Technological Rules Based Business Models Analysis: A Design Science Approach

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Received: March 16, 2011 Accepted: April 11, 2011 doi:10.5539/ijbm.v6n9p113

This research is financed by the National Natural Science Foundation of China (NSFC) (No. 70721017001) (Sponsoring information)

Abstract

This paper introduces a trend in management research recently, which is attempting to adopt a design science approach when solving the relevance problem of academic management research. Building on the related literature in design science we propose an exploratory framework based on technological rules for the research in the field of business models and give a detail of the constructing factors for a business model. We then analyze the fitness between a business model and its external environment using this research framework and get conclusions.

Keywords: Business models, Design science, Technological rules

1. Introduction

Business Model has become an important core competence of a business unit, a firm or a company. It is progressively becoming the competitive focus in business and has already been the basic consideration when a company making decision, which was dominated by strategy before. But traditional business models are lack of competence and need to be innovated to new ones. A good business model will beat a good idea or technology. The common understanding is that even with the advanced technologies, a company will not be able to capture the value without an appropriate match between high technologies and business models. Therefore an enterprise should fully consider how to design a better business model to fit the business environment according to their competitive advantages and capabilities for profits.

The concept of business model reflects a desire of researcher or manager trying to describe the activities of an enterprise from a general perspective. Researchers try to reveal the general law of business through business model theory. An ideal model is able to describe the general characteristics of all business activities with a "holographic" like feature. Business model takes a role as "holographic" photo of business activities that can be used as a new management tool.

The research on Business models is to reveal the commercial operation logic by studying the constructs and relationships in business processes. This means to design a “model” to show the internal business logic of a business. A most important question business model research should answer is that "what a company's business model is?" rather than that "what kind business model can bring good performance?” Because it is meaningless to talk an abstract business model is efficient or not in performance without considering a specific business environment.

Unlike traditional management theory, research in the field of business models is difficult to apply the classic study paradigm of "Theory Building - Theory Testing". It is hardly for business models research to contribute to traditional management theory according to the characteristics of a theoretical study in a general sense. The so-called theory is some propositions constructed with a set of concepts based on the internal logic in a series certain assumptions (Davis and Eisenhardt et al., 2007). That construct, proposition, argument and assumption

make the four elements of a theory (Simon, 2004). Popularly, a theory is an interpretation of a variety of questions to natural or social phenomena (Whetten, 1989). However, the study of business models is not to explain a natural or social phenomenon. In its essence, business model as an ontology is neither natural nor social, but artificial. In other word, business model is a kind of artifact. A business model research is not to construct a new theory, but mainly to search of solutions to practical problems. Thus, the methodology for business model research should take the "problem solving" paradigm.

We argue that business models research in a specific business environment should answer the following four questions at least:

1) What are the elements that constitute a business model?
2) What are the qualities and features of a business model?
3) What is the logic for a business model in making money?
4) How does a business model operate in real situation?

This research makes a systemic analysis of specific business models and rules matching the needs of the practice of management. It also contributes to the business model design and provides an evaluating method for companies to assess the investment value of technology and development strategies.

This article proceeds as follows: section 2 makes a review of literatures in the field of management design and business models; section 3 explains the methodology and research framework used in the paper; section 4 outlines the main finding of our business model analysis and section 5 gives conclusions for this research.

2. Literature Review

2.1 The Relevance of Management Research

Management is a very practical discipline, however, which has often been criticized because of lack of relevance (Beyer and Trice, 1982; Burrell, 1989). Academics encourage "rigorous" research, but the people who in practice appeal for the results closely to practice (Whitley, 1988; March and Sutton, 1997). How to address the gap between the academic research and practice? Nowadays, many scholars put forward different points on the gap between theory and practice due to research methods. Hambrick (1994) argues that it is the expression of the research result that makes the obstacle to academic research in practical application. He believes that the literatures of management research are rich of solutions to practical problems. But the reasons why managers can not adopt these research results is that the presentation of the research results is too complex and incomprehensible to understand and this can be solved as long as the attentions are paid on the expression of the results. Similarly, some scholars believe that only academics and practitioners are more collaborative in research, the results of their research will be more practical. They argue that researchers and practitioners should promote collaboration by interaction between each other to address this issue.

