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Abstract

Technological innovation projects must be accompanied by upstream strategic analysis on the related value creation model. It can be shown that generally successful technological innovations have also involved business model innovation. Exploration of new business models is however particularly difficult where there is a rupture in technology due to a lack of vision of the markets and applications to target. This article proposes a scenario-based method for exploring business models for technological innovation. The method includes overview questions on the business models completed by specific questions relating the developed technology. This is followed by the definition of business model scenarios based on use scenarios in various application areas of the technology considered. The development of scenarios involves the creation of contrasting but coherent business models and varying the elements of the retained business models (types of client, value proposition, economical logic, organisation of the value network, technological and marketing criteria specific to the technology). The method was developed to accompany a radical technological innovation in the telecommunications sector, as part of a European project. The article presents the technology under development and the way in which the authors defined the business model questionnaire and how they developed the various scenarios from uses of the technology. The approach opens both theoretical and managerial perspectives: it allows the notion of business model to be made operational by linking it to the technological innovation on one hand and its use on the other. The method should then be extended, by creating storyboards from strategicscenarios, in order to enable the project stakeholders to evaluate them.

Key words: technological innovation, business model, method, scenarios

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INTRODUCTION

A major stake in technological innovation projects lies in the capacity of companies to imagine their value creation potential sufficiently early, and this in a high uncertainty context both on the technological and market sides.

This issue has the same acuity for established companies carrying out R&D projects and for start-ups created around technological innovations. In both cases the project leaders need to convince the various stakeholders of the value creation potential of the innovation. If they're unable to justify a value creation model, they won't obtain the resources necessary from the stakeholders to be able to complete their project. In addition, anticipation on the targeted markets, the uses of the technology, and the value of the solution for the client, results in choices and important decisions during the design phase (definition of target costs, choice between simplicity and performance, design orientation etc.). Finally, the view of the value network delivering the offer to the client, with a map of all implicated parties can lead to decisions which have to be taken early in the definition of the offer, such as the negotiation of technological partnerships or looking for distribution networks.

The identification of market opportunities for technological innovations are made difficult by a number of things, notably uncertainty as to the pertinence of the business model to be used (Bond and Houston, 2003). In the case of radical innovations, when the market doesn't yet exist, this means constructing a vision of the future market, vision that must be built over the design phase (O'Connor and Veryzer, 2001).

This article starts with the proposition of Chesbrough and Rosenbloom (2002), which considers the business model (BM) concept as a construct that establishes the link between an emergent technology, and it's potential economic value. The authors' research is based on technologies developed by R&D « technology push » innovation processes. Based on the Xerox company case, and its initial photocopier based business model, the authors

analyse enterprise BMs created from technologies developed in the Xerox R&D laboratories (such as 3COM or ADOBE). They show that successful technological innovations are based on new BMs, different from the initial Xerox BM, and suggest that these innovations could not have succeeded inside Xerox, due to rigidities in routines aspects within the BMs or path dependence.

Chesbrough and Rosenblooms' analysis concludes on the necessity to help R&D managers include in their reflection the issue on how to create value from the technology. They propose the experimentation of alternative BMs as we experiment on technologies (« *technology managers need to extend their experiments to include experiments in alternative business models* »), and finally to consider the BM approach associated with the technological innovation as a way of carrying out "strategic prototyping" (« *The initial business model is more of a proto-strategy, an initial hypothesis for how to deliver value to the customer, than it is a fully elaborated and defined plan of action* »).

Academic literature on BMs, despite the popularity of the concept in management, remains relatively undeveloped (Schweizer, 2005; Lecoq et al., 2006). More specifically, following Chesbrough and Rosenbloom's article, very few authors attempted to study the link between technological innovation and BM innovation. The research of Zott and Amit (2002) on Internet start-ups at the end of the 90s can be cited, however. This study empirically established the fact that entrepreneurs that innovate in business models have higher performances than those that implement already known business models. The method retained, however, appears debatable [1] the results should therefore be viewed with precaution.

Contrarily to descriptive research on the relation between technological innovation and BM innovation, whether of a qualitative nature (Chesbrough and Rosenbloom, 2002) or quantitative (Zott and Amit, 2002), our project favours a design method. We propose the development of a method for exploring BMs for a given technological innovation. The objective is to help those in charge of technology innovation projects better understand the conditions in which value is created from the technology, and to imagine the alternative BMs that could enable the new technology to be brought to the client. In order to do this we have chosen an approach by scenarios in order to favour the exploration of new BMs based on a given technological innovation.

