemented by other toolkits to facilitate
concept/project evolution in the HiFFi front end of Innovation.

Having introduced the HiFFi framework, two short cases of entrepreneurial start-ups in different contexts and stages illustrate potential benefits of the use of HiFFi. In the first case, a technology originated in pre-commercial university applied research is ‘pushed’ by the inventor to find promising market routes. In the second one, an entrepreneur’s vision drives the innovation endeavour and solution ideas, ‘pulled’ by a presumed market need. In particular, these examples show how the framework can be used to support the diagnostic and design of a project process.

5.2 Emotion Sense: Smartphone technology to manage ongoing health conditions

Emotion Sense is a technology platform for building applications that harness mobile smartphone data to measure, monitor, and improve human behaviours. The mobile software collects participant's self-reported moods, thoughts, and symptoms, while passively measuring their physical activity, sociability, and mobility via the device's sensors (see Figure 5.11a). Building on research since 2010 (e.g. Rachuri et al, 2010; Rachuri & Mascolo, 2011; Lathia et al, 2013), the platform has reached certain level of maturity as demonstrated by tests in relevant environments. Three main types of experiments were conducted, which are described as follows:

- An application called "Q Sense" was designed to learn about the user's high-risk smoking locations and situations before they quit, so it could send situation-specific personalised support after the quit date (see Figure 5.11b). The purpose of this study was to assess the application when used alongside routine NHS support services (UK's national health system). Although new related research is ongoing, current outcomes demonstrate a promising technology.
- An application called "Easy M" is an application for researchers to conduct smartphone-based experience sampling studies that collect sensor data (see Figure 5.11c). This application has been shown to a set of potential customers (researchers) in the United Kingdom and has drawn the attention of some them who are eager to use it. However it is still uncertain whether a sufficient set of customers will be willing to pay for it at some point in the future (through some revenue model that is not clear yet what it should be).
- A generic application of the Emotion Sense platform was released in February of 2013, focusing on subjective wellbeing. The application has been downloaded over 36,000 times worldwide – its data is supporting research at the University of Cambridge.

(a) (b) (c)

Figure 5.11 a) A screen shot of the Emotion Sense generic application, b) Q Sense application to help prevent smoking, and c) Easy M to conduct smartphone-based research.
Sources: http://www.emotionsense.org/, http://www.qsense.phpc.cam.ac.uk/, and http://www.cl.cam.ac.uk/~nkl25/easym/

Although preliminary tests had shown a promising technology, a high-growth commercialisation route to market had not yet been validated. For example, there was still uncertainty as to whom should be the target customers for the platform/application in order to be commercially viable. Thus, the team of inventors (entrepreneurs) was assisted in their innovation journey by a multidisciplinary university team that followed a three-month standard process aimed to help turn a lab technology (embedded in some application prototypes in this case) into a commercially-viable product concept. In order to understand the process in more depth, one of the authors of this document was allowed to participate in the team.

The process was operationalised through a series of sessions/workshops running for 2 to 3 hours every week, as well as field activity estimated in about 4 additional hours during the same week (e.g. for conducting interviews). The broad process steps can be outlined as follows:

a) Getting started

The team learned about each other and met the inventors, who explained about their technology. The session also provided an introduction to the resources to get started on the project. Times for weekly meetings with team members and mentors were agreed.

b) Team brainstorming

The team generated ideas for applications and uses of the technology. The team summarised its results at the end of the session and assigned tasks between team members, based on each person's knowledge and experience.

c) Customer interviews

An interactive workshop was carried out focusing on the key communication skills to gather information and feedback from industry experts. The project team met to identify which of the generated market applications were technically feasible, so that at least three people were contacted in relevant industries during the following week.

d) First external assessment

An executive presentation was provided to a panel of three commercial experts (15 minutes to present and 15 minutes for questions) who interpreted the information provided, asked questions, and gave their impressions and recommendations. The presentation was developed according to a recommended general structure: a) summary of the product/technology and its benefits; b) the target markets or routes to market being investigated for the technology-based product; and c) a list of companies to potentially contact, and the specific profiles (with names if possible, otherwise descriptions of roles).

e) Internal assessment

The team met to: a) review feedback from customer discussions, including problems encountered, as well as any other feedback; b) discuss on how to improve the approaches to external people so that the best information could be obtained from them; c) generate new ideas for target markets; and d) assess which market applications could be technologically feasible. The team then continued with its research activities (e.g. customer interviews and secondary research) and its members agreed on next meetings.

f) Selection

The team met to: select the best applications for the technology; refine the route to market for each selected application; and plan the activities prior to the final presentation/assessment.

g) Final external assessment

Finally, the team presented its results and recommended next steps for the project to a number of external people, including mentors, and academic and industry experts, who asked questions and expressed their opinions openly.

<u>Diagnostic of project process</u>

It was evident that the process described earlier contributed valuable insights, even though the final outcome in terms of market route did not turn out to be different from what had already been identified by the inventors (i.e. it pointed to continue in the line of current experiments and prototypes). However, even in this alternative (which was the most 'developed'), key questions as to market desirability and business viability remained unanswered. Thus, there was a kind of feeling in the team that something had been missed or that time had not been enough.

When examining the process under the lens of the HiFFi framework, it became evident that a more structured process could have been more efficient and productive. In particular, the following situations that were experienced along the process may represent process improvement opportunities:

- Comprehension of the business drivers of the inventors, as well as the current status of their technology was not rapidly grasped by the team, even for non-technical matters. For example, the team realised only after several meetings that it was more about a service platform (including software, hardware, data and research capabilities) so that it should not be treated as a mere mobile technology. And more importantly, the team found out late in the process that the inventors were primarily concerned with the very short term since they were running out of funds and were in the need to prove customer traction to potential investors shortly. At that point in time, the team was encouraged to focus on finding a market route that built on the current technology with minimum additional development/investment (i.e. focus on clinical applications). Thus, applications out of that scope were put on hold. In other words, the project wasted resources such as time (at least from the three-month project perspective).
- Research was mainly directed towards secondary research and customer interviews either in person or virtually (e.g. by phone call). Thus, opportunity/problem identification and potential solution validation were limited to what a potential customer or industry expert could verbally articulate.
- Generation of new ideas and further development of concepts, as well as their evaluation, was not guided by any particular technique or tool, leaving to the team members to informally devise procedures or structures on the go. Thus, the information and knowledge that flowed from one activity to another was not totally consistent or neatly integrated.

Design of project process

By applying the HiFFi framework principles and the Project Process Expedition (PPE) approach, it is possible to delineate a potentially efficient and effective path to market. Even if the activities require a period beyond three months, the innovation process could be readily continued so to achieve the aims pursued for the short, medium and long term. A PPE might have facilitated the configuration, integration and application of particular tools along the innovation cycle, allowing for adjustment as necessary (e.g. iterations).

Before showing an example of a detailed PPE for the Emotion Sense project, a staged model is shown below to provide a reference base to facilitate the understanding of each tool arrangement in a full-cycle configuration (see Figure 5.12). The staged model comprises the four stages proposed: strategic fit, problem-solution fit, product-market fit and business model fit. The first two could be seen as what traditionally is referred as the front end of innovation (FEI), the second one as the development stage, and the last one as the commercialisation stage. It is important to recognise that although evaluation ‘gates’ are mostly self-managed (i.e. at project level) in entrepreneurial ventures, the evaluation ‘gates’ in depiction emphasise the possibility that other stakeholders are also involved as reviewers; as when panelists (e.g. industry experts and potential investors) were invited at the middle and the end of the three-month period. These reviewers may not only assess the potential of an opportunity/idea/concept but may also contrast it with other options in order to prioritise them and make the best decisions.

The PPE will be shown in consecutive parts, as indicated by the letters ‘a’ to ‘l’. Each part is carried out through an arrangement of tools. As explained in Section 5.1, the starting point is based on standard roadmap approaches and more tools and techniques are integrated as the project process evolves. It is estimated that three roadmapping ‘iterations/exercises’ could be carried out in a three-month period, and at least one rapid prototype test, given what was experienced in regards to resource allocations and constraints. Figure 5.13 shows the tools proposed for the FEI (i.e. Strategic Fit stage plus Problem-Solution Fit stage).

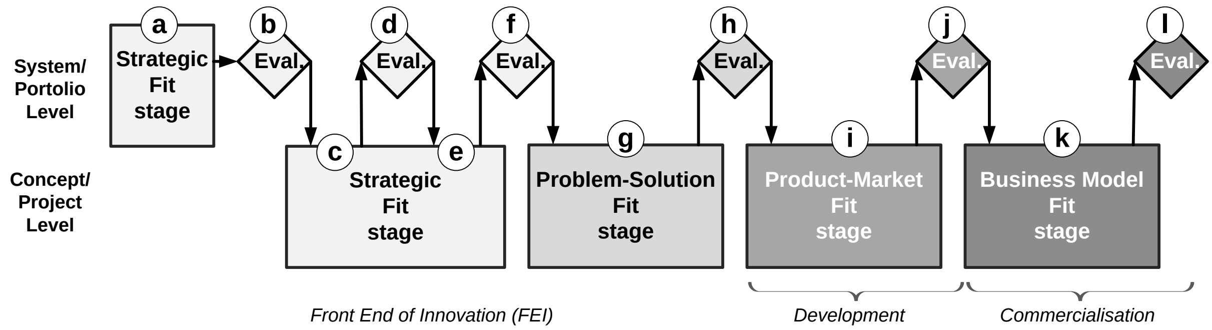

Figure 5.12 Staged Model for Emotion Sense Project (Full Cycle).

