MODELLING IN BUSINESS MODEL DESIGN:REFLECTIONS ON THREE EXPERIMENTAL CASES IN HEALTHY LIVING

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Abstract

This paper reviews the origins of modelling in design theory and reflects on its application within the new mode of innovation: business model design. Three main principles of modelling are identified in association to design theory: (1) modelling as a visual reasoning, as a (2) prescriptive aggregation of complex systems, as the (3) creation of an artefact. Drawn from designer's experiences in three experimental cases of healthy living, three additional principles of business modelling are identified: (1) prescriptions of value exchanges in network model visualisations, (2) modelling as a shared vision, communication and commitment of multiple actors and as (3) dynamic modelling across time zones. The paper proposes that by modelling, designers can offer a useful contribution to business model design.

Keywords: Modelling, Business models and considerations, Product modelling, Design methodology

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1 INTRODUCTION

In keeping pace with the changing innovation challenges of internet technologies, the activities of industrial designers are transgressing from merely product (*model*) design to product service system (PSS) design. Strategic designers are increasingly found in new positions to apply 'design theory' to these new social contexts of human experience. For designing services and systems in conjunction with the products of PSS, new concepts are needed to commensurate the complexity and value benefits of the connecting technologies and create integral solutions.

Business model *design* (Amit and Zott, 2001), proclaimed as a new mode of innovation (Markides, 2006) concerns the high complexity of multiple companies and new ways of integrating their business and technological network contexts. Overcoming organisational barriers to inherent web 2.0 technology innovation implications, involves changes of a set of variables where every change is likely to alter the other variables. Osterwalder (2004) has built a business model ontology to relate information systems to strategic management. He introduced the business model canvas (Ostenwalder, and Pigneur, 2010), that has gained considerable popularity in the design community. To some extent this canvas appears to be useful for the analysis and overview of business model elements. However, just as a SWOT (strengths/weaknesses/ opportunities/threats) canvas does not model a strategy, neither does this canvas *model* the business model, (Simonse, 2014). The need for modelling the business models is finding a way to support the reasoning of business model innovation and a quest for model objects that are manipulable, or experimentable (Baden-Fuller and Morgan, 2010; Baden-Fuller and Mangemartin, 2013). However, besides some initial reflections, little is known about business model design and the complex interplay between the designer, the use of design theory and design outcomes (Badke-Schaub et al., 2011).

The intend of this paper is to gain a better understanding here, in so far as we will review the origin of modelling in design theory and reflect on its application within business model design. This paper identifies *design principles of modelling* and proposes *new principles of business modelling* derived from three practices of business model design in healthy living cases with new product services systems. We adopted a case study method to investigate the application and transfer of the design principles into the PSS context. We reflected on the case analysis, framing principles of business modelling.

In the next section, this paper discusses the theoretical foundation of the research study along three main principles of modelling and the formulation of the research question. Then the application section follows, with attention given to the method and results of business model design in three experimental cases of healthy living product service systems. In the final section conclusions are drawn from reflections on the modelling in business model design with the identification of three particular design principles of business modelling.

2 DESIGN PRINCIPLES OF MODELLING

First we reviewed the design theory and methodology literature on conceptualizations of modelling and found three relevant perspectives from which we synthesised a main principle. From the human centred design(ers) perspective we formulate the first main principle 'visual reasoning by designers'. From the complex system perspective on the origins of modelling we formulate 'prescriptive aggregation of complex systems' and from the design methodology in the European tradition (ref. Anthology of design theory) we formulate the design principle of 'creation of an artefact'.

2.1 Visual reasoning by designers

'Modelling' is considered as an ability of creative problem solving by visual reasoning and decision making. The way designers communicate is through visual thinking, framing, and coding design requirements into new models (Goldschmidt, 1994). Architects and designers use sketching not just to record an idea, but moreover to generate it. For visual modelling designers use symbols, signs, and metaphors through the media of sketching, diagrams, and drawings and thus translate abstract

requirements into concrete objects, including 2D and 3D images, clay models and marquettes. In the context of PSS, four generic visual archetypes (maps, flows, images and narratives) have been identified. However, none of the existing tools really matches the need of representing what a service is into am synthetic and unique view (such as the sketch of any tangible products does), (Dani et al., 2009; Segelström and Holmlid, 2011). By experimenting and testing with visual generative modelling, designers have been able to design new business model solution (Simonse, 2014). Yet, the initial design toolkits provide some design support but request for further advancements.