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[1] More specifically the authors retain companies' stock value to measure company performance, despite this indicator being highly volatile in this technological context and not necessarily correlated with company performance.

This method is currently developed within a European R&D project, the e-SENSE project. The technological innovation consists in developing a telecommunications infrastructure based on wireless sensor networks in order to provide context data to mobile users. The project includes technological developments (research and prototyping), usage studies (design and test of usage scenarios around the applications foreseen for the technology), and a study on the economic potential of the technology, which we are exploring as member of this European consortium.

Our research takes it's inspiration from an epistemology of design as defined by authors such as Le Moigne (1990), Chanal et al. (1997), or, more recently, Romme (2003). This signifies that we aim to develop procedural knowledge by the development of methodologies, tried out and tested on real cases.

The objective is on one hand, the intelligence of concrete situations and on the other hand the development of management tools that are sufficiently generic to allow their use in other contexts. In this type of research, the researcher, seen to be a "research engineer", develops the conceptual model, builds the support tools for the research and acts both as evaluator and facilitator in the implementation in organisations. He contributes by doing this to improved knowledge of complex organisational processes and the emergence of new scientific knowledge (Chanal et al. 1997).

The objective of our research is therefore the development of a method for the exploration of new BMs for technological innovations. Built from a theoretical frame (normative approach) it is also adapted to the case of studied technology development (contingent approach).

Chanal (2000) and Romme (2003) qualify this type of management tool as « boundary object» (artefact) between theory and practice. It must, through abstract logic, allow the production of generally applicable information and not just provide a simple reply to a given problem. It must, through its flexible approach, be reusable in different organisational contexts. Finally, it must, through standardisation, allow for direct operational use in companies.

Due to the design approach used, we propose not to dissociate the theoretical aspects from the empirical data, but rather to present our method step by step.

We will therefore present successively:

1. The e-SENSE project and it's main technological characteristics, as well as the application areas considered for the technology (vision of the technology)

2. The general framework of our approach, which includes:
   - The identification of the dimensions to take into account for a systematic reflection on new BMs, in the context of the studied technology
   - The implementation of a scenario approach from the applications imagined for the technology

3. A first test of our approach, on two use-scenarios, in two domains: personal and industrial services.

To conclude, we will summarise our method, which successively incorporates the technological vision, the market vision through potential uses, the construction of scenarios, and finally a method of testing the retained BM scenarios. We will show how this approach completes that of Chesbrough and Rosenbloom (in particular by taking into account a perspective of uses and a scenario based approach). Following this we define the next steps of our design work, in particular the test phase involving industrial companies (which is not presented in this article).

1. **THE e-SENSE PROJECT AND THE ASSOCIATED TECHNOLOGICAL VISION**

e-SENSE is an R&D project financed by the European Union whose objective is to develop "ambient intelligence" technologies for mobile telecommunication systems beyond 3rd generation systems. It involves proposing an infrastructure based on networks of wireless sensors of various types (sensors on people, objects or placed in the environment). To reach this objective a European consortium of 24 partners has been set up including 8 major industrial actors (ex Telefonica, IBM, Thales, Fujitsu), 2 small or medium sized businesses , 4 research organisations including the French CEA (*Commissariat à l'Energie Atomique*, projet leader), and 10 academic institutions including our university, the University of Grenoble, France. The total budget of the project is 10 million euros of which the European Union finances 6, 3 million euros.

The development of advanced technologies generally requires a technological vision from which a market vision can be elaborated (O'Connor and Veryzer, 2001). The technological

vision of e-SENSE is built around the concept of "ambient intelligence", which is considered as being a future step in the development of third generation wireless telecommunication networks. To date, technologies that provide information on context to information systems are based on an ill-assorted number of elements, requiring active interactions from the user involving specialised sensors. The e-SENSE vision aims to propose a unique architecture allowing for the interoperability of different types of equipment (sensors, terminals) and networks in such a way as to be transparent for the user. The idea is to detect user contextual information, in a non-intrusive manner (for example stress level, tiredness, gestures etc,) but also data on the user's environment (for example heat or pollution) or the products used, and to use these data to provide appropriate services, using various equipment such as mobile phones or PDAs. The value creation, based on services provided by this technology, can involve actors as diversified as telecommunication operators, equipment manufacturers (computers, telephones), sensor manufacturers, information systems integrators as well as numerous specialised actors in the targeted industrial sectors (health, agriculture, sports and leisure, etc,).