As an applied research, management study tends to use the mainstream explanatory scientific paradigm. This research paradigm from the beginning is based on natural science or social science. The pattern of this explanatory paradigm is "theory building and theory testing". Its aim is to achieve the theoretical prediction. Explanation based on natural science paradigm focuses on the description and explanation of the phenomenon which is rarely associated with the solution of practical problems. From the practical point of view, explanatory research method has two obvious disadvantages: too abstract and not grounded. On the one hand, it is simplistic and difficult to be applied to practice for the needs of describing the natural or social phenomenon; On the other hand, explanatory application of management theory in practice is lack of adequate on-site verification which makes the theory not be grounded (Argyris and Schön, 1991). Van Aken takes that such mainstream management research paradigm should be responsible for the split between research and practice (Van Aken, 2004) and there needs to be a new research paradigm for management research in order to contribute to practices.

Paradigm is constituted by the shared beliefs, values, technologies, and a whole made by the members of a particular science community (Kuhn, 2003). It is the researcher's beliefs based on common understanding. Management has long been using research paradigm based on natural science to explain and to predict organizational phenomena by establishing causal models and taking it as a benchmark of academic achievements. However, there is a significantly difference between the study of management and natural science: the former is faced with the object of artificial (Simon, 2004).Thus it should take a new research paradigm to resolve the split between theory and practice. The research paradigm based on design science is just to fill the "gap" between management theory and practice.

2.2 Design Science and Management Design

In recent years, some scholars have raised a new idea of management research called "management design" (Kilduff and Kelemen, 2001), in which research paradigm based on design science is used for management research. Since 2001, Kilduff and Kelemen at the first time took "management design" as a new methodology for management research. It has developed rapidly in recent years. Under the push of renowned professors including van Aken, Andrew Van de Ven, Richard Boland, Anne Huff and Jean Bartunek, etc., this methodology is achieved great progress in the field of human resource, organizational science, strategy and other research

areas. This may be a new trend in management research.

Design science, also known as design methodology or design philosophy, reflects the artistic and functional unity of management research. The “artificial” defined by Herbert Simon (2004) corresponds with the natural phenomenon. An artificial is something made by person in processing the things for a particular purpose. The creating artificial is the process of design. Simon differentiates design science and explanatory science in his book titled “The Sciences of the Artificial”. In his point, the design science, such as management, medical, law etc, is an exploratory research. The most difference between design science and explanatory research is the ontology of the subject for study. It is created first by people in design science for a subject in research and if you want to evaluate a subject you must create it first. However, the subject for explanatory research is just out there. The goal for explanatory science is to make the understanding or awareness of natural or social phenomenon. The research subject in design science is embedded in the process of research. The artificial phenomenon is the essence for design science (Simon, 2004). The findings of design science should be based on valid data, but only after those subjects have been created the empirical data can be collected and conducted further analysis on it. To the output of the study, design science and explanatory science is very different: the purpose of explanatory research is to create theory and make prediction applying the theory; however, the result of design science is to provide practical solutions to problems. The results of the two types of research also show the difference focuses on research: explanatory science focuses on the explanation of the phenomenon and the design science concerns the solutions to practical problems. The main differences between design science (explorative science) and explanatory science are shown in table 1 which is made by Holmstrom and Ketokivi et al (2009).