2.2 Prescriptive aggregation of complex systems

'Modelling' in complex system theory is regarded as a methodology to research behaviour of large complex systems in reality. According to Simon (1990) we '*capture in our models a simplified picture of reality which, nevertheless, will allow us to make the inferences that are important to our goals'*- Simon (1990). In order to understand the consequences of opting for one decision over another designer's construct prescriptive models. For useful business model design and manipulations, a model resolution level needs to be determined that are only possible when the model is (like those of economics) simple enough to work through (or where the implications of a likely change can be programmed into it), but yet complicated enough to capture sufficient content of the firm's arrangements to make the experiment meaningful (Morgan and Morisson, 1999). To manage the complexity of representing reality in a model, basic guidelines in modelling are: First, *to separate what is essential* from what is dispensable; second, to *make use of symbols* that represent natural language where appropriate, modelling with pictures or diagrams, rather than making use of numerical description; third, *to aggregate as much as possible*. This aggregation refers to the essential notions of system theory, that artificial systems have a "boxes-within-boxes" architecture with the important property that the behaviour of the units at any specific level can be described and explained without the need for a detailed picture of the structures and behaviour at the levels below. As such a model represents reality with a certain structure and resolution level that provides insights on orders of magnitude.

2.3 Creation of an artefact

In concerning 'modelling' as the language of the designer, the actuation of an artefact is essential (Roozenburg, 1993). Grounded in the research of Hubka (1980) who found that the designer is concerned with modelling for about 30% of its activities. A 'model' is an artefact, which reproduces the properties of an object. The model supports the designer to obtain answers to queries during the design process to elaborate, synthesize, evaluate and communicate. The modelling activity has the following set of design characteristics: *object, property* and *purpose* object (Andreasen, 1994). In a product development project different types of models can be generated for representing the product, such as: experimental set-ups, design sketches, mock-up models, lay-out drawings, block-diagrams, function models and prototypes. Properties represent the quality of the product prescribed as requirements in the design specification. Thus, properties of products are, apart from other, performance, size, color, reliability, costs. Some properties are quantifiable and offer functional benefits e.g. weight, speed, energy consumption. Others are less quantifiable such as appearance and ease of operation (Buur and Andreasen, 1989; Maier et al., 2014).

In transgressing from merely product design to product service system design, this research investigates the application of these modelling principles that are grounded in product modelling into new practices of business modelling. In particular we are interested in finding answers to the question of: *To which extent modelling as a product modelling ability can contribute to business modelling and what is similar and dissimilar when we compare the modelling process and outcomes.*

3 THREE EXPERIMENTAL CASES IN BUSINESS MODELLING

Given the emerging practices of business modelling and the nature of our research question we adopted the case study method (Eisenhardt, 1989) to investigate, in-depth the application and transfer of the design principles into the PSS context. For the reflection we applied multiple case-analyses and compared three cases within the healthy living domain. The case where selected, representing a business modelling practice, a new product service system and experimental mode of modelling. A

short description of the method and results of business model design is given below, followed by the case-analysis table.

3.1 Case A: Health protection service system

Case A concerns a start-up organization that launched a health protection service system by a professional cardiologist (Meeuwen et al., 2014). The purpose of the health protection service is to make clients aware of living a healthier life by supporting them with an online service for their lifestyle advices and heart risk scores. On the PRE web app, a client creates a personal online account and gets feedback information including a grade for his or her personal lifestyle and a percentage chance of heart failure. These results are based on an online questionnaire (up to 300 questions) and a small physical examination (taking blood for glucose levels). The information service regularly gives advice on how the client can improve his or her lifestyle, and provides the client with a lifestyle score, updated bimonthly

In this case experiment for modelling the health protection service, five respondents were invited for an interactive session with the researchers. In the co-design process, e each participant was asked to visualize the business models concerning the health protection service by using the visual business modelling toolkit, a pre-crafted instrument created by the research designers. This visual business modelling toolkit is an actor map toolsets that visually captures the connections between multiple stakeholders and evaluate the value types of interactions (see table 2). All sessions were recorded. Within-case evidence was acquired by analysing the records, taking notes, and combining the notes with the created visual models. Three types of data were analysed: visual modelling data, interview data and documented data concerning the modelling process. The different qualitative data were combined to frame, analyse and synthesize the business model view of each respondent (see figure 1).