The technological partners of the consortium work essentially to solve the technological problems around this vision such as the development of communication protocols for sensor networks, or the energy consumption of the sensors. At this stage therefore, the R&D teams work with no real vision of what the potential economical opportunities of a technological leap of this type could be.

In parallel with the technical teams, the team that we are part of made up of: sociologists, economists and management researchers works on the definition of a market vision and on testing the acceptability of the technology for potential users. Our work is part of Work Package 1 (or WP1) entitled: « scenarios, requirements and socio-economic impact ».

In agreement with the technical Work Packages, it was decided to focus the WP1's investigations on the markets and usage around three application areas of the technology, seen as being relevant and potentially worthwhile by all of the consortiums' partners. The three areas are developed around examples of use, which could be concrete situations of use for the technology.

Application Space	Personal Services	Community Services	Industrial Services
Theme	Lifestyle Assistant	Wireless Hospital	Remote Asset Tracking
Use Cases	1. Mood based services 2. Entertainment 3. Nutrition	4. Wireless hospital 5. Residential health 6. Emergency coordination	7. Store of the future 8. Food processing tracking

Table 1: The application areas and examples of use retained for the e-SENSE socio-economical study

From here, our objective is to propose a method allowing parallel reflection on both the technology and the strategic conditions that enable value to be created from these visions. We believe that the described situation is sufficiently representative of advanced technology R&D projects in industry to enable the method retained for this project to be generalised and used on other projects.

We will now present the theoretical elements, around the notion of business model, on which our approach is based.

2. DEVELOPMENT OF A METHOD OF EXPLORING NEW BMs FROM THE e-SENSE TECHNOLOGY

From the technological vision presented above, our objective was to define the business model analysis framework, which could be associated with the services and applications resulting from these technologies. To do this we proceeded in three phases:

1. A general literature review on BMs to identify the main elements to take into consideration,

2. A literature review of BMs in the context of new information and communication technologies (Internet, mobile services) to take into account the specificities of the area,

A literature review on scenario methods in strategy

2.1. THE BASIC ELEMENTS OF A BM

To start with we adopt the definition of the term « *business* » proposed by De Wit and Meyer (2005) : « *a business can be defined as "a set of related product market combinations. The term business refers neither to a set of producers nor a group of customers, but the domain where the two meet. In other words a business is a competitive arena where companies offering similar products serving similar needs rival against one another in favor of the buyers*". Based on this definition, we can therefore assimilate a business to a strategic segment.

The concept of business model (BM), largely used in the professional circles since the development of companies on the Internet, is only beginning to be defined more precisely in management literature (see for example the article of Lecoq et al. 2006). The most cited authors are Timmers (1998), Amit and Zott (2001) and Magretta (2002). Their definitions include the following elements: the architecture of the offer and the resources implemented, the value proposition for the client, the position of the company in the value network and the revenue model. These elements are to be found in the definition of Voelpel et al. (2004) which we have retained for the rest of our work: « *The term business model can be defined as the particular business concept (or way of doing business) as reflected by the business's core value proposition for customers; its configurated value network(s) to provide that value, consisting of own strategic capabilities as well as other*

(e.g. outsourced/allianced) value networks and capabilities to continually sustain and reinvent itself to satisfy the multiple objectives of its various stakeholders »

> At this stage we therefore retain the following elements for the analysis of a BM:
>
> - The value proposition for the clients
>
> - The resources and capacities necessary to develop the solution
>
> - The structure of the value network
>
> - The economic model (economic logic for revenue generation)

Our questions will however have to be adapted to the technology considered, and require the identification of the specific BM dimensions related to the technological context.

2.2. SPECIFICITIES OF THE BMS IN THE TECHNOLOGICAL AREA STUDIED

2.2.1. A disruptive innovation context

We consider that the e-SENSE technology will produce disruptive innovations. According to Christensen, Anthony and Roth (2004), who introduced this concept, disruptive innovations provide a new value proposition. In doing so, they create new markets or deeply modify the structure of existing ones. Christensen et al. (2004) distinguish two forms of disruptive innovation: « low-end » innovations and « new-market » innovations. The « low-end » innovations corresponds to situations where the client offer provides useless performance, not valued by the client. In this case there's a place for less expensive offers, which are closer to the clients' needs (example of Dell). On the other hand, « new market » innovations come about when existing solutions limit the number of potential clients or when consumption involves situations that aren't practical for the client (example of E-Bay).