Simon is the first one to define management as design science. The elaboration on contingency phenomena of artificial in organizational science in his book “Administrative Behavior” reflects the views of a design. Many scholars in this area subsequently conduct in-depth study. Van Aken (2004) introduces the design science research methods systematically to the study of management. He divides science into three categories based on the paradigm: the first category is formal sciences, such as philosophy and mathematics; the second category is explanatory sciences, such as physics, biology, economics, social science; The third category is design sciences, such as engineering science, medicine, science and modern psychotherapy (Aken, 2004). Experience is invalid for formal science for its main task is to establish the inner-consistent system of propositions and to verify consistency in its inherent logic. Explanatory science is to explain the observed phenomena and make prediction to some degree within the scope of their research. The result of explanatory science should be tested by academic community. It usually describes, explains and predicts the phenomenon observed as much as possible through the causal model especially in the quantitative model to deepen understanding of nature and society. Design science is primarily focusing on product development design and implementation of appropriate knowledge and its application and eventually to achieve the desired results. Design science's task is to develop design knowledge, to solve structural problems, or improve the performance of existing entities. Description of existing design theory and practice is located in applications, such as engineering, medicine. The results of their research and practice in the academic community has been greatly recognized (Aken, 2005). Design science's goal is to establish "technological rules " (Bunge, 1967), which is defined by van Aken as a series of "interference" of knowledge in order to obtain some results in certain conditions (Van Aken, 2004). Every factor in a technological rule is verifiable. Management design focuses on problem solving, rather than the problem itself (Geertz, 1973).

The general logic of a technological rule can be described as "to get result Y in condition Z, it would take action X.” The action X is the core of a technological rule; it is a kind of general conceptual solution. The extraction of technological rule is like the "clinical research” in medical, that is, to study the impaction of interference factors in particular scenario. The causal model of explanatory science in the laboratory by a closed system is usually to exclude (or control) the other factors of the independent variable. The extraction of technological rules in a specific application environment is also verified under the rules of the effectiveness of technology, but the technological rules often do not resolve the relationship between the dependent variable and the independent variables, as long as you can verify the effects of intervention factors. Technological rules are always extracted from multiple case studies by working out some "measures" to answer a series of questions of the same type and are validated and refined and then replicated to the other cases. Different from the general sense of the consulting work, the result based on design research is not aimed at an individual enterprise and it is not a specific solution, but a number of generic domain knowledge-based heuristic program. These generic programs are instructive, also more general applicable. In practice, the application of the general program must be of in-depth understanding, and then be chosen and moderated to the specific scenario (Van Aken, 2004).

Technological rules should be tested its effectiveness through multiple cross-case analysis. Validation method can be used "α-β test." which is introduced by van Aken, Where α and β testing are borrowed from the field of software development processes and methods of product testing in IT field. The α test is conducted by the researchers their own to verify that the criteria for the validity of the original environment; the β test is conducted by a third party, that is to convert the rules to be applied to other situations, by which to evaluate its effectiveness in other conditions and make a final improvement. The α test is to ensure the internal validity of technical rules and the β test is to ensure the external validity of technological rules.

Generating mechanism is the technology to ensure the construct validity of the rules. This concept is first proposed by Pawson and Tilley. They use the formula of "Situation + Mechanism = Results" to answer "why is this intervention produce this result." That is to influence the outputs through necessary interventions under a specific situation. Technological rules are more often built on the basis of the formation mechanism rather on the basis of universal law. Technological rules are highly related to scenarios and result-oriented. It addresses the particular context of a class of problems through the implementation of technological rules to achieve the desired results. It is by reliable analysis based on the generation mechanism that to guarantee the validity of technological rules. The generating mechanism of technological rules is similar to the causal model of explanatory science. However, the more important goal of the generating mechanism of technological rules is to find solutions to problems instead of revealing the internal logic. Interventions can be seen as the "independent variables" of technical rules. This process is with a clear artificial nature and it is a series of well-designed interventions. The explanatory variables in the study is an external objective reality. After experimental verification for analysis intervention activities can also be revised. In the management area, technological rules based on design science are used to solve problems and improve the design problems, for instance, to design an organizational structure, to design a development strategy, to improve the organization's operating efficiency and to improve cost control system, etc. After all, the object of management study is different from engineering, medicine, law, etc.: the organizational management is of contingency. Therefore, simple designs rules can not guarantee achieving the design objectives and the implementation of the design rules effectively often play a critical management role.

2.3 Business Models

The research on business models is an emerging hot area in recent years. The definition of business model is not clear and there hasn't been one universally accepted academic definition so far. Different researchers or managers often give it different meanings. In most cases, researchers define the concept of business model from their own needs which is always based on a different perspective. Some researchers describe the business model as a set of activities or behaviors; however, some describes it as a set of business rules.