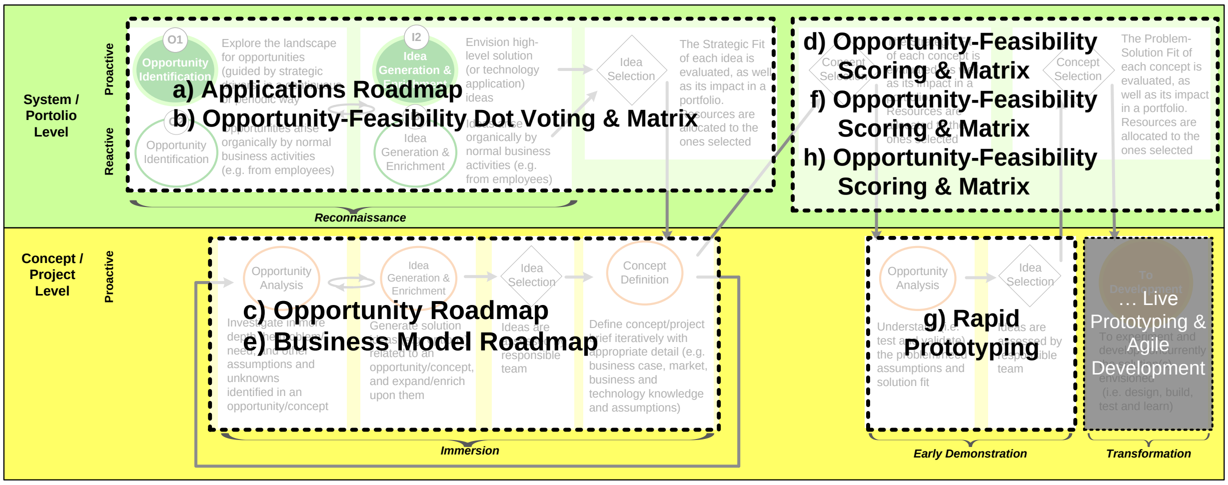

Figure 5.13 Tool selection for the initial iterations in the front end of the Emotion Sense innovation project process (i.e. an initial three-month period)

Strategic Fit stage

a) Applications roadmap ('reconnaissance') (see Figure 5.14, up to step 6):

0) Applications roadmap. To prepare the workshop templates/tools, agenda, procedures and environment. An applications roadmap is set-up to explore possible applications (solution opportunities/ideas) of Emotion Sense in the short, medium and long term. At the end of the workshop, outputs are shared for reflection and the way forward is agreed (to opportunity roadmaps).
1) Current state. To capture in the roadmap the key details on the technology, capabilities and resources involved so that possible strengths and weaknesses are comprehended by the team.
2) Business drivers. To capture in the roadmap the aims and constraints of the inventors so that the overall vision, aspirations and strategy through time are clear to the team at the outset.
3) Evaluation criteria (factors). To define collaboratively the assessment categories and factors of opportunity (impact/value/benefit) and feasibility (difficulty/effort/risk) to be used later for individual scoring, taking into account the business drivers.
4) Evaluation criteria (scaling statements). To define collaboratively the scaling statements for each of the factors of opportunity (impact/value/benefit) and feasibility (difficulty/effort/risk) which later facilitate a more objective assessment of each of the factors by individuals.
5) Market drivers. To research and capture in the roadmap the key market trends and drivers that may be relevant to Emotion Sense so that possible opportunities and threats are comprehended by the team.
6) Applications brainstorming. To envision (and capture in the roadmap) application options that can be matched to the business and market drivers. The description of every brainstormed application option should briefly integrate its unique/valuable features, the market target and potential, the technology and resources involved, and the time frame for its realisation (e.g. short, medium or long term).

b) Evaluation (see Figure 5.14, the last two steps):

7) Opportunity and feasibility dot voting. To prioritise the options in the roadmap by voting based on the impact/value/benefit of every option and the difficulty/effort/risk involved in its implementation.
8) Prioritisation (opportunity-feasibility matrix). To map the application opportunities (options) in a two-dimensional matrix according to their number of votes in each dimension so that decisions can be made on which of them to work on further. This step will lead to second order (project level) roadmaps, one per opportunity selected.

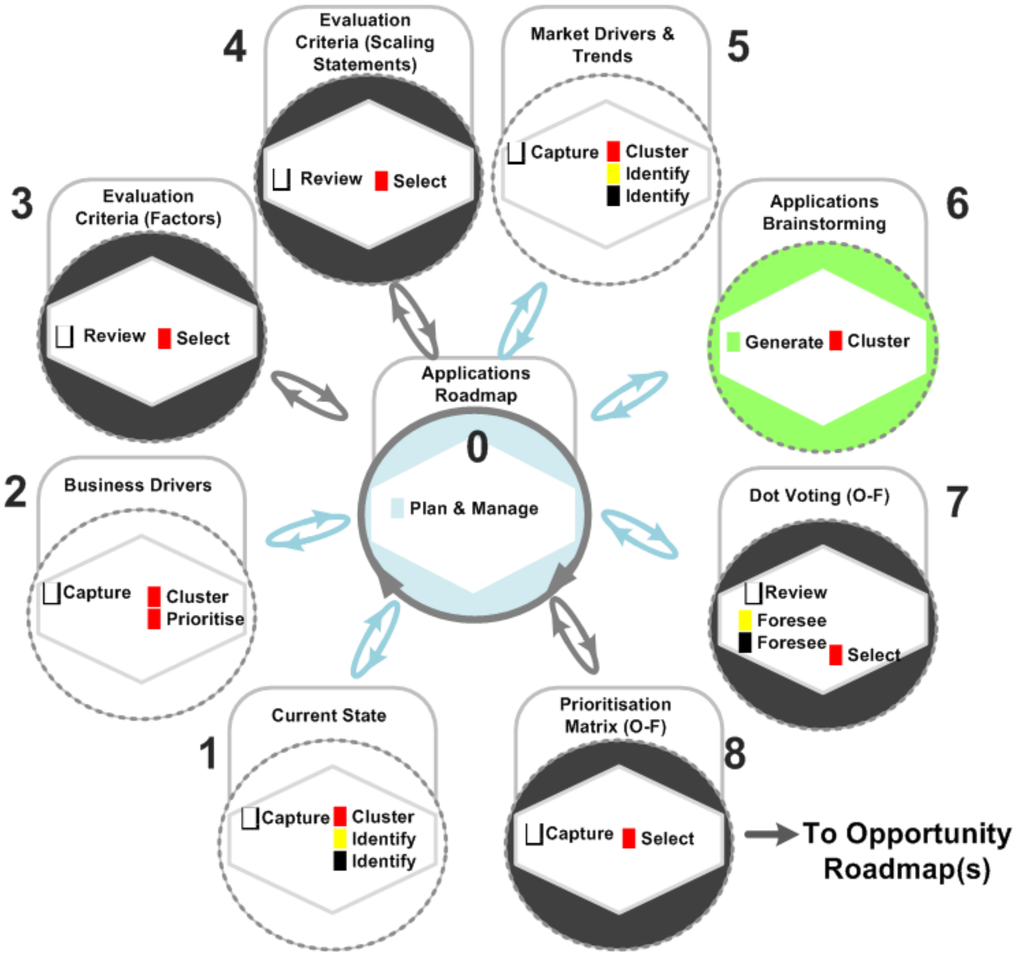

Figure 5.14 Parts 'a' (steps 0 through 6) and 'b' (steps 7 and 8) at Strategic Fit stage.

c) Opportunity roadmap (first 'immersion') (see Figure 5.15)

0) Opportunity roadmap. To prepare the workshop templates/tools, agenda, procedures and environment. An opportunity roadmap is set-up to explore a selected opportunity in more detail. At the end of this part, outputs are shared for reflection and the way forward is agreed (to opportunities evaluation).
1) Opportunity research. To conduct initial primary and secondary research related to a selected opportunity.
2) Opportunity vision/scenario. To define in the roadmap the successful value opportunity scenario, including the value proposition and potential market value (if possible).

3) Current state. To describe in the roadmap the current position in terms of value proposition, technology/capabilities and resources.
4) Core path to vision. To envision in the roadmap what might be done to achieve the vision, including how and when (e.g. deliverables, demonstrators and decision points).
5) Market and business drivers. To map in the roadmap the market, business and commercial drivers.
6) Technology/resources. To map in the roadmap the technology, finance, resource and partnering requirements.
7) Alternative paths/options to vision. To define in the roadmap alternative path/options.
8) Key learning points. To summarise in the roadmap the enablers, barriers, decision points, knowledge gaps and risks.
9) Opportunity concept brief. To synthesise in the roadmap the key aspects of the opportunity (e.g. what is the purpose or goal of the opportunity, why it is exciting and can be justified, how it can be achieved, when the first results would be achieved, who the key stakeholders are and who would be responsible for taking the opportunity forward).

Figure 5.15 Part ‘c’ at Strategic Fit stage.

d) Opportunities evaluation (see Figure 5.16)

0) Portfolio roadmap. To prepare the tools, agenda, procedures and environment. A roadmap at system/portfolio level is set-up to allow a selected opportunity to be analysed in relation to the other opportunities, as well as to other projects ongoing and on hold (if convenient). At the end of this part, outputs are shared for reflection and the way forward is agreed.
1) Individual scoring. To score an application opportunity individually based on the defined criteria organised in two dimensions: opportunity and feasibility. Then, an overall two-dimensional score can be obtained.
2) Prioritisation (opportunity-feasibility matrix). To map the application opportunities (options) in a two-dimensional matrix according to their overall scores so that decisions can be made on which of them to work on further. The portfolio roadmap can support decisions by adding clarity on the links to other innovation efforts and facilitating new insights. This step leads to activities for the development of business model roadmaps, related to selected opportunities.

In this example, the evaluation activities indicated as the parts ‘d’, ‘f’, ‘h’ and ‘j’ in the staged model (see Figure 5.12) are carried out following the same arrangement of tools. That is, only the first (‘b’) and last evaluation (‘l’) in the innovation cycle would be different. However, it should be recognised that as progress is made, the project uncertainty is reduced so that financial techniques should also be included at some point (e.g. in the evaluation activity of part ‘j’).