Figure 1. Healthy living case A: Business modelling for health protection product service system

The outcome of the modelling experiment is a visual business model design, created from the different actor perspectives. From extracting valuable actors, transactions and value attributes that were commonly modelled, we, the designers, created building blocks. The artefact of the business model design consists of five building blocks:

- Building block 1: involve a health professional, since this will ensure privacy and reliability in the transactions between the client and the service.

- Building block 2: provide an online flow of information with regular interactions to the client in order to stimulate self-management of personal health.
- Building block 3: involve an intermediate organization with a large customer base to extend the service's reach.
- Building block 4: involve a service-dedicated health expert for personal face-to-face contact with clients in order to ensure and increase the perceived quality of the eHealth service.
- Building block 5: include social interaction with other clients of the online service with a view to motivating and supporting the self-management of personal health.

For the construction of this care model, actors, transactions and value attributes are essential elements. The modelling of the care model structures these elements in a visual way. Guided by the business modelling toolkit, the care model design artefact is visualized in the context.

3.2 Case B Personalised medicine service system for Diabetes

Case B considers the business modelling for the 'Artificial Pancreas' device that is currently developed by the Dutch company DIAGO Diabetics (name changed for confidentiality reasons) (Schultes and Tekeli, 2014). The device offers a closed loop system that automatically controls and continuously monitors the blood glucose levels of insulin dependent diabetic patients. Based on the measured values, the device administers the right dose of insulin or glucagon. (see figure 2)

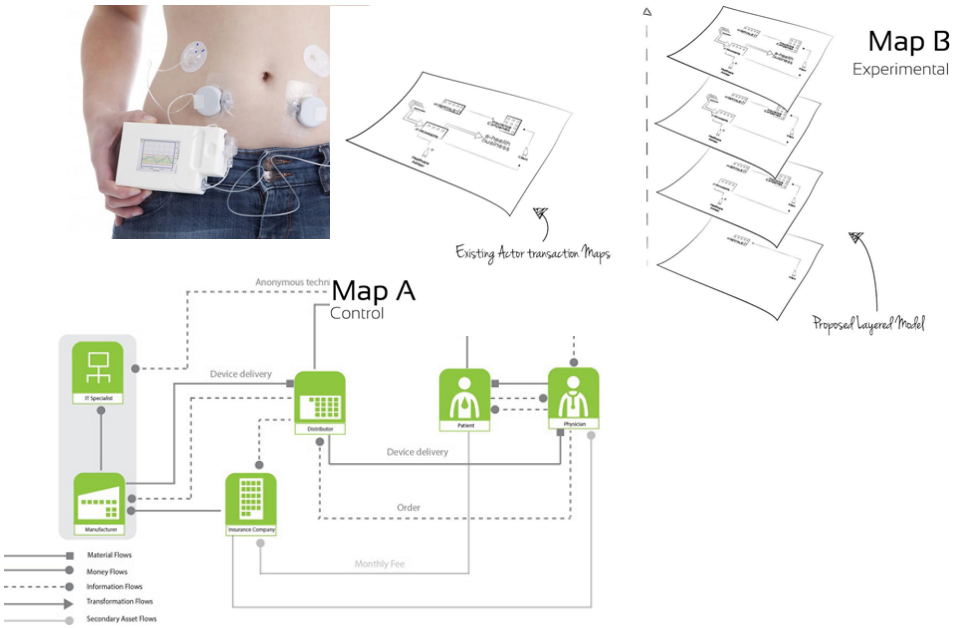


Figure 2. Healthy living case B: Business modelling for Diabetes self-measurement service system

In this case study, participants of a product service system on diabetes self-measurement service were invited for an interactive session to experiment and test the usefulness of the layered map as a boundary object against the actor transaction map of the visual business modelling toolkit. Together with the CEO and the marketing manager of DIAGO Diabetics, the designers developed the initial business model for the 'Artificial Pancreas' (see figure 3). With the layered visualization business modelling toolkit, separate layers communicate the business model in a chronological way. In the experiment set-up, the researchers used the visual business modelling toolkit in the session with the first group and the layered visualization modelling toolkit with the second group. A structured evaluation protocol was used, a pretest-posttest experiment set-up (Cozby and Bates, 2011), to collect the experimental data for comparison on the boundary object criteria for efficient reasoning, creative problem solving and decision making (Carlile, 2004).

Table 1 . Synthesis of pre-and post- test results.

