A digital transformation business model for innovation

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A digital transformation business model for innovation

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Abstract: In this paper, we study the changes in business model innovation induced by the industrial internet (also termed ‘industry 4.0’) or more generally by the transformation to digital technologies. We develop a model of changes induced in business models as the industry goes digital. The model connects changes in business model components and their linkages with the specific characteristics of digital technologies. The model is based on a business model framework with causally linked components. It is developed from two directions: bottom-up from practical case studies and top-down from the theoretical perspective of the underlying digital technologies. The model can be used to understand the likely consequences of digitization for a given business model. The underlying aim of this work is to provide testable, causal models of business model innovation.

Keywords: Digitization, business model innovation, industrial internet, industry 4.0.

1 Introduction

Across industries, the business world and the private sector, digitization has become a massive phenomenon where traditional products are replaced with digital counterparts – or at least equipped with new digital features. It has become evident in many sectors that digitization goes far beyond improving products, services, and production processes. It has the power to fundamentally change many economic characteristics, in particular business models. While it is clear that business models change, it is not always straightforward to fully understand the features driving business model innovation arising from digitization.

In this paper, we study the changes in business model innovation that are induced by the industrial internet (also termed ‘industry 4.0’) or more generally by the transformation of the economy to digital technologies (‘digitization’). We develop a model of changes induced in business models as the industry goes digital. The model connects changes in business model components and their linkages with the specific characteristics of digital technologies.

The research presented here aims to provide an improved way of modelling the digital transformation of businesses. It aims to causally connect components of business models with characteristics of digital technologies. This also results in a tool for innovators to better understand the impact of digital transformations and to innovate business models.
Innovation research methodology

Several authors have criticized management research and also innovation research for a ‘relevance gap’ (Starkey & Madan 01) and an overemphasis of ‘correlational methods’ (Miller & Tsang) that ‘do not directly test the explanatory mechanisms proposed by [...] theories’. More generally, management and innovation research suffer from a general lack of causal modelling, cf. Prem (15). The work presented here aims to move from mere surface structures to a business model framework with causal connections. Such a model carries the potential to improve the understanding of the necessary principles governing successful business models as they shift towards digital. If successful, it thus provides a tool for innovation researchers seeking to understand the consequences and changes in business models induced by changing in the underlying technology.

From the management perspective, going digital is often followed by a movement from longer-term, static business models to a much more dynamic situation requiring constant business model innovation. Our model provides a systematic tool for business model innovation in such situations.

2 Previous work

Several recent studies discuss the notion of business model innovation in relation to current trends in the digital transformation of the industry, e.g. (Fraunhofer IPA 15, Roland Berger 15). This shift has been labelled ‘industrial internet’ in the U.S. or ‘industry 4.0’ in Europe. It includes the increased usage of digital technologies in industrial production on the one hand, but also the increased application of digital technologies in products. In production, this often results in flexible automation and new partnerships but also new revenue models. For the customer, digital features create new value propositions rooted in better quality data, data analysis features, flexibility and more often a shift from products to services. For the enterprise, digitization can result in strong changes in its processes – from design, production planning, collaboration with partners to production, marketing and revenue collection. In short, digitization potentially impacts on all key processes in the firm. This naturally implies the importance of digitization for innovation and in particular for business model innovation. A range of case studies exist that investigate changes in various business model components. To the best of our knowledge, our paper describes the first application of a causally linked model of business model components to the digital transformation.

Even before the advent of ‘industry 4.0’ scholars were interested in the changes induced in businesses by digital technologies. Often, the focus in these studies is on components of business models such as value proposition, channels or products and partners. A direct connection of the different components and their linkages is often missing, however. Schallmo and Brecht (10) presented a business model framework including labelled links for the various components, similar to the well-known business model frameworks of Osterwalder and Pigneur (10). These links can be interpreted as describing causal relations in the sense of creating, changing, triggering connected components. We use this framework and extend it to the special case of digital transformation of the various components.

The shift towards dynamic business model generation has been addressed by Chesbrough already in 2007 and Hedman and Kalling already described a longitudinal
time axes in 2003. More in the direction of our aim to provide a method for permanent business model innovation, Narasinhala (13) describes a systematic and general method for business model innovation based on listing business model components and their features from empirical analysis.

We take this approach further based on the analysis of concrete instances of the business model components from literature for the case of digitization one the one hand and reasoning about the induced changes from a theoretical analysis of digital technology on the other. Based on both points of view, we also study the consequences of changing business model components following digitization, in particular changes induced in the linkages between components.