We consider that the e-SENSE technology will result in innovations of the « new market » type. This is because the applications that use the sensors involve limited contexts, and to date, the technology available would not allow for the provision of services that would supply a user with real time contextual data, treated according to his/her specific needs, in a practical and a non-intrusive way. The targeted clients are therefore « non-consumers » who will benefit from services not currently available.

2.2.2. The web BMs or "e-business models"

In line with the BM concept, the concept of e-BM was proposed to designate the BMs of service offers on the web and those involving mobile communication.

Rappa (2006) identified 9 categories of web business models:

1. The brokerage model: ex E-Bay

2. The advertising model: ex Google

3. The infomediary model: it is based on consumption information that allows for targeted marketing campaigns: example audience measurement, or Nielsen panels

4. The merchant model or product distribution or services: ex I-tunes

5. The manufacturer or direct model: ex Dell

6. The affiliation model (orientation of the Internaut to partner sites): ex Amazon

7. The community model (based on the loyalty of the Internauts; the revenues come from derived products or services): ex Wikipedia

8. The sales by subscription model: ex Internet access suppliers

9. The utility model: based on a "pay as you go approach" : ex press sites

If these models, which highlight essentially a service-invoicing logic, can be useful to us, they don't cover the full complexity of the technologies considered, which include the notion of user mobility. We have only identified one research project treating the evolution of traditional web service BMs towards BMs involving user mobility (typically web services accessible by mobile telephones or PDAs), that of Looney et al. (2004). This research analysed the various BMs of financial brokering companies offering web-based services on mobiles.

They deduced a mobile BM typology with two dimensions:

- The technological dimension: the technology developed is either open or closed (multi-platform, multi protocol),

- The market dimension: the offer is uniform (one offer, one price) or adapted to different market segments.

It is to be noted that these dimensions are to be found in the BMs described by Chesbrough and Rosenbloom (2002) on the subject of start-ups created from Xerox technologies. The main points that differentiate the BMs described by the authors are on one hand the technological choices (proprietary system approach or open modular approach) and on the other hand the distribution modes (integrated distribution as within Xerox, or in partnership with OEMs who can personalise and adapt the offer for their own clients).

2.2.3.   Exemplary value networks for this type of technology

One of the elements of the BM is the value network. The notion of value network, notion introduced by Brandeburger and Nalebuff (1997), refers to the model of the distribution of value created across the different actors, who either contribute to the creation of the offer, or who are in competition.

The model distinguishes:

- On the horizontal axis: the actors who have economic relations between them (notion of extended value chain), with suppliers upstream and distributors and clients downstream;

- On the vertical axis: the actors who don't have direct economic relations: competitors (direct or indirect) and complementary actors (*complementors*), for example game developers for the value network of video game consoles.

The BM literature concentrates essentially on the economic logic of value creation, but relatively little on the value network as such. However, an innovation can globally be source of value creation, but this value can be recuperated by actors of the network who have not invested, or hardly, in the development efforts. This phenomenon is known as « value migration» (Slywotzky, 1998). Upstream reflection on the BMs must therefore include as a key element a map of the actors involved and the model of value distribution between them.

A first reflection on similar applications to those supplied by e-SENSE gives us an initial idea of the potential actors of the value network. We think that the applications resulting from the technology will concern the following actors:

- Telecommunication operators (mobile telephone, video, data transmission),
- Sensor manufacturers (sensors for the environment like cameras or sensors on objects like RFID labels)
- Service suppliers (ex geo-localisation service by GPS),
- Software and interface developers,
- Terminal manufacturers (telephones, PDA or others),
- IT integrators (ex IBM),
- Specific actors in the domain under consideration (ex supermarket chains, hospitals, schools, automobile manufacturers etc.).

Having identified the actors, the next stage is to imagine, for each of the applications considered, how these actors, and other possible actors, are likely to position themselves within the value network.

A possible approach to the organisation of value networks is given in Ballon's article (2004), the only research identified treating BMs for mobile 4t^h generation mobile services (wireless local area networks or WLANs). The author has identified three main possible organisations of BMs in this field:

1. *The network operator is s the central actor:*

   In this model, the client is in direct relation with the network operator, who fixes the price of services and receives the payments. The services are in most cases offered in the form of fixed price contracts paid in the form of subscriptions.

2. *The contents portal is the central actor*

   This model supplies access to services through a portal that provides a range of services. In this model the client can be in relation with the portal of content and separately with the network operator. Payment of content and access to the network can be separate.