Level of Boundary Object	CRITERIA	MAIN INFLUENCING FACTOR	SINGLE LAYERED	MULTI LAYERED
TRANSFER	Understanding the BM principle (get the idea, concept)	TOOL	GOOD	BETTER
	Imagine thyself in the BM scenario, Assuming an active role in the BM	EXPERIENCE & VISUALS	GOOD	GOOD (BETTER)
TRANSLATE	Recognize the dependencies of different stakeholders	EXPERIENCE & VISUALS	GOOD	GOOD (BETTER)
	Recognize/ Identify potential challenges, problems and pitfalls		GOOD	GOOD (BETTER)
TRANSFORM	Propose a solution (improve the BM by adapting it)	EXPERIENCE & VISUALS	GOOD	GOOD (BETTER)
	Transform the system/ map		GOOD	GOOD (BETTER)
	Discuss / explain s.th. along the map		GOOD	GOOD (BETTER)

The pre- and post-test measured on the criteria of *transfer of knowledge*: 1) Understanding the concept of the business model; (2) Imagine thyself in the business model scenario, assuming an active role in the business model; Measured on *translate knowledge:* (3) Recognize the dependencies of different stakeholders; (4) Recognize/ Identify potential challenges, problems and pitfalls; And on the last level of boundary objects *transform knowledge:* (5) Propose a solution and improve the business model by adapting it; (6) Transform the system/tool; (7) Discuss / explain this along the tool (see table 1). Results of this experiment show that the overall usefulness of the visual business model as a boundary object can be increased by the chronological layering of the model, on the level of transferring knowledge, when it comes to the understanding and communication of the business model content. Compared to the single layered version, for translating (co-analysis) and transforming (co-design) knowledge, overview and layering are similar useful. For these levels of boundary objects, the professional experience of the respondents as well as the clear and structured style of the visuals and structured style of the visuals that are used in the visual business model artefact turned out to be important.

3.3 Case C Personalised Hip healthcare services

Case C relates to hip replacement services tailored to the personal needs and preferences of the patient. (Posthoorn and Gedde, 2014). The service design is provided by a network consortium of a hospital, university and orthopedic implants firm. This case explored business modelling in the context of overcoming the barriers in the patient journey of hip replacement. The modelling in this case connects the patient journey mapping (Mould et al., 2010) to visual business modelling mapping (Simonse, 2014). The purpose of business modelling was to identify, understand and visualise where the actors can add value, to the different stages of the hip replacement journey in order to improve the patient experience and enable them to manage their personal health.

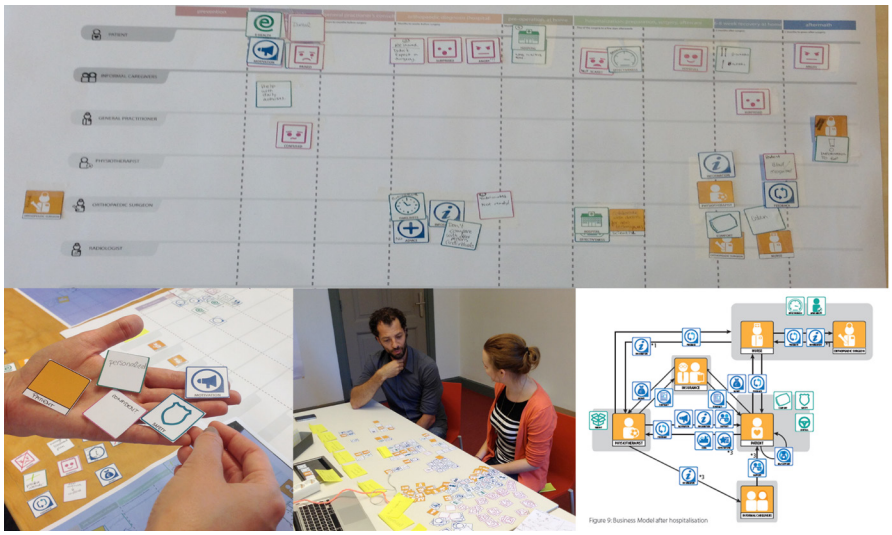


Figure 3. Healthy living case C: Business modelling for hip replacement rapid recovery service system