**Digital transformation of industry**

A useful characterization of business model and value creation changes triggered by digitization is presented in Roland Berger (15). It describes four ‘levers and triggers’ resulting from digitization:

1. Collection, processing, and analysis of digital data, e.g.: Big Data, Internet-of-Things, wearables etc.
2. Automating value-adding activities and products, e.g.: robotics, autonomous vehicles, additive manufacturing, etc.
3. Networking of previously independent systems, e.g.: cloud computing, digital products, etc.
4. Creation of direct customer access for intermediaries via (mobile) online interfaces, e.g.: mobile internet/apps, social networks, e-commerce etc.

For example, recent progress in predictive maintenance (or ‘e-maintenance, cf. Muller et al. 08) roots in digitization of production machines and the recent ability to collect, store and analyse the data resulting from such a machine’s operation (Big Data, Internet-of-Things). The value proposed by predictive maintenance for the user ranges from shorter down times, better planning to lower costs of failure. For the machine producer, predictive maintenance models improve customer relation or planning.

The Roland Berger study emphasizes the shift from static and sequential value creation models to a much more dynamic situation, where value is created in rather changeable and dynamic networks of business, customers and other players (e.g. consumers). Importantly, a growing number of IT companies enters traditionally non-IT markets with disruptive innovations. These companies are able to offer value resulting from digitization (e.g. equipping traditional products with new sensors), from the analysis of data or through the provision of system solutions.

**3 Methodology and analysis**

The design of the model presented in this paper is based on three different lines of reasoning: (i) a choice of a general business model framework from the literature; (ii) information extracted from case studies in the literature (‘bottom-up’); and (iii) theoretical reasoning (‘top-down’) about the nature of digital technologies.
We take real-world case studies of successful digital transformations of business models as described in the literature to analyse the impacts and changes of moving towards a more digital world on the business model components. Secondly, from a theoretical perspective we connect the business model directly with known characteristics of information and communication technologies such as mobility or zero marginal costs of software reproduction. This often influences the links between the components.

**Business model framework**

Since the turn of the millennium, a range of business model frameworks has been presented, cf. Schallmo and Brecht (10). The model of Osterwalder & Pigneur (10) has become very popular because of its graphical format. However, there are huge differences in the components selected as parts of these model. Gassmann et al. focus on just four aspects (target customer, value proposition, value chain, revenue model), Osterwalder & Pigneur use nine components. Schallmo and Brecht use a 10-tuple of business model components: partners, activities, resources, costs, product/services, value proposition, customer relationship, channels, revenue, and customer segments.

We choose to follow Schallmo and Brecht, because the separation of value proposition into products/services and value proposition is sometimes useful in the description of digital business models. The main reason for using Schallmo and Brecht’s model is, however, their introduction of causal links between the components, represented as directed edges (labelled arrows) with labels. The arrows represent causal links between the components in the business model. The arrows mean that a change in a given component is likely to induce a consequential change in the connected components.

For example, the products/services component links to the value proposition through a connection labelled create. Also, resources connects to costs via a link labelled cause. The resulting linked and labelled graph therefore models business components and their linkages. The edges in principle represent causation, but can be more specific such as create, apply, communicate by etc.

**Case studies from literature**

Several authors have recently presented a range of case studies to study business model innovation, in particular Narasimhalu (2013), Fraunhofer IPA, Capgemini, Gassmann et al. Note that these studies differ substantially regarding the level of detail, although they all focus on changes in business models. Fraunhofer IPA and Capgemini present the cases from the perspective of digitization. The interest of Gassmann et al. and Narasimhalu is a general and systematic approach to business model innovation.

In total, we have collected more than 30 examples of business model innovation from the above list based on our own assessment as to whether the case can be taken as a consequence or example of digitization. In particular, we are interested in the components of the business model that are reported to change in these cases. Since the case studies and authors differ in the used business model framework, our own assessment of the changing business model component was required. In general, the selection of cases is not without problems: it can be difficult to distinguish between real changes to traditional models and more general new, digital businesses. It turned out that the main purpose of the case studies was to validate the model and to suggest some interesting linkages. The studies are mostly used to validate the model and to suggest linkages as discussed below.
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Sources of the cases: Narasimhalu 13, Gassman et al., Fraunhofer IPA, Capgemini, own assessment of affected components, own additions of comments/explanatory remarks.

As an example, Fraunhofer IPA lists the case of e-machineshop, a company that offers the design, production, and delivery of 3d-printed parts from single pieces to very large numbers. The main changes in the business model resulting from digitization are the value proposition (lot size 1, additional services such as online design) and new customer segments. Of course, it is difficult to assess the full size of changes in business model precisely, for example in this case we can expect that there are also new activities,
new partners etc. However, these features on the production side of the business model are rather general for digitized businesses.

Table 1 presents selected examples from the cases described in literature. Some business model innovations are often mentioned, e.g. the shift from selling a product to providing a service is quite often mentioned in the literature with examples such as Rolls-Royce engines, Car2Go and similar.