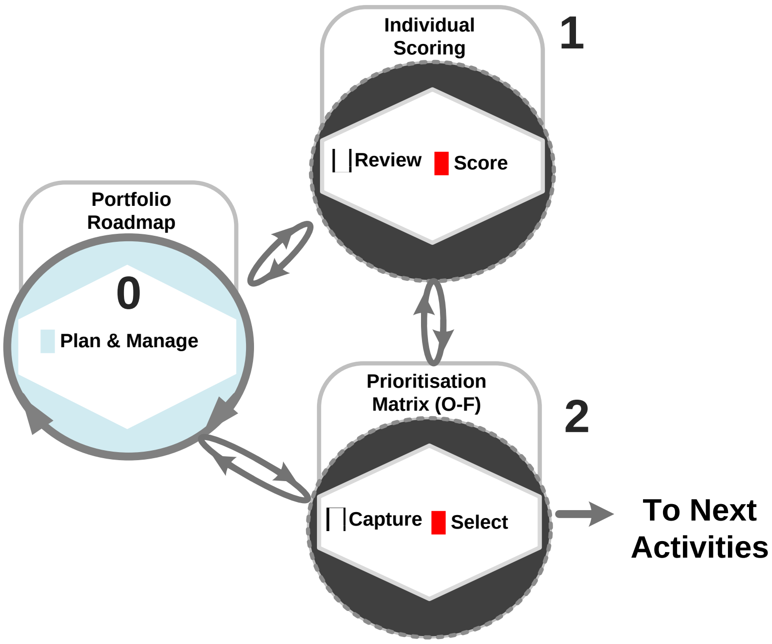

Figure 5.16 Evaluation tools and activities for parts ‘d’, ‘f’, ‘h’ and ‘j’.

e) Business model roadmap (second ‘immersion’) (see Figure 5.17)

0) Concept/project brief and business model roadmap. To prepare the workshop templates/tools, agenda, procedures and environment. The project brief is set-up with the key aspects of the opportunity, as well as a roadmap to capture business models that can turn the opportunity (application idea) into reality. Information/knowledge previously obtained such as the market and business drivers and the current position in terms of value proposition, technology/capabilities and resources, is ‘pre-populated’ in the roadmap at this point.
1) Stakeholder interviews. To gather insights directly from stakeholders related to the application opportunity and identify positive and negative aspects..
2) Business model canvas(es). To generate in one or several canvases (wall charts) alternatives of business models that enable the application to create value for the stakeholders (e.g. customers, suppliers and the organisation/inventors).
3) Business model risks and assumptions. To foresee the risks related to a business model and its elements, and be able to identify and prioritise the key assumptions for a business model to work. This knowledge may support team members to quickly assess the desirability, feasibility and viability of business models, and make better voting decisions in the next step.
4) Opportunity and feasibility dot voting. To prioritise the alternatives by voting for the preferred business model canvases based on the impact/value/benefit of every option and the difficulty/effort/risk involved in its implementation. This step facilitates decisions on what business model(s) to pursue.
5) Stakeholder interviews. To gather insights from stakeholders related to the selected business models and identify positive and negative aspects.
6) Core business model path. To map in the roadmap what should be done to achieve the top priority business model, including how and when (e.g. deliverables, demonstrators and decision points).
7) Alternative paths/options. To map alternative paths for the top priority business model and also the paths of other related business models that might have been prioritised (if there are any and it is convenient).
8) Business model risks and assumptions. To foresee the risks related to a business model and its elements, and be able to identify and prioritise the key assumptions for a business model to work. This way, key assumptions could be tested later.

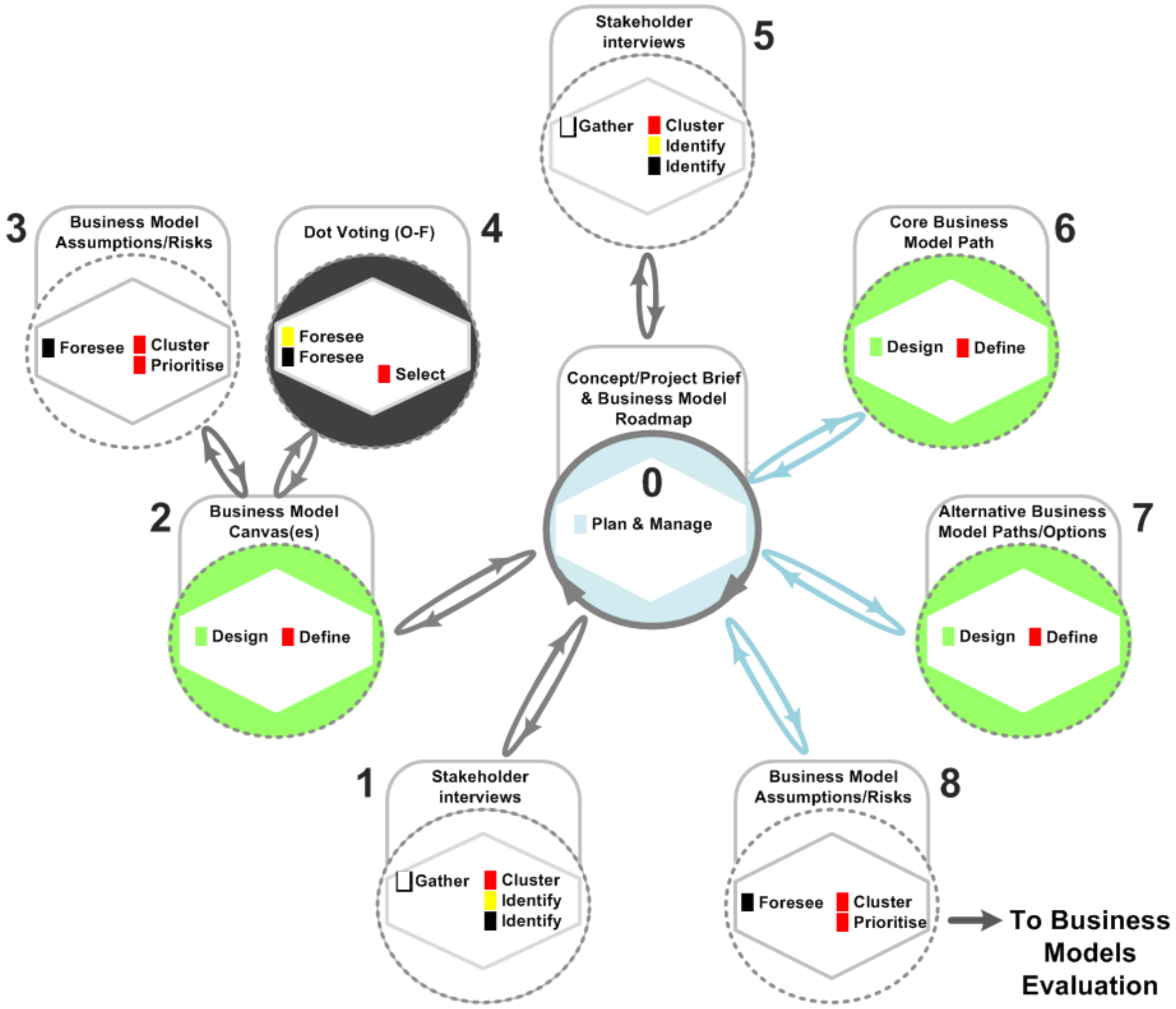

Figure 5.17 Part 'e' at Strategic Fit stage.

f) Business model evaluation

As mentioned earlier, the evaluation activities of this part are facilitated by the same tools configuration as in part 'd' (Figure 5.16). A business model is not only required to prove the corresponding kinds of 'fit' at this point but it must also prove a positive impact to the portfolio in order to be approved to move to the next stage (i.e. Problem-Solution Fit stage) and obtain additional resources.

Problem-Solution Fit stage

g) Validation of assumptions related to customer, problem and solution (see Figure 5.18)

0) Concept/project brief and business model roadmap.
    a. To review and update the concept/project brief (aims and key knowledge). Key knowledge of the Emotion Sense project at this point would include key insights and assumptions about the potential customer type (market).

b. To plan and manage the work, including preparing the workshop templates/tools, agenda, procedures and environment. A business model roadmap is pre-populated to support the design and analysis of experiments.

1) Stakeholder interviews. To gather insights directly from stakeholders related to a business model and its elements, and identify positive and negative aspects.
2) Experiments board. To review and capture the key assumptions to be tested, as well as to generate and prioritise the experiments to be performed to validate or invalidate the assumptions. Key assumptions of the Emotion Sense project at this point would include those related to a customer problem/need and the envisioned solution.
3) Rapid Prototyping. To carry out the experiments supported by fast and inexpensive prototypes (e.g. two-dimensional prototypes such as sketches or drawings, or even simple three dimensional prototypes to understand if the solution might actually solve an important customer's problem).

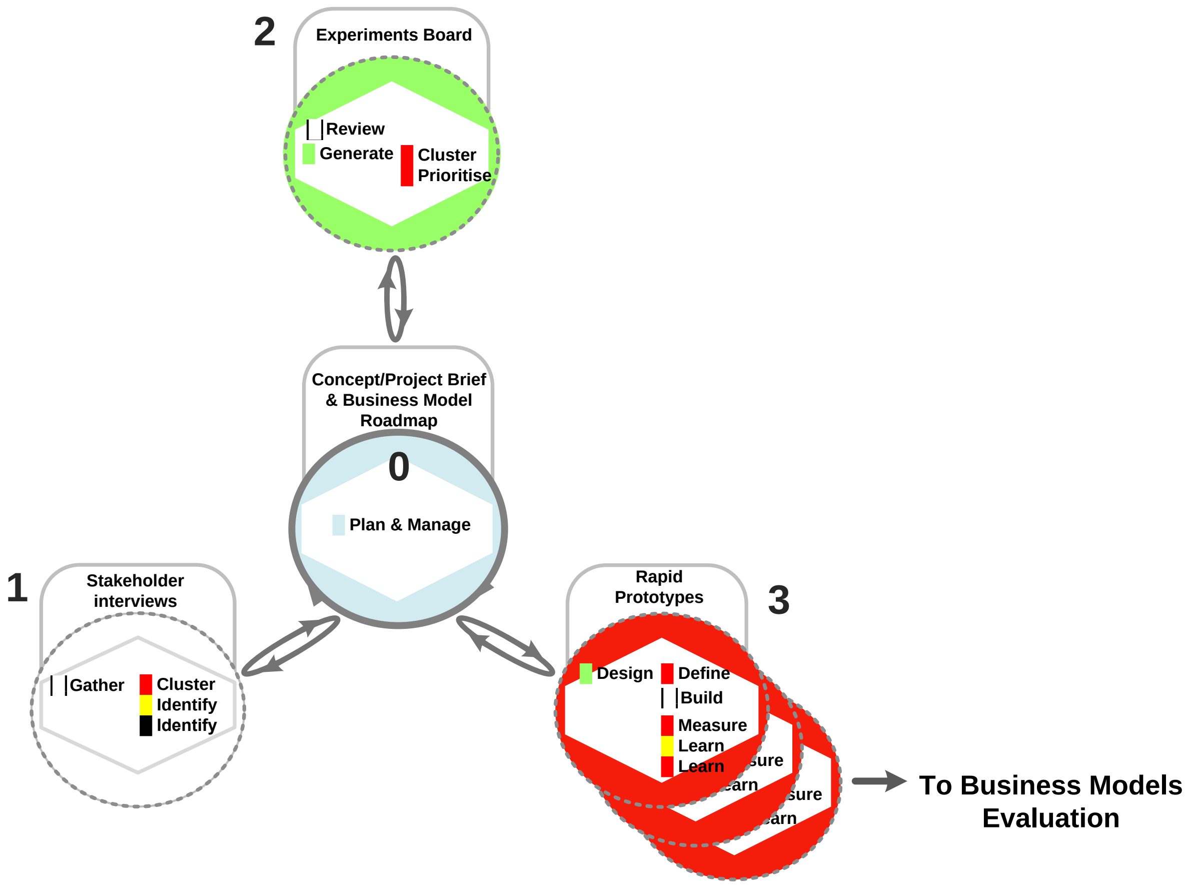

Figure 5.18 Part 'g' at Problem-Solution Fit stage.

h) Business model evaluation

As mentioned earlier, the evaluation activities of this part are facilitated by the same tools configuration as in parts 'd' and 'f' (Figure 5.16). A business model is not only required to prove the corresponding kinds of 'fit' at this point but it must also prove a positive impact to the portfolio in order to be approved to move to the next stage (i.e. Product-Market Fit stage) and obtain additional resources.