3. *The content supplier is the central actor*

   This model is similar to the preceding one but the client can have access to different suppliers of content and pay them separately. In this case, the number of services is high but the number of transactions per person and per service is relatively low.

This typology insists mainly on the dichotomy between the network operator and the supplier of content. The author indicates that other arrangement can be found with other central actors in the value network: telephone manufacturers, suppliers of software platforms such as Microsoft who controls the terminals through the power of their operating system.

To summarise, it appears that the central actors for the type of service supplied by e-SENSE can be: the mobile telephone operators, the manufacturers of terminals, the developers of protocols, or the suppliers of content (either individually or through a service portal). We feel, to take things further, that for professional applications such as in the health sector, or distributors in the food industry, IT service companies can also be at the centre of the value network.

To summarise, the specificity of the e-SENSE technology leads us to specify our BM analysis framework with four additional criteria to consider:

- An entirely new value proposition for « non clients » (market creation);

- Economic logics based on web BM models (transactions, advertising, subscriptions, information provider, community models etc.) or on the contrary on something else according to a new logic to be identified;

- An offer standardisation dimension to be considered (from the technological and market perspective);

- The central actor of the value network to be defined: generally the network operator or the content supplier.

2.3. IMPLEMENTATION OF THE SCENARIO APPROACH IN THE EXPLORATION OF NEW BMs

The interest of a scenario-based approach in defining business models has been highlighted by several authors. Chesbrough and Rosenbloom (2002) talk of the cognitive role of BMs and of the « strategic prototyping» function, Voelpel et al. (2004) propose a BM innovation approach, Pateli and Giaglis G. (2005) propose a method for the definition of scenarios for new BMs which focuses on the analysis of the impact of the new technology on existing BMs.

Two different approaches exist in the definition of strategic scenarios. The first approach proceeds by extrapolation of the past, and the identification of strong tendencies in the environment. This approach generally results in « continuity » scenarios which re-enforce existing paradigms. They tend to be based on forecasting techniques and result in defining the future based on the present at best, sometimes on the past (Millet, 1988).

The second approach is based on the construction of « rupture » scenarios through a process of making sense out of uncertainty factors. These factors are those that we postulate will have a strong impact (either positive or negative) on the strategy or the project (Strauss et Radnor, 2005). These scenarios aim to modify the representation that the actors have of their environment, highlighting the contradictions and anomalies that result in questioning old and existing paradigms. Rather than try to reduce uncertainty, it becomes a key element in the thought process in order to get the best out of it (Cornellius et Ali, 2005; Van der Heijden (1996). The environment is analysed as a sum of factors undergoing change that the various scenarios attempt to illustrate (Wright, 2005).

Based on this perspective, the scenarios are built as being possible futures. They should therefore increase creativity, improve attention and help managers to take into account the uncertainty and complexity in their environment more effectively.

Pateli and Giaglis (2005) propose a method of building business model scenarios from technological innovations, which can provide useful insight in the construction of our approach. These scenarios take into account both factors related to the sector and factors specific to the company. Their method involves the following six stages:

- Describe the current BM
- Evaluate the influence of the technological innovation
- Identify the roles or the missing actors in the value chain
- Define the scenarios
- Describe the new business models
- Evaluate the impact of the change on the existing BMs

Pateli and Giaglis' article doesn't however detail the various dimensions of the BMs that need to be considered not how to build the scenarios. What we provide here is a step-by-step method for building BM scenarios based on the context of a new technology. The next stage (step 2) involves the systematic evaluation of the impact of the technological innovation on the various elements that we have identified, rather than just globally. The scenario building approach involves formalising the organisation hypotheses of the BM based on the various dimensions and then building contrasting but coherent scenarios from the considered applications of the technology.

We will now illustrate the proposed scenario approach on the e-SENSE technology and its applications.

3. CONSTRUCTION OF BM SCENARIOS FROM e-SENSE TECHNOLOGY APPLICATIONS

The technology as described, is insufficient to allow us to directly explore new BMs without first carrying out a reflection on the possible applications of the technology and the benefits provided to the user by the applications. In other words, how could we imagine the value provided by a technology as generic as « wireless sensor network» without more precision on the applications that the technology could provide and which have meaning for the potential users?

We will therefore now present the work involving the definition of use cases based on the e-SENSE technology followed by the construction of BM scenarios based on the use scenarios.