Understanding digital technologies
For several decades, ICT have been changing a broad range of established processes in the public and private sector, but the dynamics of these changes appears particularly strong in recent years: authors like Rifkin (14) argued that ICT is currently changing the economy as a whole. In innovation research, the importance of ICT for innovation is also clearly visible (Gann & Dodgson 06). In Prem (2015b) it was argued that ICT is even fundamentally changing scientific processes from hypothesis generation to experimenting and data analyses.

Indeed, it is not surprising that the impact of ICT is strong in areas that fundamentally build on knowledge processes as information and knowledge are closely related. Thus it is only natural to study the technological characteristics of ICT in order to better understand these changes. This is potentially an enormous task as ICT is used today as an abbreviation for an extremely broad range of technologies ranging from semiconductor materials to applications in practically all areas of our society. A few characteristics of ICT are, however, rather general and fundamental to ICT. We are interested in those closely linked with the current impact of ICT on economic sector activities. Some of these characteristics are in particular:

- the disentanglement of service delivery and location,
- the mobility and bi-directionality of electronic communication channels,
- the general networking features of ICT,
- the phenomenon of zero marginal cost production and distribution.

Disconnect of service from location
The fact ICT facilitate remote services is perhaps rather straightforward, but it lies at the root of the truly internationalized character of IT service offerings and indeed practically all internet-based businesses. The costs of offering digital services on a global scale are a fraction of those necessary for local offices. But even non-digital services (e.g. product purchase) benefit from this feature in supporting low-cost service provision for practically all processes in the value chain except production and delivery.

Bi-directionality of communication
The digitization of communication implies a shift towards low-cost, rapid, low or high-bandwidth channels to communicate with customers, clients and other stakeholders and to receive feedback, often immediately, where previously slow, unreliable or unidirectional channels had to be used.

Mobility of communication
With the advent of ubiquitous wireless communication infrastructure and a broad range of wireless devices, ICT services have become mobile. This mobility is characterized by
additional features such as geo-positioning, personal identification or context-dependence of services that in turn can support the automated localization and personalisation of service offerings.

**Networking**

Today’s networking of computers, machines, and people is rather different from the kind of simpler networks that were used in the age of telephony or fax machines. Many of the recent networks including social networks connecting people are group-forming, i.e. they facilitate the dynamic creation of user groups and connection of groups with other groups or users. This implies a network value growth in proportion to $2^n$ where $n$ is the number of nodes in the network. This is an extremely fast growing function that lies at the root of many economic phenomena related to internet services, crowdsourcing or social networking business models, cf. Prem (15b), Reed (99).

**Zero marginal cost of production and distribution**

The fact that software is a non-subtractible good produced at near-zero marginal costs (Hess & Ostrom 07) is another key technology characteristic of ICT that differs from most other goods. Also, software and other digital goods can be often delivered at practically no costs over data connections. This implies significantly different business process characteristics and supports the creation of new business models often found in digital businesses such as the Freemium model, advertising models, or data harvesting schemes.

**Changes in the business model resulting from digitization**

Both the theoretical analysis and the case studies suggest that business models change as its components move towards digital. In the following, we describe typical changes in business model components such as value proposition, key activities, customer access and networks:

**Value proposition**

Digitization and equipping products with new sensors (or effectors) implies the generation and consequently collection of data and/or controllability. Most of this data is new and could not previously be collected and studied. This has the potential to offer new value based on insights into the data and underlying processes (‘Big Data’) or to enable novel control applications (‘Internet of Things’). A special case is the continuous analysis (and control) based on repeated data collection (real-time data). Analysis, real-time characteristics, and control provide the basis for services and for the shift from products to services associated with digitization. Another typical effect is better personalization and individualization of products and services with digital components. In addition, services can often be delivered within short time frames and while on the move.

**Key activities**

Digitization of automation technologies and of products facilitates highly automatized processes and ideally also accelerates speed, resource efficiency, quality and flexibility of production (‘Smart Factory’, ‘Lot Size 1’).
Channels
Digital interfaces make it possible for companies to directly access their customers and to eliminate intermediaries. Conventionally unidirectional channels become bidirectional. In the case of open interfaces this also means to enable new access channels to the customer and a whole range of new actors getting access to customers. This in turn leads to new offers, but also platforms that not only trade products and services, but also support their creation (open innovation). Again, we see a move towards mobile channels, but also real-time channels as they move towards digital.

Revenue
Digitization of products and production processes often leads to service fees, brokerage revenue or income form lease and licensing rather than just selling products.

It is important to realize that the business model components are causally linked so that a move toward digital in one component generates effects in other components in turn. For example, equipping conventional gears with sensors (going digital in the product) can be used to create novel services: a sensor measuring gear wear induces a change in the product/service component and creates novel value propositions such as the potential anticipation of maintenance needs. This in turn leads to new software applications and opens new distribution channels in the business model.