Product-Market Fit stage (Development)

i) Validation of assumptions related to the value proposition and supporting capabilities (see Figure 5.19)

0) Concept/project brief and business model roadmap.
    a. To review and update the concept/project brief (aims and key knowledge). Key knowledge of the Emotion Sense project at this point would include the state of existing technology and capabilities, as well as business drivers such as the need of the inventors to deliver and capture value in the short term.
    b. To plan and manage the work, including preparing the workshop templates/tools, agenda, procedures and environment. A business model roadmap is pre-populated to support the design and analysis of experiments.
1) Stakeholder interviews and observations. To gather insights directly from stakeholders related to a business model and its elements, and identify positive and negative aspects.
2) Experiments board. To review and capture the key assumptions to be tested, as well as to generate and prioritise the experiments to be performed to validate or invalidate the assumptions. Key assumptions of the Emotion Sense project would include those related to the value of features and functionalities of the solution, as well as to the feasibility and viability of technologies and capabilities that support them.
3) Live prototypes and pilots. To carry out the experiments supported by live prototypes designed to gradually but quickly build a value proposition that resonates with the market, as well as by pilots that allow to ensure that the solution can actually create value for all stakeholders.

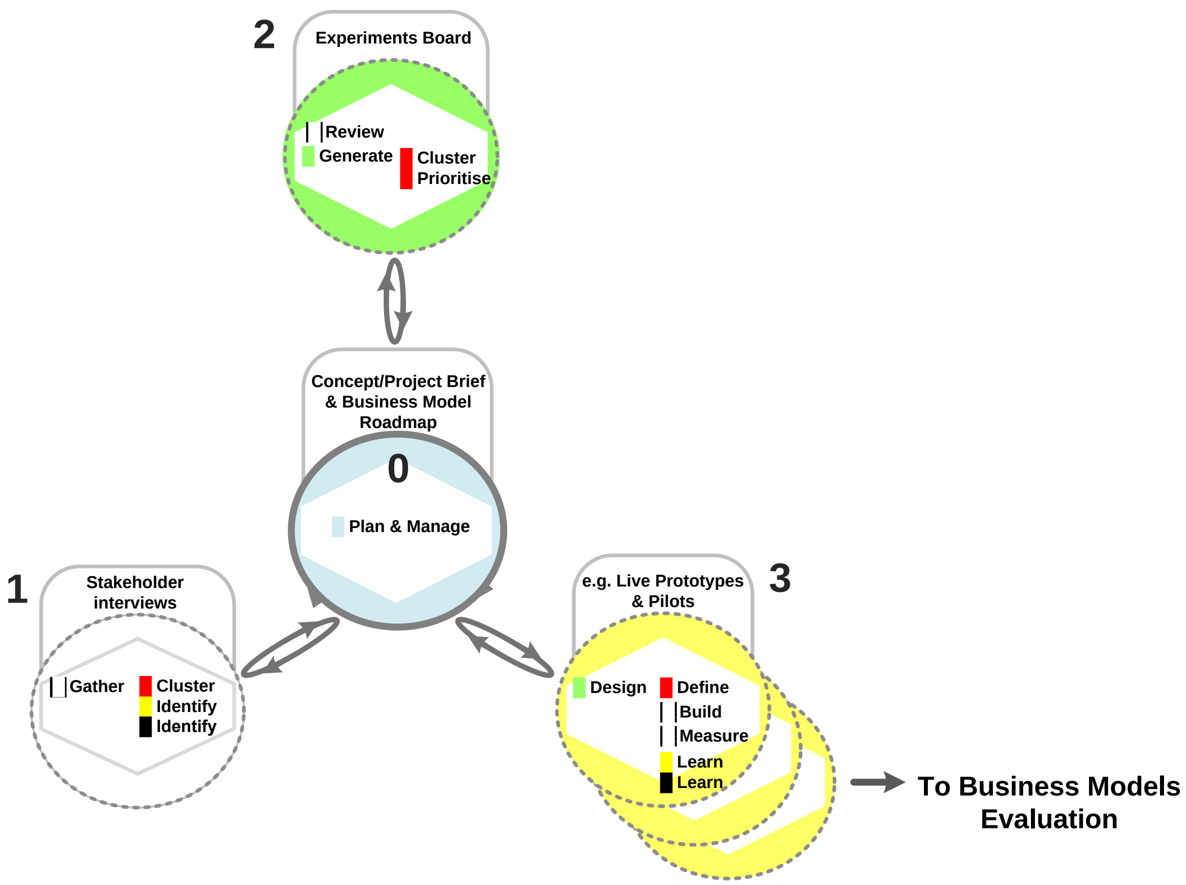

Figure 5.19 Part ‘i’ at Product-Market Fit stage.

j) Business model evaluation

As mentioned earlier, the evaluation activities of this part are facilitated by the same tools configuration as in parts 'd', 'f' and 'h' (Figure 5.16) but financial methods must also be established at this point. A business model is not only required to prove the corresponding kinds of 'fit' at this point but it must also prove a positive impact to the portfolio in order to be approved to move to the next stage (i.e. Business Model Fit stage) and obtain additional resources.

Business Model Fit stage (Commercialisation)

k) Value capture (profitability and growth) assumptions validation (see Figure 5.20)

0) Concept/project brief and business model roadmap.
    a. To review and update the concept/project brief (aims and key knowledge). Key knowledge of the Emotion Sense project at this point should be mainly concerned with the formal launch/introduction of the application in the marketplace, especially targeted to potential customers with the profile of early adopters.
    b. To plan and manage the work, including pre-populating a business model roadmap to support the optimisation of business capabilities (e.g. marketing and sales channels) and defining the measurements to be performed (related to growth and profitability).
1) Sales and operation optimisation. To deploy the appropriate marketing and sales capabilities and structures, as well as to scale-up the necessary production capabilities, in order to ensure that the solution can actually achieve the desired growth and profitability. Iteration to development would be needed to improve the solution towards a mainstream market that ensures growth and profitability throughout the industry lifecycle.

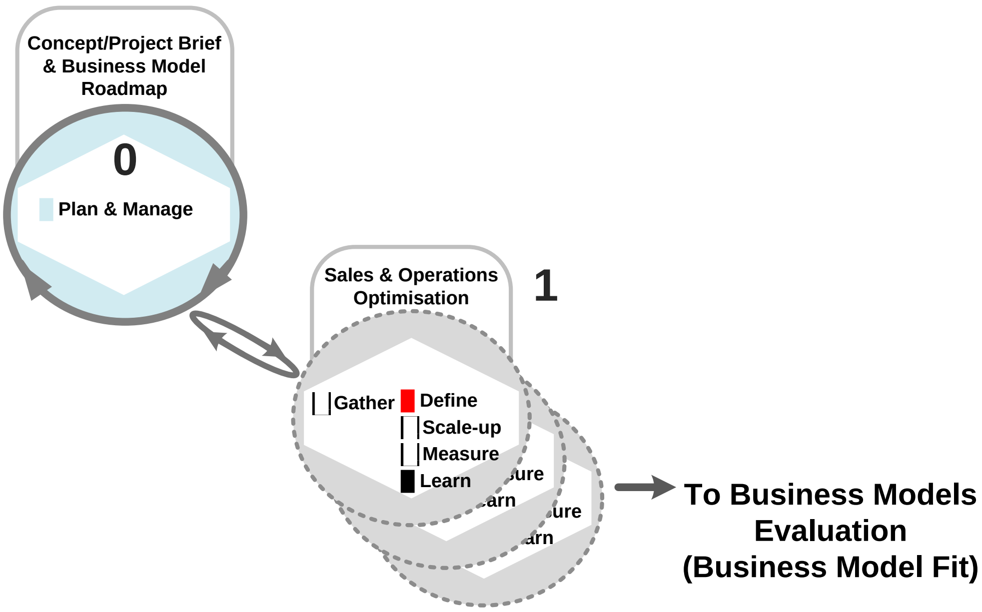

Figure 5.20 Part 'k' at Business Model Fit stage.

l) Business model evaluation (see Figure 5.21)

0) Portfolio roadmap. To review the roadmap at system/portfolio level to allow the business model operation to be reviewed in relation to the performance of other business operations. A business model must achieve and maintain business model fit at this point. Otherwise it should be optimised; pivoted (looped back to another stage, for example, to improve its value proposition or change its monetisation mechanisms); or retired from the market (for example, when the target market is exhausted and there is no way to improve/renew the value proposition).
1) Performance review. To gather information and interpretations of performance measurements, and assess the strengths and weaknesses.
2) Prioritisation (business portfolio matrix). To map the business models (if there were several) in a two-dimensional matrix. The matrix along with the portfolio roadmap can support decisions by adding clarity on the links to other innovation efforts and facilitating new insights (e.g. relationships between businesses and improvements planned).
3) Review performance metrics. To review and define the metrics that should be used from this point on.