3.1. THE CREATION OF USE SCENARIOS FOR THE TECHNOLOGY

The approach followed to create the use cases is based on defining different types of scenario before presenting them to potential users. The objective is to explore the needs of the users, their values and beliefs. With the help of a « *focus group* » it involves an analysis of the social values and psychosocial values of the perceived, or expected, uses by the future users. The construction of use scenarios is inspired on the sociological theory of innovation (Flichy, 1994) and more precisely by the work on the sociology of uses (Mallein and Toussaint, 1994). This means taking into account a variety of potential usages in the very early stages of design, by the construction of scenarios including existing or anticipated social practices as well as the conditions for the adoption of the technology. Within the e-SENSE project, the use scenarios were constructed on the basis of considerable technical constraints imposed by the project's partners, in other words in a context involving « technology push ». We are therefore clearly in a context of situations involving breakthrough innovation, which is what we are interested in this paper.

The first constraint is that of technical feasibility and the necessity of showing the potential of the contextual data capture system, whether they be the physical conditions of the user (i.e. stress), the state of machines or such things as the perception of environmental data.

The second constraint is the pressure brought to bare by the various industrial partners of the consortium who, each according to their sector of activity, have their own specific demands concerning the use of the data capture system that concern notably the targeted

application areas (domain 1: personal, domain 2: health and domain 3: industrial). We also find ourselves in the typical situation where breakthrough innovation, managed by incumbent companies, is developed in the context of existing business. It involves the well-known phenomenon identified by Chesbrough and Rosenbloom (2002) of path dependency and concerns the difficulty that companies have in renewing their BMs when confronted with radical innovation.

In this context, a number of consortium partners, who have already worked on sensor systems, notably on ambient intelligence, wanted to share their experience whatever the state of advancement. This enabled the project to formalise the user requirements, which, crossed with the technical and industrial constraints of the e-SENSE technology, resulted in the identification of the three application areas described above.

The use scenarios were then built, based on the three identified areas, and brainstorming was used to imagine several scenarios for each area. The « Léa » and « Store of the future » scenarios are examples of what was produced. Storyboards were then defined for each scenario in order to be transcribed into films of 2 to 3 minutes each. This was done to enable them to be tested by the consortium partners and adjusted as necessary. Below is an illustration of the approach around two of the scenarios developed, in the personal and industrial areas respectively (as illustrated below).

Personal application area:

Scenario "Lea"
Lea, a secondary school pupil is on her way home from school. She's playing with her mobile telephone. Whilst walking she's surprised by three boys of her age. Surprised and panicked she tries to run away. The sensor system (on her mobile phone) reacts to her fear and detects a stress situation. A message is sent to her father who, using a geo-localisation system, sets off to find her. He arrives quickly on the scene, and the three boys , who were attempting to steal the mobile phone, ran off.

Industrial application area:

Scenario « Store of the future »
Anna, a young lady, enters into a food shop to do her shopping. On her arrival, the sensors detect the items on her shopping list, which she had previously entered into her mobile phone. The system asks if she wants to be guided in the shop's alleyways in

order to optimise her shopping and lose as little time as possible. It also suggests a number of promotions that might interest her. The system can even advise her when buying a bottle of wine by indicating whether or not the selected product is likely to be corked.

These storyboards of user scenarios are then transcribed into films in order to be presented to groups of potential consumers to test the use scenarios. The objective is to identify what makes sense or not to the users and to identify the first value propositions concerning perceived uses.

3.2. The construction of BM scenarios form the user scenarios

At the end of the user scenario phase, the researchers have a number of user scenarios validated both internally by the project stakeholders and tested with potential users. They can therefore define what the product can offer, how the consumers could use it, as well as the meaning and the values that they attribute to it. A first value proposition can therefore be identified.

The user scenarios are therefore a critical input in the process of defining business models. As Chesbrough and Rosenbloom (2002) underline, the elaboration of a business model can only be done based on the validated uses in order to have a number of value propositions and to see what makes sense for the potential consumers.

We now move on to the elaboration of BM scenarios from the use cases described above.

A work group, including the various competencies of the projet (marketing, strategy, technical, usages) was organised to construct the BM scenarios based on the questionnaire grid defined above. For each item, the facilitators push the group into imagining different possible responses.

For example, in the « Lea » scenario, the group defined a target segment (the personal segment, and more precisely families), a value proposition (improve child safety), a logic of invoicing the service according to the same principles as insurance (all subscribers mutualise the financing of risks), a technology limited to mobile phones. The variations on the items proposed involved the organisation of the value network and the segmentation of the offer. As far as the value network was concerned, the group's members considered that the central actor of the network (the one that proposes the service to the clients) could be either the mobile phone operator or an insurance service. The decision concerning

segmentation was that it could be standard (the proposal of a security « package »), possibly with different service levels and prices (Table 2).