This case research involved five actors in the patient journey: a patient, physiotherapist, orthopaedic surgeon, orthopaedic nurse, and a business consultant in the eHealth services. In interactive sessions, maps, stimuli cards and free format sketches where used as tools to get a deeper and detailed understanding of the different participant's feelings, thoughts and frustrations regarding the different steps in the hip replacement patient journey. Starting with the patient journey, the cards were reused in the next step of business modelling in which the participant identified and drawn the transactions between actors. During the sessions, the use of the tangible stimuli cards helped the participant remember events. Participants used the map to structure their story and organise the cards. The timeline on the map enabled the participants to indicate when they experienced emotions, needs or values, and who was involved. The data analysis involved getting an overview of the different perspectives of the actors. All actor maps were combined into a bigger business model map. The different clusters of the cards were compared to identify similarities and differences about barriers and value exchanges. The main barrier, the lack of information, in terms of unknown expectations of actors, was found to be a root to faults and mistakes in the system. By working visual and tangible, it was easier to discuss the different types of value exchange between the actors within the process. An integrated care model design was generated for the pre-, during and post hospitalisation services of hip replacement.

Integrated care model for personalised services before, during and after hospitalisation
After the consultation with the general practitioner, central in this service is the consult with the orthopaedic surgeon in the hospital. However, a secondary stream of information to the patient comes from interaction with the nurse and a third from interaction with the physiotherapist. To personalize the information with respect to the motivation of the patient, and the short amount of time of the consult [12 min] with the orthopaedic surgeon, in this integrated care model all information is shared and collected by the nurse who is dedicated to this service of preparing for hip replacement hospitalisation. With eHealth technology the patient and the nurse exchange expectations, questions and concerns beforehand. Knowing these personal information and profiles, in this way the surgeon can provide more personalized information and support to comfort the patient.
During the hospitalisation, the integrated care model of shared information per patient is used for services of personalised surgery and personalised exercise program. Furthermore the nurse and the patient interact intensely with high attention for any question the patient asks.
After the hospitalisation the physiotherapist and the patient interact intensively to tailor needs into a personalized treatment. In this service of the integrated care model, the patient is in the lead to actively and passively provide treatment data about his progress to the physiotherapist, who in return will adjust the rehabilitation plan and tailor it to the patient's needs. This enables the patient to stay motivated to perform the exercises, and feel more in control of their own health.

The integrated care model improves the communication between the actors concerning information, feedback and reassurance. By making expectations explicit to actors will enable the care to become more personalized, which will make the patient feel more secure of a treatment tailored to his needs.

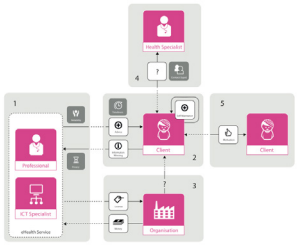
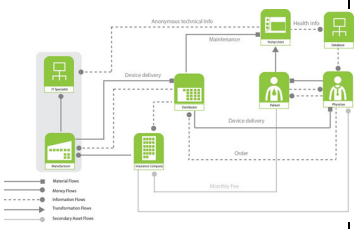
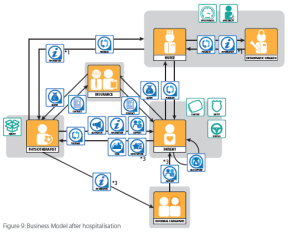
3.4 Case analysis

In the case analysis across the three healthy living cases: first the application and transfer of the design principles into the PSS context is compared; second the striking characteristics of the business modelling process and new insights on the nature of business modelling are synthesized (see table 2).

4 DISCUSSION AND CONCLUSION: DESIGN PRINCIPLES OF BUSINESS MODELLING

In this section we reflect on the case analysis and the enfolding literature with respect to the research question: *To which extent modelling as a product modelling ability can contribute to business modelling and what is similar and dissimilar when we compare the modelling process and outcomes.* Drawn from the logic across cases, in comparison to contrasting and supporting literature, three additional principles of modelling are identified: (1) Actors modelling: translate the cognitive configurations into action, (2) Modular prescriptions: transform value exchanges of the network

Table 2.Comparision of application of modelling principles, modelling process and new insights across cases of business modelling