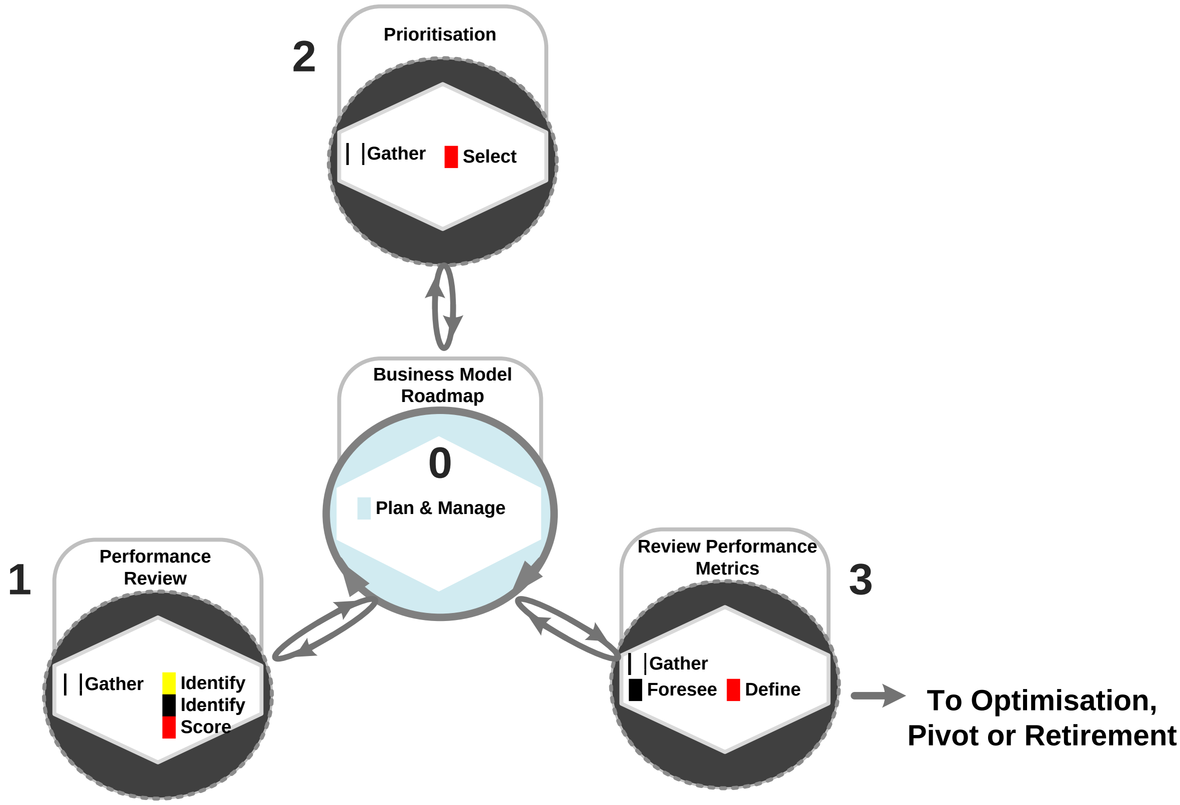

Figure 5.21 Part ‘l’ at Business Model Fit stage.

5.3 Ungga: A social network or a transactions portal for university students?

Ungga was a startup company founded in Mexico in April of 2012 by an entrepreneur and an IT integrator company, which jointly provided the funding. By the end of 2013 it had ran out of resources to continue the journey. At that point, the company decided to shut down its operations after about twenty months of hard work and financial drain.

The company was seeking to, on one hand, facilitate university students an interactive way to access tangible benefits at no financial cost; and on the other hand, facilitate commercial organisations an efficient way to understand student profiles so to promote and sell them products/services according to their needs. The vision of the entrepreneurs was to build an IT technology-based mechanism that could bring together students with similar preferences and with organisations interested on providing them value. This would be done by creating not only a virtual world that offered the students entertainment through an online university social network but also a real world where they could get and enjoy tangible benefits such as free photocopies, food, drinks and events tickets, all which could be 'purchased' through a 'currency' system called 'Unggas'. Under this system, a student could earn and accumulate amounts of 'Unggas' by answering marketing surveys and participating in social network activities. The original revenue model included selling the market research to the interested parties (e.g. market research companies, consumer goods vendors, etc.) as well as other type of income related to activity enabled by the social network such as advertising, and behavioural studies of student communities where inferences about needs and wants could be done. While innovation in the previous case was driven by a technology potential, in this case was driven by the (presumed) needs of two markets: students and vendors (aimed to be linked).

Figure 5.22 illustrates the design of the user interface. It includes a variety of features as indicated by the numbers, namely:

1) Chat area
2) Advertisements from sponsors
3) Stream/Publications
4) Friends
5) Search engine
6) Profile information
7) Groups
8) Balance account in 'Unggas'
9) Available surveys
10) Exchange code to collect benefits
11) Help to locate a physical exchange point

Unlike the previous case, in which a technology platform had already reached a certain level of maturity, the Ungga IT system was built from almost nothing, taking advantage of only a few pieces of open source software that were deemed to be useful for the purpose. Everything was built following the vision of entrepreneurs, who pushed the efforts hard towards implementing a value proposition and business model full of assumptions that were never deliberately tested (i.e. no incremental development and testing of functionality and features).

This case was reviewed by interviewing its former entrepreneurs and employees, and examining internal company documents. As in many start ups, there was a lack of a formal process from the idea/vision to its implementation. However, an historic 'process' with a few broad stages can be outlined as follows:

a) Kick-off

The entrepreneurs formalised the mission and vision statements, as well as a business plan. During this stage, the team conducted creativity sessions in order to generate novel ideas for the IT system to be developed (e.g. social network and benefits for students) and define the business model to be pursued.

b) Operations and IT planning and development

The operational and technical capabilities were designed and developed at this stage (e.g. provisioning and IT processes). Negotiations with potential partners were conducted to enable 'intermediary points' where particular benefits could be obtained in exchange for 'Unggas' (e.g. photocopy 'kiosks' within or near a university). The first version of the IT system was developed and then tested in a laboratory environment according to the plan.

c) Basic functionality pilot

Following the successful initial tests of the IT system, the entrepreneurs decided to put it to test in the market as well by targeting a medium-sized university. They decided to also take advantage of this opportunity to start attracting the first users and sponsors/advertisers (and thus, the first financial resources). The students were offered basic entertainment benefits through the 'local university' social network enabled by the IT system. The pilot went reasonably well from a technical perspective. However, despite all promotional effort and investment in this initiative, the rate of students signing up was too low and thus, it proved impossible to attract paying organisations (sponsors/advertisers).

d) Potential stakeholders interviews (students and organisations/vendors)

The entrepreneurs conducted a series of interviews with potential stakeholders in several universities. In general, the feedback seemed to have confirmed the interest of both interrelated target markets of the envisioned business model: the students (users) and the organisations/vendors (customers). Thus, the development of IT, operations and partners continued unchanged according to the planned functions, features and vision.

e) Value proposition pilot

As soon as the required functionality to provide tangible/physical benefits was available (i.e. the Unggas 'currency' system), the entrepreneurs decided to carry out a pilot with the value proposition targeting the student community of a large university. Lacking of paying sponsors at that moment, the entrepreneurs decided to fund themselves the cost to provide tangible benefits to be exchanged by 'Unggas'. It was decided to start by offering drinks at 'popular' restaurants, bars and night clubs where negotiations had turned out convenient for the company. They failed again. But this time, it was the end of the journey for Ungga.

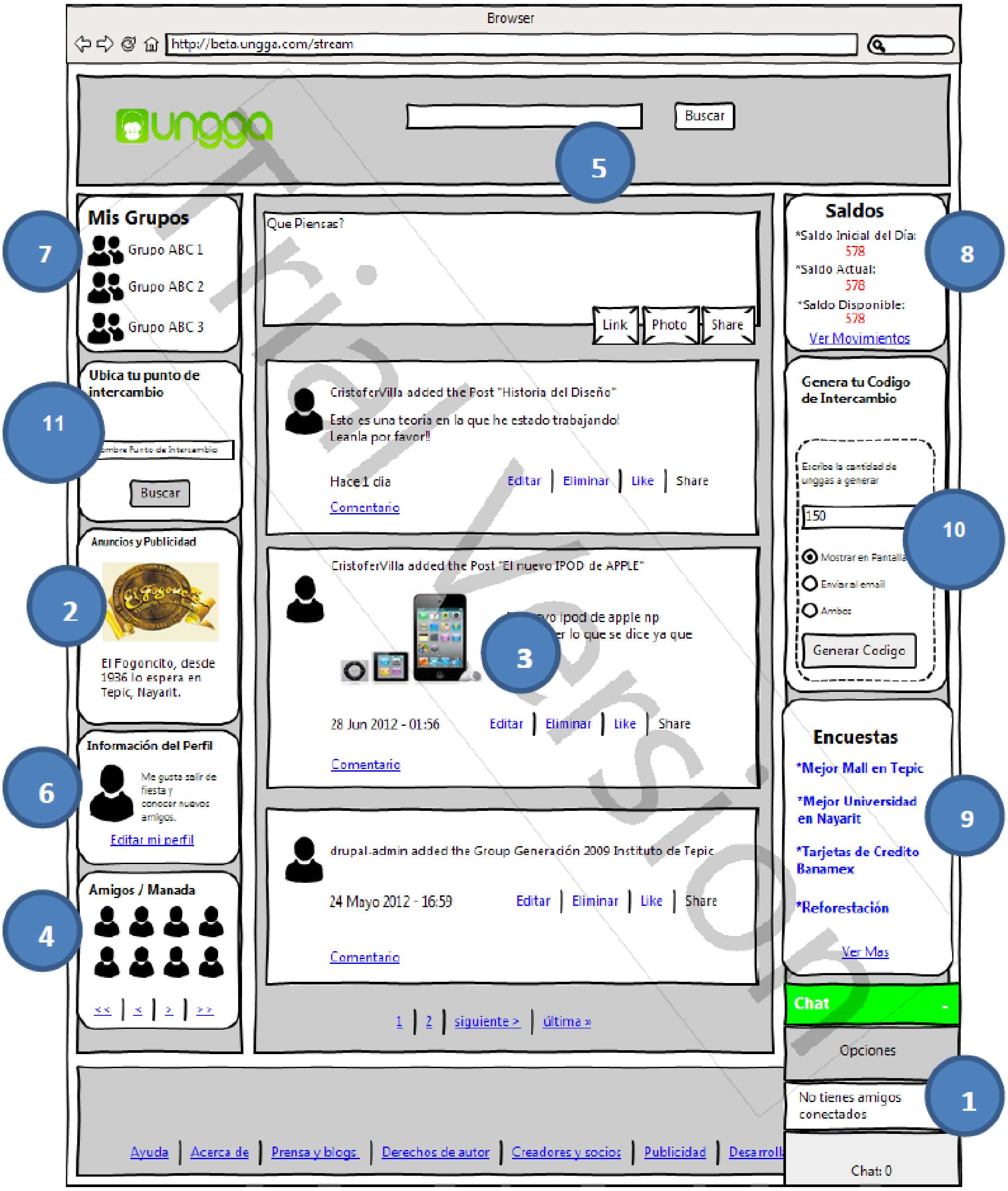

Figure 5.22 Main view of the interface.
Source: Ungga company files.