Criteria	Probable responses and possible ruptures		
The client	*1* *Personal (families)*		*2* *?*
Value proposition	*1* *Improve the safety of children by providing an alert system on their mobile phone*		*2* *?*
Resources and capacities to develop the solution	*1* *Technological capacities (technology under development)* *Marketing capacities (distribution network/ offer marketing / network of prescriptors)*		*2* *?*
Central actor of the value network	*1* *Mobile telephone operator*	*2* *Service of insurance companies*	*3* *?*
Economic logic and revenue generation	*1* *Insurance principle: fixed price contract for the total implementation of the solution.* *(Mutualisation of risks between clients which implies a sufficient volume of clients to be able to offer attractive rates)*		*3* *?*
Level of technology standardisation	*1* *Low: system adapted to the mobile telephone*		*2* *?*
Level of offer standardisation	*1* *High: one unique offer* *(Packaged security solution)*	*2* *Weak: various price levels according to the retained intervention and alert levels*	*3* *?*
Coherent scenarios	***Scenario of BM 1a (1,1,1,1,1,2)***	***Scenario of BM 2a (1,1,1,2,1,2)***	**…**

To create the various BM scenarios, we combine the alternatives on the most uncertain criteria, as suggested by Godet (2001) in his method of prospective scenario definition. Based on « Lea's » story, if we combine both alternative « central value network actors» and the « level of offer standardisation», we obtain two relatively coherent BMs, one where we have a standard offer proposed by a mobile telephone operator, with additions to the fixed telephone contract (kinds of « security options»), and one where the offer is more sophisticated, with different price levels, but this time proposed by an insurance company.

Lea: BM scenario n° 1	Lea: BM scenario n° 2
The offer is proposed in a standard way by the mobile telephone operator and included in an offer of special contracts for children	The offer is proposed by an insurance company in the form of a range of insurance policies covering various situations (journey to and from school, holidays etc.)

If we role out these two scenarios on a value network, we can see that the actors (economic actors and prescriptors) and the modes of access to the market, in particular distribution, are different according to each of the two BMs considered.

We can carry out the same work of BM definition on the use scenario « Store of the future ». This scenario is more complex as it involves the actors of large-scale-distribution, logistics, while directly impacting the personal. A potentially larger number of more complex BM scenarios will therefore result from the analysis as illustrated in Table 3 below. For example numerous criteria can vary such as:

- The client criteria: the considered technology can be sold to shops such as hypermarkets who then propose it for free, or not, to their clients. It can also be proposed directly to the clients in the form of a paying service.

- The value proposition can consist either in advising clients on their purchases, or on the optimisation of the time taken shopping to save time, or both; the value proposition can also concern the distribution networks providing better service to their clients and at the same time marketing data on their purchasing behaviour.

- The central actor of the value network can be the distribution chain, a mobile telephone operator or another actor not currently present on this type of offer (ex. logistics firm).

- The revenue generation logic and the offer standardisation could be done in the form of a subscription, an *à la carte* service, with globalised prices or personalised prices depending on the service desired. The system could also be proposed free of charge with the purchase of a bankcard or a shop's frequent user card.

Criteria	Probable responses and possible ruptures			
Client	*1* *Distribution chains*	*2* *Personal*	*3* *?*	
Value proposition	*1* *Facilitate purchasing through personalised services*	*2* *Optimise shopping time*	*3* *Propose marketing: monitoring client behaviour*	
Resources and capacities to develop the solution	*1* *Technological capacity (technology under development. Marketing capacities (distribution network / marketing of the offer / network of prescriptors)*	*2* *?*		
Central actor of the value network	*1* *Distribution chains*	*2* *Mobile telephone operator*	*3* *?*	
Economic logic and revenue generation	*1* *Subscription principle: fixed price contract for the total implementation of the solution.*	*2* *Principal of payment "à la carte": fixed price contract for the total implementation of the solution.*	*3* *Free with the shops frequent user card*	*4* *?*
Level of technology standardisation	*1* *Weak: system adapted to mobile phones*	*2* *?*		
Level of offer standardisation	*1* *High: one unique offer (Standard solution)*	*2* *Weak: different prices according to the personalised help desired*	*3*	