With further research, the content business models continue to be refined and enriched. It was first in the 1970's that the business model began to appear as a special term in the management literature. Konczal (1975) and Dottore (1977) use the "business model" as a term first in the process of data modeling. Since then, the business model is applied to overall planning of IS that described the information system structure of an enterprise.

With the rapid development of e-commerce, business model is gaining popularity in commercial practice. At this point the concept of business model from information management field has been extended to much broader business management areas. The original connotation of this concept is a "method of making money" (Voelpel et al., 2004). Business model focuses on the characteristics of the fundamental ways of value creation and value appropriation. The hierarchical organization, network organization and market organization are the three basic blocks of a business model from Klasson's (2000) perspective of organizational structure. He thinks that value creation is the purpose of an economic unit and the organizational structure is the way to achieve it. Dubsson-Toray (2001) integrates the creation and realization of the relationship between the structure and organization and takes that business model is the formation of corporate structure and partner network of an enterprise in order to achieve value creation. Linder and Cantrell (2001) argue that business models cover all the problems form profitability to organizational structure of an enterprise.

What are the fundamental elements made of a business model? Different researchers hold their own views. Pigneur (2002) took that the business model should emphasize on the business, products and value proposition. Dubsson-Toray (2001)'s framework of the proposed business model includes four elements: products and services, relationship capital, infrastructure and network of partners, financial condition. Mahadevan (2000) argues that the business model of an enterprise is critical in terms of value stream, revenue stream and logistics; Thomas (2001) argues that a business model is involved in enterprise business processes, stakeholders and resource capacity of the overall structure and a complete business model includes assets, resources, capacity, and cost structure. Alan and Christopher (2001) take that business model includes customer value, scope, price, source of income, related activities, implementation capacity, sustainability, and several other components. Chesbrough has been promoting open innovation in business for a long time. In his view, companies are no longer focusing on isolated or closed innovation and it is more effective to succeed through technology transaction in an open technology market. Business model is the bridge of technology and its economic value (Chesbrough et al, 2002). Appropriately, Chesbrough and Rosenbloom (2001) present 6 major functions for their business model: value proposition, market positioning, value chain structure, cost structure, value network and competitive strategy. Business model innovation is helpful in industrializing a new technology. Business model also makes better use of technology to realize its potential economic value.

Alt and Zimmermann (2001) distinguish between the 6 elements of business models after compared the various formulations of business model through literature review which are mandate, structure, processes, benefits, legal issues and technology. Hedman and Kalling (2001) propose elements a business model including customers, competitors and provide products or services, business activities and organizations, and other factor market and

production inputs. Hoque et al (2001) propose a business model framework including 8 elements: competition, product and services, customers, suppliers and distributors, partners, marketing strategy, processes and organizational structure.

From the above literatures review on the conceptual business model we can see that although what a business model is in the definition is confusing most business model formulations involve in the most fundamental problem, namely, achieving the ways and means to value creation.

3. Methodology

Borrowed the research framework of March and Smith (1995) and the research results of van Aken's "technological rules" (Van Aken, 2004; van Aken, 2005), this study proposes a research framework for business model research that is based on design science. In information systems (IS) research, March and Smith (1995) introduce the methods from design science and present a research framework combining explorative research and explanative research. The IS research also concerns about the phenomenon of man-made things rather than natural or social phenomena. The research on IS deals with man made things, such as organization structure and information systems. Man-made objects can be created and be studied as existing phenomena, which determine the IS research has not only involved in natural sciences. March and Smith think that "to ensure relevance and effectiveness of research design science and natural science research activities are both necessary." Accordingly they propose a framework for information technology research.