In other examples, shifts from a pure product concept to a digital services concept induce a change in the revenue structure from purchase-based to recurrent lease-based payments. In this way, the collection of such changes enriches the model with empirical information about causal consequences of becoming digital in a business.

4 Results

In Figure 1, we present a first graphical version of the digitization business model innovation framework. The model is depicted as a directed graph whose components are causally linked. The nodes represent components of the business model framework and contain descriptions of typical effects resulting from digitization.

The way to read this model is to start with a node that is affected by digitization, e.g. shifting from products to digital features will typically create new value propositions, such as real-time data, a potential for data analytics, remote access, etc. Often, this will generate new digital, bidirectional channels, etc. As such, the model is an explanatory model of current changes in businesses. However, it is also possible to exploit the model structure for the study of the consequences of going digital. The model then should be read in sense that a change in a component will naturally imply a predicted change in the connected components. Importantly, such a causally connected business model thus naturally supports a more general analysis of the consequences of going digital for previously unseen cases and can be tested and further improved. Of course, it is possible to describe the model in more detail, e.g. going back to individual case studies. For reasons of legibility this information is not include in the Figure above.
In this model, there is an important link from the channels component to customer relations and back to activities (with a potential added circle from channels to customer segments to customer relation for the case where the new digital channels also open new customer groups). These links are built from the consideration of hybrid value creation (Reichwald & Piller 06, Velamuri 10) often triggered by digitisation. Although the joint value creation of businesses and their customers does not rely on being digital, it is particularly widespread in the digital world and has been labelled co-creation, open innovation, crowdsourcing etc.

The model clarifies that – as products or services shift towards digital, it can be expected that the associated channels become digital. This is direct consequence of the underlying technology characteristics – low-cost, direct and bidirectional. This in turn induces a change in the customer relationship and will often naturally lead to open innovation approaches that exploit the bidirectional communication for the design of products/services. For the innovation practitioner this suggests to include hybrid value creation approaches whenever a product is equipped with a digital component.

5 Discussion

The model presented here aims to represent both empirical objects and empirical characteristics of phenomena businesses experience when going digital. It models in particular components of business models and assumes an underlying causality in the linkages between components following changes in any given component. The model is both descriptive of a set of cases described in literature, structured using technical and economic characteristics of information and communication technology, but also predictive with respect to yet unseen cases of digitization. Causality is modelled using
directed links that suggest consequences in a component resulting from changes in another.

The underlying motivation behind this paper is to provide such causal linkages as a central element in improved economic models of innovation processes. It has previously been argued for the theory of innovation management research that innovation research (and management research in general) exhibits a lack of causal models. This lack often unnecessarily opens the whole field to severe criticism as it makes it very hard, if not impossible, to test and validate research results. The model presented here is only a first step and should be tested with novel cases of digitization and, where necessary, refined further.

Secondly, the model offers a systematic approach to the study of effects on business models of going digital. We have already seen how the change in one component (products) generates consequential changes through a range of components (up to ‘activities’). In order to model this change, it was indeed necessary to introduce added causal links (not present in the Schallmo and Brecht (10) framework). It is to be expected that more such links will be identified when studying a large number or perhaps more detailed case examples.

Thirdly, from a practical perspective, the model can be used to develop or to refine new digital business models. It offers an opportunity to study the whole spectrum of potential changes induced by digital technologies starting from an existing business model.

Further work

Like all models, the digitization business model framework can be expanded in many directions. Further data about business model innovation may create new links between the elements. Perhaps more importantly, the model can be improved in precision with respect to details about the digitization. For example, the model could provide information about constraints such channel characteristics, amount of data, real-time requirements and their effects on other components of the model.

Such models should be tested with respect to usefulness for innovation researchers in further developing the theoretical underpinnings of the field. They may in particular lead to improved studies of causal relations in business model frameworks. As rightly stated in Fraunhofer IPA (15), the current transformation of business models is still at an early stage, for example for the German economy. There, the machining sector currently focuses on adding product and service value by means of digitization, e.g. using new sensors. A complete networking or optimization of whole production systems is yet to occur. We hope that the model as presented here adds to the creativity of innovators in general and business model innovators in particular to utilize the full potential of digitization.

References and Notes


Erich Prem (b), ICT and science 2.0: technology-mediated trends and characteristics of new scientific practices. Proc. 15th International Conference on Knowledge Technologies and Data-Driven Business, ACM, 2015.


Wieselhuber & Partner, Fraunhofer IPA, Geschäftsmodell-Innovation durch Industrie 4.0 (Business model innovation through industry 4.0), March 2015.