				?
Coherent scenarios	*Scenario for BM 1b (2,1,1,1,3,1,1)*	*Scenario for BM 2b (2,1,1,1,2,1,2)*	*…*	

Table 3 : Development of BM scenarios for the « store of the future » use scenario

4. SUMMARY OF THE PROPOSED METHOD AND FURTHER STEPS OF THE RESEARCH

To explore new BMs evolved from a technological innovation, the first stage consists in establishing a list of key questions to be asked about the business architecture of the offer. The first questions are generic, they concern all types of BM:

- Who are the clients and what is the value proposition that the technology can provide?
- What resources and capacities are necessary to develop the solution?
- How can the value network be organised?
- What is the economical logic for revenue generation?

The next set of questions are specific to the technology, and need to be defined ad-hoc according to each project by analysing the closest existing technologies. For e-SENSE, we identified the following five additional criteria:

- The clients are « non-clients » (disruptive technology « new market »);
- The question of economic logic (similar or different from the economic logic of web based services);
- The level of technological standardisation;
- The level of marketing standardisation of the offer;
- The central actor of the value network (network operator, content supplier, or other central actor).

The second stage involves the definition and test of use, or use scenarios, in the various identified application areas. The BM scenarios can only be developed on the basis of use scenarios that make sense for potential users.

The third step aims at building the BM scenarios based on the most promising use scenarios by proceeding as follows:

- Reply to each criteria by identifying possible alternatives for each one;
- Build the scenarios on different and contrasted alternatives in order to produce coherent BMs.

20

Next we elaborate storyboards for each BM scenario in order to test them with managers of target business areas (in the same way as the use scenarios are tested). For Magretta (2002) the BMs must satisfy two relevance tests: the financial test and the narrative test. Our hypothesis is that in the early phases of technological innovation projects, the financial projections, particularly the part related to forecast revenues are practically impossible to define. The narrative test, however aims to check that the considered BM makes sense to the economic stakeholders. It is exactly what we aim to verify, in order to provide food for thought and facilitate decision-making on whether or not to continue the R&D investments. The storyboard method has not yet been developed and will be the next step of our work. At this stage, and based on recent work on storytelling in strategy, we think that the storyboards, based on the BM scenarios could, schematically follow the following logic:

- A number of user problems exist that remain unsolved (or unsatisfactorily solved) by existing solutions.
- The technology has been invented and translated into a value proposition to provide a solution to the client.
- The story is built on the results of the analysis on how to best provide value to the client and create value for the company, by overcoming any obstacles encountered.
- If we apply a classical BM, we will probably encounter difficulties that will make any investment risky: for example the technology is too expensive, the distributors find it too complicated or it competes with other well established offers.
- What is required is to invent a new BM to overcome these difficulties: for example through alliances with a competitor, giving the technology (free) and financing it through complementary services, get rid of intermediaries in the value network, standardise the offer (or segment the offer) etc.
- By doing this we have a high chance of being successful as the client wouldn't see the risk any more, or the distributors would be short-circuited etc.

CONCLUSION

This work is based on the hypothesis that successful technological innovations are often accompanied by innovations in business models. Technology managers are not however equipped to think through the way in which a technology could provide value for the client, nor through which value creation model (or business model) it could be brought to market. Based on this, the research presented in this article aims to develop a method for the systematic exploration of new business models associated with a given technical innovation.

The case on which we are experimenting this approach appears to us to be exemplary of the « technology push » type of technological innovation: a project pushed by R&D, numerous stakeholders (represented here by the industrial partners of a consortium), a potentially very broad range of applications and innovation of the disruptive type.

In comparison to the first outline of this method proposed by Pateli and Giaglis defining business model scenarios for technological innovations, our approach has the advantage of being more detailed and in addition provides a framework for analysis that is adapted to each technology studied.

The method also shows how to concretely integrate the results of anticipatory user studies (usually managed by marketing teams) and how to implement a scenario-based approach to facilitate group exchange around new business models. The implementation of this method should, in our opinion, be accompanied by more cross-functional responsibilities in the very early phases of technological projects. This should be done in order to improve the structuring of ideas between the technological, marketing (around usage), and strategic (on value creation models) perspectives.

This research is only at the development stage of the methodology. To a certain extent, this method can therefore be considered to be at the prototype stage. In order to take it further, the next stages of our work will involve improving the formalisation of the scenarios using a storyboard approach and then in carrying out in-situ tests. To our knowledge this type of work around strategic scenarios has not been investigated to date.

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