The framework consists of two axes which are research outs and research activities. The research results include: construct, model, method, and instantiation. The research activities include: build, evaluate, theorize, and justify. Constructs are the most basic elements of research. They include description of the environment such as the vocabulary used to describe the problem and solution. Constructs provide a specialized language and shared knowledge, such as the "entity ", "property" and " relationship",” constraint” and so on in IT object-oriented modeling areas. Models (abstract and presentation) are the relationships between the formal frameworks and used to describe problems and solutions to problems. Methods (algorithms and practices) are the solutions to the problem in guidelines and rules. They can be used for particular models focusing on the linkages, such as the IS method in the field of network database, relational database methods and so on. Instantiation (implementation and the prototype system) is a man-made thing in its environment, for an instance, the ERP systems and assist decision-making expert systems.

Design science research activities include building and evaluation. A specific purpose of construct is to create artificial things such as the implementation of an activity. After building work it is the evaluation on the performance of man-made things to make sure whether the artificial runs well or not in a specific environment.

March and Smith's framework is the research results of a high-level overview in the field of IS. The framework takes a role of reference for research in other areas such as business models study. Based on what made by March and Smith on information system, we propose a business model framework based on design science (seen figure 1). The core of this research framework for a business model design is composed of building, models, methods and its further evaluation.

We take the basic concepts of business model, business logic, and business models from multiple case studies and we promote the "technological rules" of professor van Aken into business model framework. The study of business model based on design science is generally divided into two steps: create and evaluate. The creating step mainly uses literature review, interviews, case analysis as research methods. Specifically, through literature review and interviews with managers we get the most basic elements of a business model. The business logic of a business model will be extracted through case study with presented as technological rules to ensure that it is valid. The real business environment of a business model can reflect its instantiation in a specific case.

There have been different evaluation methods for business models designed in different steps. The evaluation process of business model research holds different content and different evaluation methods and strategies: the evaluation criteria of the constructing are common sense. Construct validity of business model research is the most basic evaluation criteria; the evaluation of modeling reflects the business logic responding to the real situation loyal subject; the evaluation of the technical rules uses α-β testing, that is the method of combining the internal testing and external testing. The evaluation for the design for a business model is mostly made by its fitness with the specific business environment of it.

4. The Constructs of Business Models and the Analysis on Fitness

4.1 Technological Rules Based Business Models

The existing literatures on the business model focus primarily on the strategic level and operational level, and a business model at least consists of the 5 layers from a hierarchical perspective: strategic layer, network layer, the technical layer, the action layer and presentation layer. Each of the business model layers can be divided into three sets in accordance with the degree of abstraction: basic elements, proprietary elements and technical rules (Morris et al. 2005). Figure 2 shows the proposed hierarchical model of the business model of this research.

The set of technological rules which are designed for the business model is an abstract design from a point of

view of management design. We call it "designable" business model described a series of technological rules of an enterprise based on their own values to follow in order to achieve value creation. These technological rules reflect the business activities of enterprises. The constraint relationships between the technological rules of business models by enabling business model characteristics show different adaptation to the surrounding environment of an enterprise. The technological rules based business model can be formulated in following ways:

BM = F(TR1, TR2, …, TRn)

BM — Business Model

F — Business Logic

TR —Technical Rules

n = 1, 2,…

4.2 Analysis on Business Models' Fitness

An innovative business model consists of five basic elements (Klein, 2008) and they are value proposition, competitive strategy, organizational design, network management and the capacity of local learning. Our framework is based on innovative technological rules. The technological regulations for the five elements reflect the basic characteristics of business models: value, ability, scalability, innovation and embeddedness. The coordination and confliction between technological rules constraints the actual operating characteristics of the business model's affect on the performance of a business model though showing in different adaptability to their surroundings. The logical relationships between technological rules and the external environments are shown in Figure 3:

Although business models provide a starting point for the research on commercial activity as a "holographic" tool, but we believe that research of business models should focus on the core business logic. Therefore, corporate values, and corporate strategy and corporate social responsibility should be treated as external environment. In addition, the external environment faced to the innovative business models also includes the geographical local business culture. The fitness between the qualities of business models and the special needs of the local market is shown in Figure 4.

The fitness between a business model and its external environment has two aspects: flexibility and stability. In this research, we focus on the difference between stability and flexibility of a business model when fitting with its external environment. Finally, we propose the following 3 propositions got from multi-case study:

Proposition 1: A business model is a hierarchical structure with several layers and it relies on a set of specific technological rules.