Diagnostic of project process

By analysing the case under HiFFi lens, several lessons can be learned which span different themes related to the different enabling elements in the HiFFi framework (i.e. strategy, processes, structures, people, culture and networks). It is our belief that a more formal project process would have increased significantly the chances of survival and eventual success. In particular, the following key issues were identified:

- The vision of the entrepreneurs involved an IT technology-based solution for two interrelated markets (university students and organisations/vendors) and was assumed to solve important problems/needs for them. However, the problem-solution fit was not properly researched and validated in the first place. Although some research was conducted at the outset, only secondary sources were used (e.g. publicly available over the internet) so that key business assumptions remained for a long time. For example, competitors and substitute offerings were downplayed under the belief that the envisioned solution (business model) was unique, basing this conclusion on the scarce information gathered during the secondary research and the informal feedback from colleagues, friends, family and a few students from local universities. It was only after the first attempt (belated and failed) to attract customers and sponsors that formal interviews were conducted (i.e. about a year since the kick-off). That is, some primary research started by the time when most of the planned development had already been done. And yet, as the case history shows, it was insufficient to spot any critical flaw.
- No formal approaches for experimentation, evaluation and selection were in place to gradually de-risk de project. This fact is striking given the entrepreneur's assumption of solution uniqueness, which implies high uncertainty. Thus, no criteria was discussed and established along the journey as a basis to incrementally design laboratory and marketplace experiments, build the solution, and measure its desirability, feasibility and viability more objectively. Collective intuition of the entrepreneurial team (and closely-related people at times) was used to make a decision whenever an unexpected event or new information arose. However, the lack of measures and an appropriate method for proactive validation of business assumptions did not allow vital insights to emerge on time. The project was managed following a sequential 'waterfall-style' model, with a significant planning effort (although not so rigorous as far as research is concerned) followed by a considerable development stage before piloting the whole solution. Although this approach might be suited to projects where requirements and scope are fixed, the product/solution itself is firm and stable, and the technology is clearly understood, it is clearly not suitable for innovation. In consequence, the original business plan was not challenged for a long time, which proved to be ultimately fatal.

These issues are, of course, related and share an underlying management weakness: the lack of an appropriate innovation method and integrated tools. In the first one, this weakness allowed a kind of 'group-think' so that key assumptions (testable from the outset) remained unchallenged for a long time. The case study reveals that the problem was not even well understood in the first place. For example, giving away photocopies (in exchange for information) was not a primary need given the increasing use of electronic media and copyright restrictions. Additionally, although other needs/benefits seemed to be confirmed by the student market, such as 'free food', some needs (that had to be taken into account in the solution) were not being addressed. For example, the mobile component/application was not given high priority from the beginning (which would be unimaginable these days), until the student interviews made this need evident. And most importantly, it was not realised until very late in the project (i.e. during the late pilot) that the potential users were not actually interested in another social network but only in obtaining the 'free' tangible benefits. This critical learning posed a very difficult question to entrepreneurs: Should they find another user market for the already developed solution or should they stay with the same market but 'trim' all social network features that were not valued and only caused confusion? The entrepreneurs reasonably decided for the latter since the features of the social network were weak if compared to other mature social networks of the kind. After all, the vision revolved mainly around the 'ungga' system of 'benefits-for-information' exchange. The decision led to the most significant change in the solution and its enabling features, directing the IT system as a purely transactional mechanism that provided benefits (through 'unggas') in exchange of information (now only through 'digital surveys'). The entrepreneurs then faced the challenge to adjust the business model including a monetisation mechanism that compensated for the loss of potential revenue streams that had been projected from advertisements and other potential activities in the social network. It was uncertain that revenue streams coming from the sale of market research alone (directly provided by students through surveys) would allow the business to survive and grow.

The second issue has to do with an inadequate management of risk and uncertainty, where the value proposition of the solution (e.g. enabled by the IT system and business capabilities) were not designed by building and learning incrementally based on facts and feedback from the students and sponsors/vendors. In contrast, learning was only possible after all the planned functionality and features had already been developed. In fact, the generation of new ideas and alternative concepts was not formally attempted until the business concept turned to be somehow flawed during the full pilot. Unfortunately, most financial resources had already been used by that time (most of them wasted in features that had to be 'trimmed' away) and little room was left to work towards the more focused business concept. Sadly, the company ran out of resources while adjusting the value proposition in the quest for product-market fit.

Design of project process

Following a HiFFi philosophy, the company could have designed and maintained a path with a low cash burn rate until the company had validated its value proposition by finding paying customers. Figure 5.23 shows the staged model for the Ungga project, in which evaluations at system level are depicted to better manage risk[15]. In this case, the reviewers could have included senior representatives of the joint venture (i.e. of the investors that provided the funding).

A similar PPE arrangement as in the Emotion Sense case might have helped, but starting at the project level (i.e. driven by the concept/project vision). This might be considered an exceptional situation where the starting point of a 'formal initiative' is at the project level because there was no one to play the role of a Strategic Innovation System (SIS). However, it should be recognised that opportunity identification, idea generation, and idea selection must have taken place first at system level in some form. From the perspective of the entrepreneur, these activities may have probably happened in the mind of the entrepreneur, who may have shared his thoughts (i.e. opportunity/idea) with other trusted people who may have helped him to 'evaluate and select' among a range of options. From the perspective of the third party (other investor), starting points at the 'system' level may have occurred formally or informally before making the choice to invest.

The starting point for activities in the Ungga case would also be facilitated by an orchestrating roadmap (see Figure 5.24). However, primary research (e.g. interviews with stakeholders) would be considered at the outset (see Figure 5.17 of the Emotion Sense case), before generating and designing business model options. Iterations at this level would take place until key business assumptions were validated (e.g. customer/problem assumptions).

[15] Recognising that self-managed evaluations at project level may also take place.

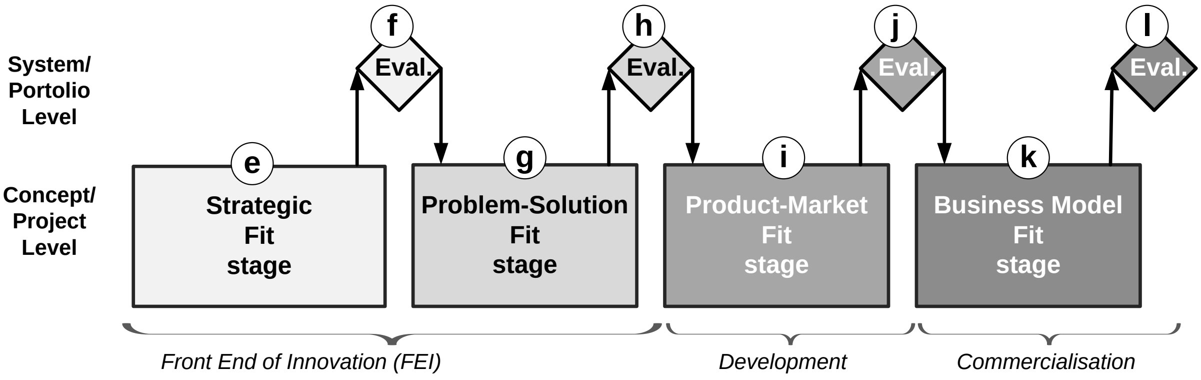

Figure 5.23 Staged Model for Ungga Project (Full Cycle).

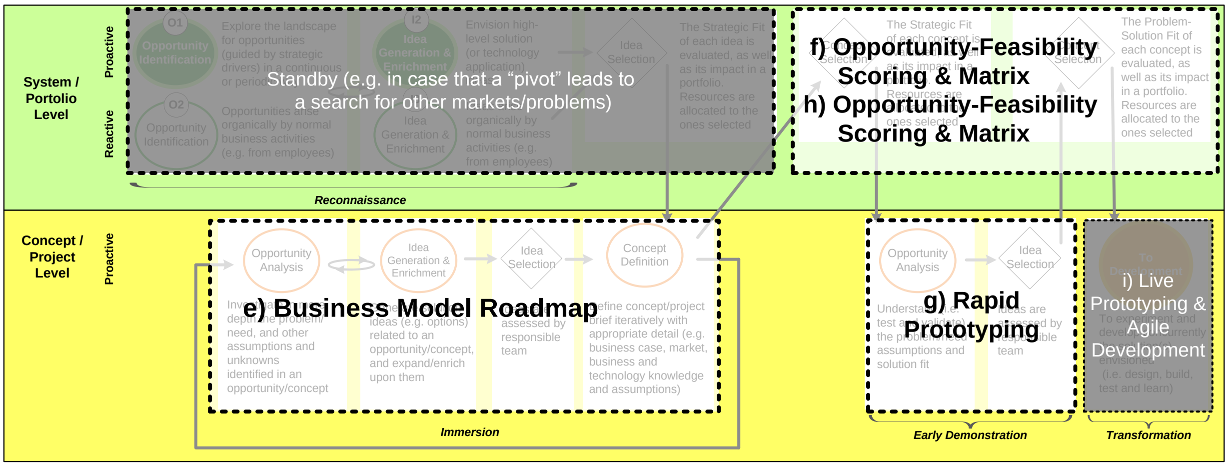

Figure 5.24 Tool selection for the initial iterations in the front end of the Ungga innovation project process

The PPE is briefly reviewed next for the Ungga project case, indicating the approaches/tools according to the step in the staged model (Figures 5.23 and 5.24). In this context, the PPE might have been planned to:

- Research and define a preliminary business model and possible alternative paths towards the vision, as well as to conduct experiments (e.g. through demonstrators or rapid prototypes) in order to validate key assumptions related to the potential users and customers (i.e. find problem-solution fit). Tools and techniques include:
    - Business model roadmap and business model canvas (step ‘e’)[16]
    - Evaluation gate (step ‘f’)[17]
    - Rapid prototyping (step ‘g’)[18]
    - Evaluation gate (step ‘h’)[19]

[16] The‘micro-sequence’ of functions/tasks is shown in Figure 5.17 of the previous case (Emotion Sense project).
[17] See Figure 5.16.
[18] See Figure 5.18.
[19] See Figure 5.16.