Experimental Case	**Healthy living Case A**	**Healthy living Case B**	**Healthy living Case C**
Key reference	(Meeuwen, Walt Meijer and Simonse, 2015)	(Schultes and Tekeli, 2014)	(Posthoorn and Gedde, 2014)
Healthy living product service system	**Health protection service system**	**Personalised medicine service system for Diabetes**	**Personalised hip healthcare services**
Designer's instrument for Visual reasoning	Visual Care Modelling toolkit: icon cards for actors, transactions, value attributes. Blanc cards, markers and A3 paper. -Client and Health professional – start cards.	Visual Business Modelling toolkit: icon cards for actors and objects. Blanc cards, markers and A3 paper.	Visual Business Modelling toolkit: icon cards for actors, e*motion values*, added value, channels. Blanc cards, markers and Patient journey (Timeline) map
Prescriptive aggregation for Business model	Network structure properties: identify all actors, transactions and value attributes that provide the service to the client (including peer-to-peer client exchanges).	Layering actor-transaction building blocks in business-to-hospital service network structure.	In connection to patient journey, start from barriers - model network actors value exchange solutions of eHealth service providing for Hip.
Artefact Business Model Design (Outcome)			
Modelling process	Modelling in co-design with actors involved. Start with interactive session with service owner and with client to discover important actors. Generating multiple actor view models. Synthesis of Business model Design by strategic designer. Create artefact with building blocks of actor-transactions.	Co-analysis and Co-design of business model with service owners – strategic design team: Venture CEO / Marketing manager / two strategic designers. Designers communicate the artefact with layers to other actors involved in the network.	Modelling in co-design with actors involved. Start with emotion value cards to identify barriers in patient journey. Collect multiple actors' viewpoint on barriers and value adding solutions. Synthesis of new value exchange solutions by strategic designer. Create artefact with building blocks of new actor-transactions solutions.
New insights on nature of business modelling	Tangible knowledge on values exchanges, the mental models of actors, become explicit by visual business modelling. (For discovery of *new* network structure properties - blanc cards are very important).	Shared vision, translating (co-analysis) and transforming (co-design) roles and value exchanges into model. Useful communicated by building blocks.	Timeline object evokes dynamic modelling by iterative loops and integration of actor's views and expansion of value exchanges.

structure into building blocks of the business model and as (3) Shared vision: transfer of communication and commitment.

4.1 Actors modelling: translate the cognitive configurations into action

All cases design the business model by combining actor's views. A number of different actors, participate in an interactive sessions to visualize what they perceive as the business model from their point of view. In the actors modelling, four actor views appeared to be important for the synthesis of the different views into a comprehensive model:

a) Client -user modelling: in correspondence to findings of Hienerth et al. (2011), building on the 'user as designer' notions of Von Hippel,(1988).
b) Health professional -expert modelling: important for the credibility, viability and privacy of the service (Meeuwen et al., 2014).
c) ICT-developer - web-technology modelling: inherent to business model innovation notions of business model design (Simonse, 2014).
d) Network intermediary - eco-system modelling: perquisite for integration of business organisation perspective.

The commonalities of at least the views of these actors influence the business model design.
By visual modelling, the tangible cognitive configurations on values exchanges, the mental models of actors, become explicit. The use of the visual toolkit stimulates the articulation of each actor's view, the translation of the cognitive considerations associated to (perceived) customer desires and the delivered service structure. The icon cards, instead of texts, provide easy recognition and ease of use. For mediation across the boundaries of organisations collaboration of strategic managers with designers appeared to be very useful. This corresponds to the findings of Buur et al. (2013) on similar approaches of participatory business modelling, evidencing that the visual and tangible modelling process is extraordinarily successful in initiating conversations about how to innovate business in cross-disciplinary and cross-functional groups.

4.2 Modular prescriptions: transform value exchanges of the network structure into building blocks of the business model

In all cases, building blocks with the properties of actors and value exchanges are modelled to construct the whole business model design. The business model design include both a high-level overview of the network architecture that illustrates the whole care service delivery and enough detail of specific roles and activities of value exchange in modular building blocks of between at least two actors. Similar to product modelling (Alexander, 1964) is in business modelling, the modular prescription in substructures. Dissimilar to product architectural innovation (Henderson and Clark, 1990) is the relational object of modelling: the network structure of collaborating actors who are connected by internet technology. The initial properties of the network structure of a business model are the actors and value exchanges. The modular building blocks evoke transformation of the current situation by iterative loops and integration of actor's views and expansion of value exchanges in substructures.

4.3 Shared vision: transfer of communication and commitment

In all the cases, the business model artefact had an embedded story or scenario communicating among the various audience involved, for example how it provides people with protecting their health, or personalizing their glucose medicine dose or their information provision concerning their hip treatment. The model objects are therefore more than the denotation and source of information as some product models can be restricted to. The business model design has a catalysing role in communication. It is the explicit reason for their creation, in contrast to product modelling where it can be a second. Business model designs frame the inter-functional communication of interpretation and demonstration across the different organisations. The business model designs constitutes a shared vision in correspondence with Bucciarelli's notion (1994).

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