Proposition 2: The relationship between the technological rules (coordination or confliction) affects a business model's performance though different flexibility to external environment.

Proposition 3: The fitness between a business model and its environment affects the innovation behavior of an enterprise.

5. Conclusions

We build a framework of business model based on technological rules, that is, a business model is a set of technological rules from a design perspective. The linkages of the technological rules with business actions can impact the qualities of a business model's performance. We bring innovation activities into business models design by the means of technological rules. The essence of a business model fitting with its environment lays in the implementation of innovation rules through innovation activities. This explains intrinsic relationships between technological rules and business models. We also analyze the measurement of matching between the technological rules and business models which can be used to measure the degree of a business model fitting with its surrounding business environment. The interactions between the technological rules and business models, that is, coordination or confliction, will affect a company's financial and social performance through its business model. The company's values, strategies, social responsibilities and local culture are all treated as the external environments of a business model in this research. By analyzing the match of its external environments the scalability of a business model can be explained.

How to address the relevance of management theory? The key is to build a bridge that links theory with practice and the research based on design science may play such a role of "bridge" just like the role of engineering takes in the natural science and practice. The design science based research paradigm of management plays a good interactive role between theory and practice and it solves the practice management problems by enabling collaboration between research and practice. Design science based paradigm is effectively applied in management research areas such as information systems, business models and so on.

The research framework of business models based on design science does not involve the theory building and verifying which remain to be further improved in future studies.

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Table 1. Differences between exploratory and explanatory research

	Exploratory Research (Design Science)	**Explanatory Research (Theoretical Science)**
The phenomenon	"artificial phenomena" have to be created by the researcher	"Out there"
Data	created, collected, and analyzed	collected and analyzed
End product	solving of a problem	explanatory theory, prediction
Knowledge interest	pragmatic	cognitive/theoretical
Disciplinary basis	engineering, fundamentally multidisciplinary	natural and social science, primarily unidisciplinary

Source: Holmstrom and Ketokivi et al., 2009

		RESEARCH ACTIVITIES	
		Build	**Evaluate**
RESEARCH OUTPUT	**Constructs**	Business Concepts	Literature analysis
	Model	Business Logic	Interviews
	Method	Business (Technological) Rules	α-β Test
	Instantiation	Business Cases	Case Study

Figure 1. A research framework for business models based on design science (based on March & Smith, 1995)