- Build the solution incrementally in order to validate the key assumptions related to the value proposition (i.e. find product-market fit). Tools and techniques include:

    - Live prototyping and piloting (see step 'i')[20]
    - Evaluation gate (see step 'j')[21]

- Scale-up the necessary resources and capabilities in order to accelerate growth of users and profitability (i.e. ensure business model fit). Tools and techniques include:

    - Innovation (growth) accounting and optimisation (see step 'k')[22]
    - Evaluation gate (see step 'l')[23]

As explained earlier, the 'stages' in practice are associated with HiFFi subsystems and thus, iterations may occur within and between them. Stages 1 and 2 would be mostly related to the front end of innovation where the investigation, generation, evaluation and understanding subsystems take a front-seat; while stage 3 would be related to the implementation subsystem; and stage 4 to the value capture subsystem. As it was previously described in the case, the issue triggering the most waste was the lack of understanding of the markets and fit of the solution in them. Once the development plan was triggered, because of the 'waterfall-like' project approach, there was no way of stopping an enormous waste of resources. Thus, stages 1 and 2 would have been key to survival, preventing the company to start development in the wrong things (e.g. lots of social network features) in the first place; stage 3 would have also prevented financial drain by gradually building, testing and measuring with a philosophy of minimum viable product (solution) for the target market of users (students) and customers (organisations); and stage 4 would have allow the entrepreneurs to finally capture good value in return for all their investment and effort.

6. Discussion and conclusions

This document has set out work undertaken to contribute mainly to the areas of strategy and innovation management. However, the endeavour is multidisciplinary, which is reflected in the literature review that incorporates a variety of disciplines and areas. The document describes the theoretical foundations and practical implications of a framework called High Impact Framework For Innovation (HiFFi), which aims to facilitate to any type of organisation to develop and sustain a Strategic Innovation System (SIS).

HiFFi was designed to address key challenges that organisations face while attempting to innovate. Based on a review of the literature and experience of the authors, there are many aspects that must be taken into account in dealing with the challenges appropriately, to increase the chances of successful innovation. These include organisational and human aspects that give rise to an holistic system framework comprised of the external environment and six enabling elements: strategy, processes, structures, people, culture and networks. This approach is intended to facilitate an organisation to regularly assess/diagnose its current state regarding innovation capability, as well as to plan/design, improve and manage innovation initiatives in a flexible and agile manner, according to context and needs. In order to

[20] See Figure 5.19.
[21] See Figure 5.16.
[22] See Figure 5.20.
[23] See Figure 5.21.

illustrate this, three short cases were provided: One provided a brief example of an assessment of innovation capability based on the six enabling elements (see ITCo case in Section 2.4) and the other two provided short ‘simulations’ of using the HiFFi framework for diagnosis and design (Emotion Sense and Ungga cases in sections 5.1 and 5.2 respectively).

The framework recognises that an innovation process is always to some extent a journey of discovery with new knowledge being acquired along the way. Thus, the framework and associated tools aim to help practitioners to plot their course through an uncertain terrain, taking into consideration that the path and the destination itself may change as the route unfolds (Goffin & Mitchell, 2010). The term ‘project process’ is used to reflect this in a context where configuration, integration and application of tools can happen in a flexible and adaptable way. This can be done in practice with the guidance of a set of HiFFi principles and a subsystems framework that support the planning and operationalisation of innovation endeavours/projects. These projects are visually managed through ‘Project Process Expedition’ (PPE) charts in the ‘Touch Room’, where tools with well-defined mechanisms can be applied continuously to achieve the desired outcomes.

HiFFi has been designed to be modular, scalable and applicable at an appropriate level of granularity/detail, which allows an innovation project process to be depicted and managed from macro to micro perspectives, supported by design guidelines for roadmaps (Phaal et al, 2006b) and other management tools/toolkits (Kerr et al, 2013). From a macro perspective, HiFFi can show how the overall process will be rolled out. That is, the broad steps that an organisation plans to take in the short, medium and long-term. An iterative and adaptive ‘staged model’ approach is proposed, aiming to improve the management of uncertainty/risk and investment prioritisation, where evidence is required, facilitated by building, testing and learning through experiments (e.g. demonstrators/prototypes). While loopback mechanisms, such as those described in the HiFFi staged model as ‘pivots’ or iterations, may seem to delay the front end of innovation and other stages of an innovation endeavour, several authors argue that they help to prevent waste (e.g. Ries, 2011; Maurya, 2012; Blank, 2013), and accelerate innovation introduction by shortening the total cycle time (e.g. Koen et al, 2002; Cooper, 2014), provided that the projects are properly resourced and activities throughout stages are flexibly configured (Cooper, 2014). From a micro perspective, HiFFi deals with a level of detail associated with the short term, such as the agendas for specific workshops. The micro level includes the tools, techniques and procedures that feed into the macro level to realise the goals of the organisation. Flexible and adaptable ‘micro sequences’ (procedures) can be designed/configured to perform HiFFi subsystem functions/tasks and achieve outcomes.

Progress to date sets the stage for further development and testing, aiming for a method that stakeholders can understand, apply and adapt with consistency according to their context and needs, both at system and project levels, from start to end. A method that alleviates the issues and confusion caused by the fragmentation of the subject and the proliferation of tools. HiFFi aims to articulate a ‘complete solution’ for strategic innovation management, and thus its design incorporates ‘best of breed’ features from established and progressive approaches that have proven their value, and facilitates the integration of tools/toolkits that such approaches provide. Thus, benefits delivered by approaches such as Stage-Gate™, Creative Problem Solving, TRIZ, Lateral Thinking, Design Thinking, Lean Startup and Agile Development/Scrum, which address different management needs, can be brought together in a single and coherent framework, integrating tools purposefully and seamlessly along an innovation cycle (see Figure 6.1).

However, it should be recognised that the flexibility of HiFFi with regard to tool integration should be considered with care. The recommended approach is to start with a small set of generic core tools that can be customised to fit the purpose, such as the Roadmap (e.g. S-Plan) and Portfolio Matrix (e.g. Opportunity-Feasibility Matrix) approaches described in this document (e.g. Kerr et al, 2015). From there, as maturity in the use of the core tools increases and richer knowledge is required, more tools can be incorporated and applied in an synchronised fashion (enabled by a focal integrating roadmap). It is hoped that the HiFFi framework can bring clarity, integration and adaptability to innovation management in any organisation, leading to knowledgeable and agile decisions and actions, thus improving innovation success rates, while preventing a large amount of waste.

As the framework has been designed to support the development of innovation generally, development and testing will be required in a range of contexts, such as corporations, supply networks and pre-commercial university applied research. The three cases presented in this document are part of the initial demonstrations of the potential of HiFFi, each in a substantially different context: a) ITCo presents the context of an SME organisation operating in the telecommunications industry, where significant sales decline and financial growth in the long term are the main triggers for innovation; b) Emotion Sense presents the context of a university applied research searching for markets/problems that a technology can solve (i.e. a 'technology push' situation); and c) Ungga presents a context of a start-up seeking to fulfil the needs of two markets simultaneously (i.e. a 'market pull' situation, where the vision is based on multi-sided business model targeting and linking students and vendors).

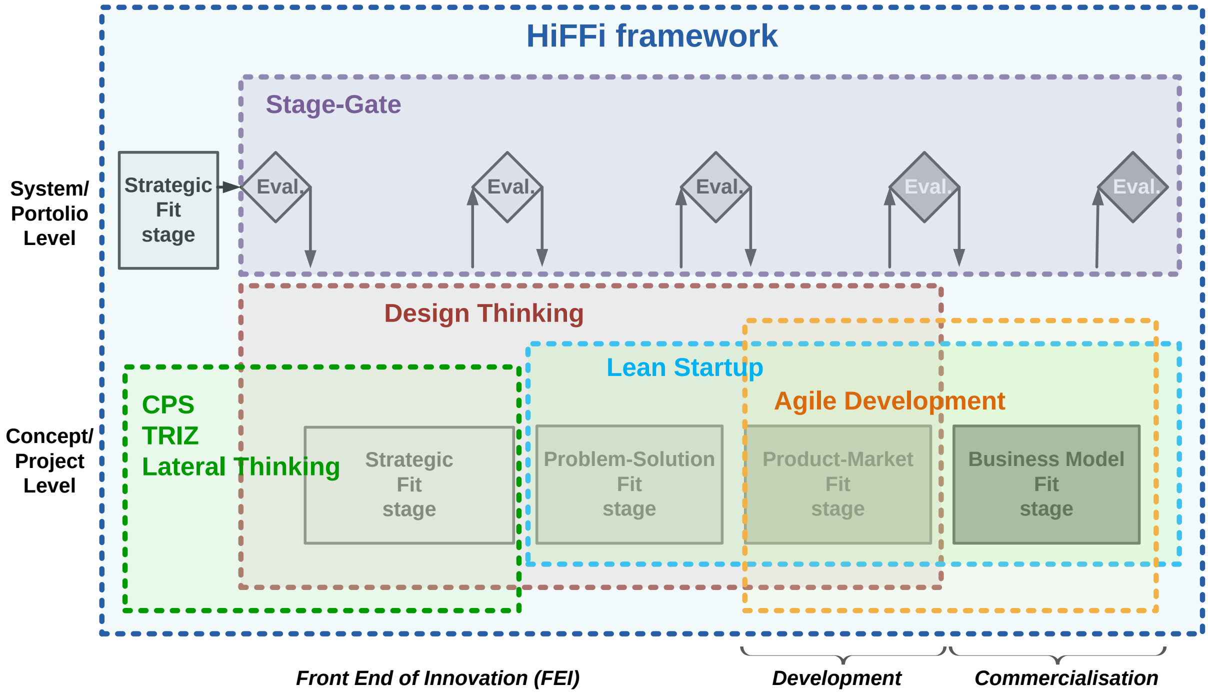

Figure 6.1 HiFFi compatibility with other methods.