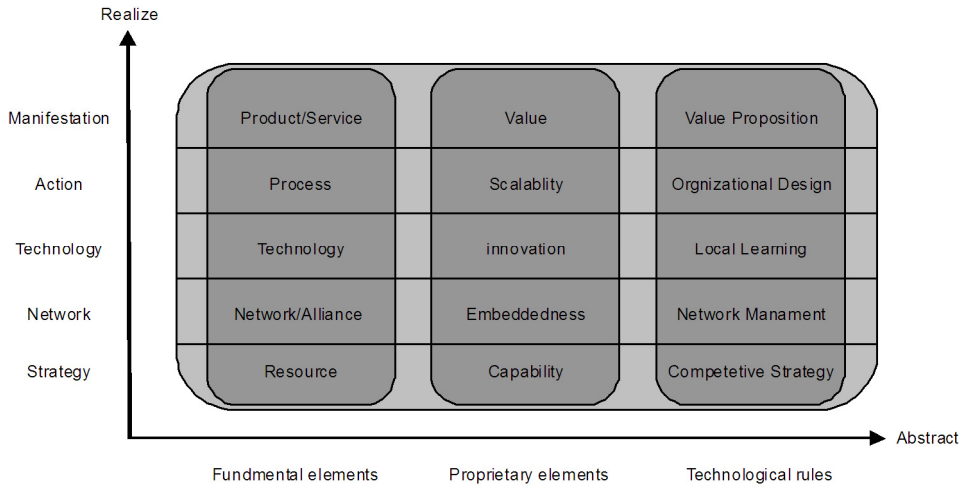

Figure 2. Framework of multi-layered business models

ISSN 1833-3850 E-ISSN 1833-8119

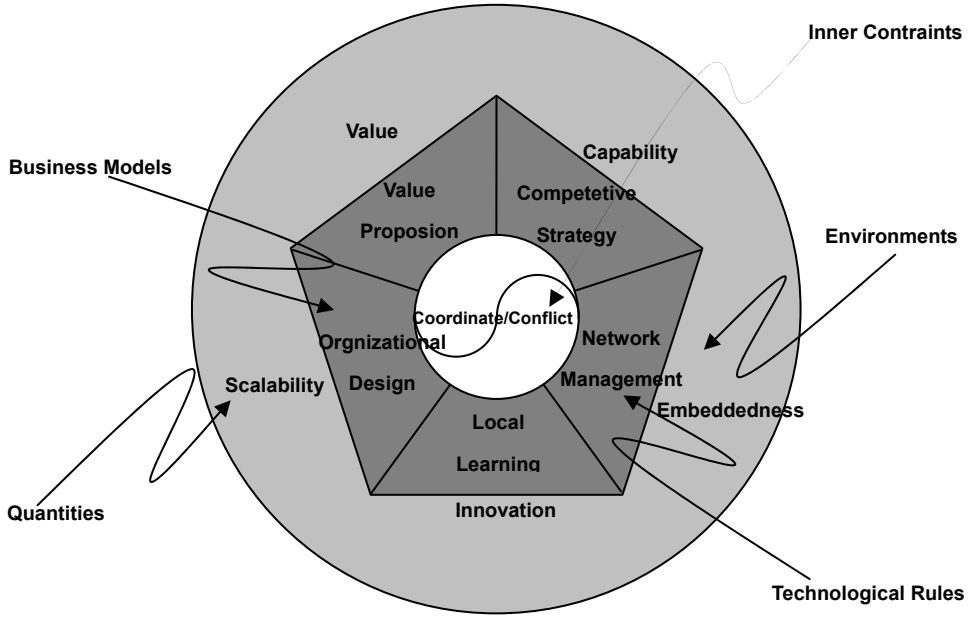

Figure 3. Technological rules, Business models and environments

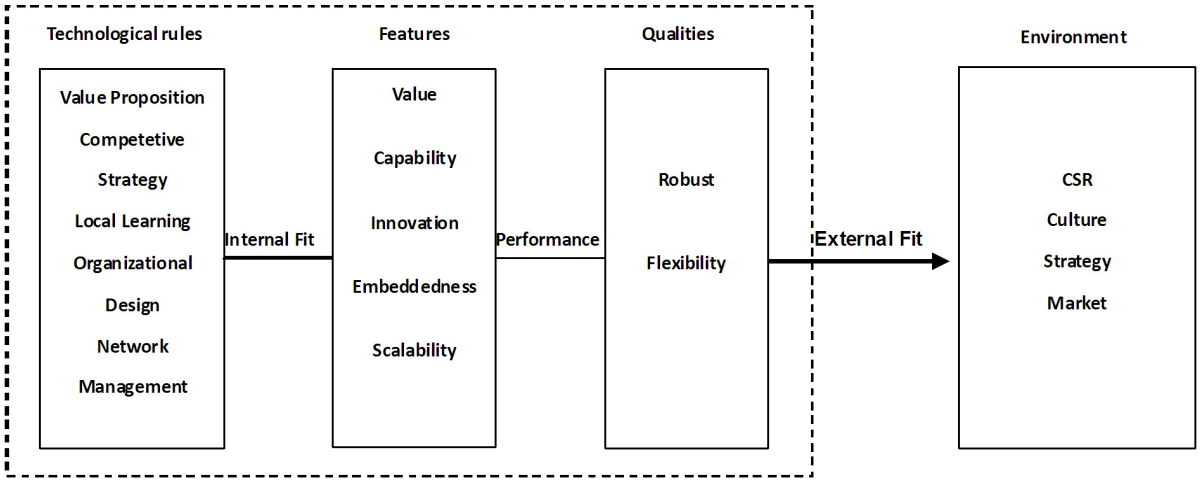

Figure 4. Fitness between business models and environments