However, if the vision of a universal and complete strategic innovation framework is to be achieved, then several issues need to be addressed. Figure 6.2 describes how a virtuous cycle of continuous research, development and practical application (field tests in real-world situations) might lead to achievement of the vision, while clarifying progress to date and challenges ahead.

The HiFFi framework can support *diagnosis* of the business context and innovation capability of an organisation. A project process expedition and enabling conditions (i.e. strategy, structures, people, culture and networks) can then be *designed* into specific forms to be *applied* in accordance to the business context. The knowledge generated and lessons *learned* throughout the practical experience could then serve as a base for future endeavours, provided that key lessons can be shared externally and a base of reusable and shareable knowledge can be built. This body of knowledge would allow other organisations in similar contexts or situations to learn from others through codified knowledge (e.g. building blocks in HiFFi 'language', such as PPE industry templates related to an industry, type of organisation, and/or type of innovation challenge), *adapt* it to their specific situation, and accelerate their learning curve and outcomes. This knowledge would also allow the HiFFi framework to *evolve* by incorporating the lessons learned into generic forms through enhancements and additions to the current state.

As is shown in Fig. 6.2, significant progress has been made in research and development of the HiFFi framework. However, limited progress has been made with regard to practical testing of the different parts working together, and thus, very little progress has been made with building of reusable and shareable industry knowledge. The way forward to address these challenges is described in the next section.

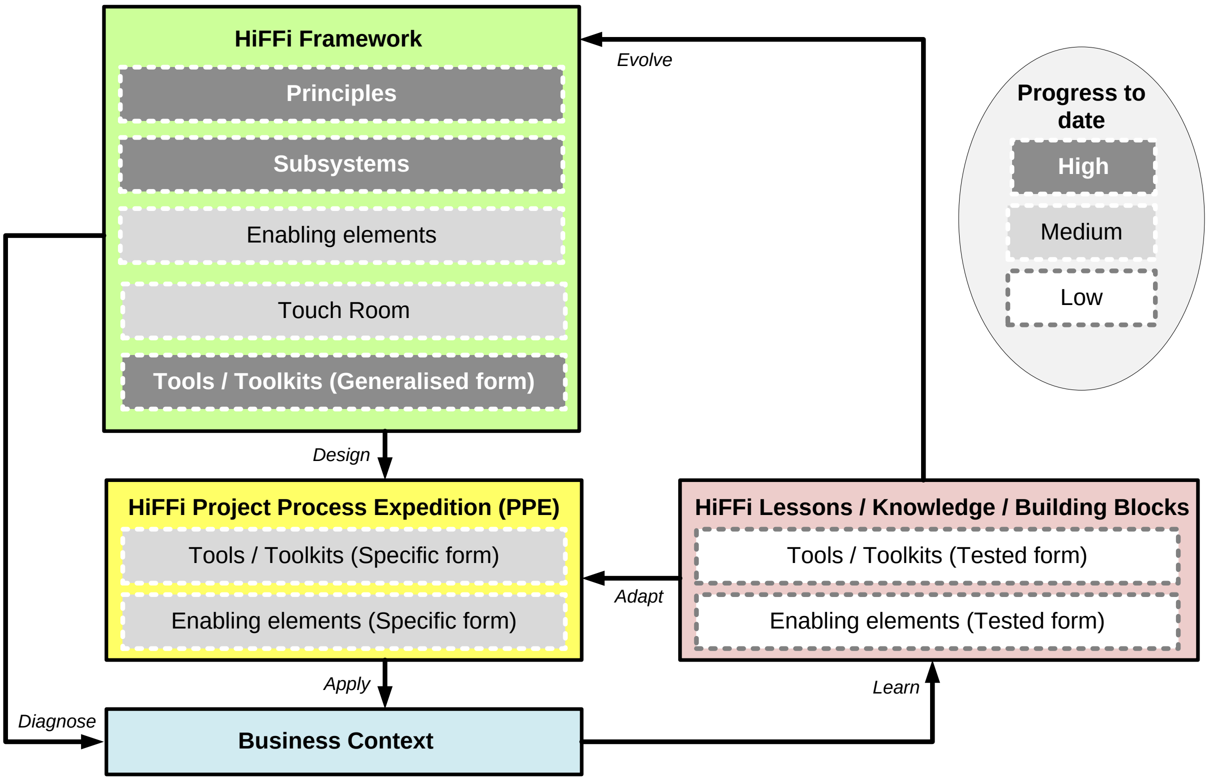

Figure 6.2 Virtuous cycle of HiFFi research, development and practical testing.

7. Future work

As implied in Figure 6.2, a number of priority issues need to be addressed in order to achieve the HiFFi vision:

- Further research into the conditions that enable/inhibit innovation needs to be carried out (e.g. innovation structures and culture). The aim should be to acquire a deeper understanding of the HiFFi enabling elements, so as to improve the approach for assessing and designing each of these elements. Some new tools have been recently tested with promising results, where assessments have been run as a collective workshop so that strategic dialogue is facilitated (see Figure 7.1). However, further testing is needed to confirm the benefits of this approach.
- Further research and testing of the design and operation of a visual management 'Touch Room' is needed to have a deeper understanding of its impact on the efficiency and effectiveness of innovation activities of a project, as well as on the other elements of innovation capability of an organisation (e.g. structures, people and culture). For example, the use of sticky notes and wall charts that integrate not only arrangements of subsystem tools but also 'enablers toolkits' (e.g. 'culture toolkit') should also be tested in a wide variety of situations, ideally in a visual 'Touch Room' environment to understand how it can contribute to maintain the engagement of the team and the vitality (continuity) of the Strategic Innovation System (SIS). The use of information technology should also be further investigated and tested to better understand its current and future potential to support this type of environment.
- Further research is needed with regard to experimentation during the stages of Problem-Solution Fit and Product-Market fit (e.g. designing experiments and storing/managing learning points). Generic forms of demonstrators (e.g. rapid prototypes and live prototypes) need to be identified, classified and associated HiFFi stages and subsystems. The experiments board and its links to the corresponding synchronising roadmap should be further tested with real-world problems.
- Testing in a range of different contexts is needed to identify areas of opportunity for improvement and to start collecting industry lessons that may be transferrable to other business situations. In particular, the planning chart for a 'Project Process Expedition' (PPE) with particular arrangements of tools/toolkits should be tested for different problem domains/types.
- Practical guidance needs to be developed on how to deploy a HiFFi system, as well as the core and other tools/toolkits, so that they can be used in a consistent and professional manner.
- Systems should be in place so that knowledge and experience in academia and industry can be shared and improvements made, supported by a community of practice.

Achieving the vision of a 'universal' and 'complete' strategic innovation management framework requires considerable work and support from both the academic and industrial communities, in terms of research, development, education and practice. It is recognised that future development work will also be influenced by the outcomes of future tests and the feedback and contributions of the different stakeholders involved.

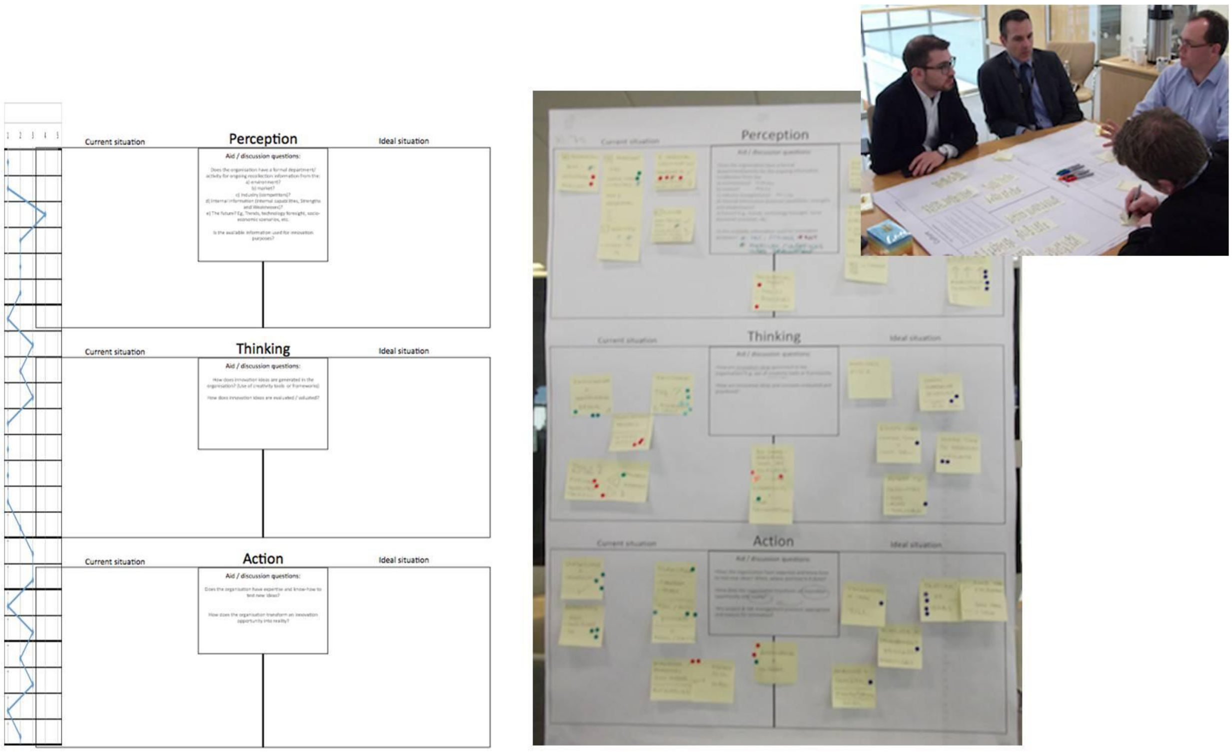

Figure 7.1 Innovation capability assessment through a workshop approach.

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