LINKING STRATEGY AND OPERATIONS USING A SERVICE BUSINESS MODEL – A HYPERGRAPH THEORY-BASED APPROACH

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ABSTRACT

Business models are used to implement an organization's strategy and are used to structure a company's value creation and how to monetize their offerings. Aggregated strategic business models are useful for executives to base their decision on, whereas more detailed business models are used by organizational units to further operationalize the strategy. However, to ensure that the strategy is executed correctly, both perspectives need to be aligned. Yet, a conceptual gap exists between the strategic model and the operational model. We aim to contribute towards linking that gap by introducing a mathematical approach to model business models on both strategic and operational level. In practice, the mathematical model can be applied to implementing future information systems that link high-level strategic conceptualizations to operational enterprise system. This enables strategic level business models to be fed with real-time operational data, providing better insights for top-level decision makers.

INTRODUCTION

Business models (BM) have become increasingly important and versatile abstract tools to both describe businesses on a strategic, as well as on an operational level (Wirtz *et al.*, 2016). They structure businesses to understand what a business does to remain competitive (Johnson et al. 2008). Those research streams (e.g. Magretta, 2002; Johnson et al. 2008; Wirtz et al. 2015) identified the importance of BMs for the success of a business, as well as practice revealed that financially successful companies ascertain twice the level of importance to BMs than less successful companies (IBM, 2007).

Business models include a businesses' core strategy, required tangible and intangible input factors, value-creation processes and a networked business perspective, with an underlying financial model to ensure the profitability. Literature shows, a rather heterogeneous understanding of business models and research could benefit from an underlying theoretical model that can help structure business models in a rigorous approach (Wirtz et al. 2015).

Additionally, businesses that have readily taken on the service perspective are confronted with an increasingly complex, interconnected and digital world, yet typical business model tools, such as the business model canvas (Osterwalder et al. 2005) only provide a somewhat non-descript framework for structuring a business and is only partially useful in regard to explaining how the business model works in detail.

Since there is limited theoretical grounding, it makes it difficult to use a business model from an abstract or strategic level and link it to an operational model. We therefore propose a hypergraph theory-based underlying model for business models that retain the component-based perspective and includes the necessary information to understand how the business works both from a high-level strategic perspective, as well as from a detailed operational perspective, thus linking business model and operations. Our resulting service business model can thus be understood as a model of value creation (Arend, 2013).

Our service business model draws strongly from the service sciences perspective of service systems, which structures businesses using the configuration of resources (Maglio and Spohrer, 2008), actors and activities (Li & Peters 2018). Our model is formally correct and includes a graphical representation, due to its inherent graph theory perspective and has both the component perspective, as well as a process perspective, showing how value is created. By modeling service businesses using the service business model we model the fundamental business structure. This model can be used for different operational purposes, such as scheduling, planning and cost analyses. The level of detail can also be regulated based on the modelling level of detail thus enabling a high-level strategic perspective to be integrated into the operational perspective, linking the gap between strategic-level models and operational-level models by leveraging hypergraph theory-based approach and its system-in-systems perspective.

RELATED WORK – BUSINESS MODELS

In the past decades, there has been extensive research on how to structure and present business models (Turetken *et al.*, 2019; Veit *et al.*, 2014; Gordijn *et al.*, 2000; Gordijn and Akkermans, 2001; Roelens and Poels, 2015; Osterwalder and Pigneur, 2010) and it has emerged as a separate unit of analysis. Also, it explains how firms “do business” at a holistic system-level and explain *how value is created*, rather than how value is captured (Zott *et al.*, 2011).

Some streams of research have focused on value-driven (requirements) modeling (Akkermans and Gordijn, 2003; van Eck *et al.*, 2009). A business model is therefore geared towards value-creation to understand what is required to create value for the customer. Therefore, a key concept in both service and business models is the value proposition (Johnson *et al.*, 2011). It is the “job” that needs to be done, the problem that needs solving and the value offering, all of which promises value to a customer. Profit formulas (consisting of revenue models, cost structure, margin models and resource velocity), key resources (people, technology, products, equipment, information, channels, partnerships) and key processes (processes, rules and metrics and norms) are essential for a successful customer value proposition.

The concept of business models can be analyzed from a strategic perspective, which looks at the industry contingencies from a more company-level perspective and analyzing its competitive situation (Hamel, 2002). This coincides somewhat with the organizational perspective on business models, which use business models as an abstract conceptual tool to represent an organization (Zott *et al.*, 2011). The business model therefore represents a form of company architecture or structure (Keen and Qureshi, 2006). Sometimes software tools are used to engineer business models (Ebel *et al.*, 2016). On a more operational perspective, business models are oftentimes more detailed on a product-level with an operational process perspective, sometimes referred to as systems modeling (Pateli and Giaglis, 2004; Wirtz *et al.*, 2016; van Eck *et al.*, 2009; Gordijn *et al.*, 2000).

Business models are therefore used to implement a company’s strategy (Johnson *et al.*, 2011; Veit *et al.*, 2014). On a strategic or organizational level, business models can therefore help to structure value networks of different organizations (Wirtz *et al.*, 2016). However, we argue that the higher-level business models should also be compatible with more operational level business models, to leverage the advantage of more detailed data sources that enable more realistic *profit formulas* (Johnson *et al.*, 2011).

MULTI-LEVEL BUSINESS MODEL FOR SERVICE SYSTEMS

Business Models at a strategic level

To bridge the above-mentioned conceptual gap between a strategic level business model and a more operationalized model, we draw upon hypergraph theory to model business models that describes relevant strategic factors for a company’s offering (Johnson *et al.*, 2011). More importantly, our research relies on a mathematical model to describe business models, which are of high-level strategic order. This allows us to connect the operational model more closely to the strategic business model using hypergraph theory. In short, we apply an object-oriented hypergraph-based approach to business models and therefore model organizational units as hyperedges $u \in U$ and all the nodes of the hypergraph that an organizational unit has access to are called *business elements* $e \in E$. Business elements can be service offerings, target customers, technology, products, equipment, information, channels, partnerships, alliances, brands, more broadly speaking anything that is required for a sustainable company's profit margin (Johnson *et al.*, 2011). They can also contain entire service systems and service objects as elements (Li *et al.*, 2018). Next we define the central concept of *business objects*.

Definition 1: A finite non-empty set O_b with tuple of O_b (E, U) is called *business object* where

i. E is a finite set of business element with $E=\{e_1, e_2 \dots e_n\}$
ii. U is a family of subsets of E with $E=(u_i)$ in which $u_i \neq \emptyset$; $u_i \subset E$ and $E=\bigcup_{i=1}^{n} u_i$ for $i \in \{1,2...n\}$.

This definition shows that a business object is a hypergraph and we continue with defining the business model.

Definition 2: Given hypergraph $O_b = (E, U)$ as set of business objects with element set $E \neq \emptyset$; *Organizational unit* set $U \neq \emptyset$ and mapping $\Phi(\Phi^-, \Phi^+)$: $O_b \rightarrow O_b$, where $\Phi^-(O_b) \cap \Phi^+(O_b) \neq \emptyset$ and $\varphi^-(o_b) \cap \varphi^+(o_b) = \emptyset$ for $\exists\ o_b \in O_b$ and $\varphi \in \Phi$, then the mapping Φ is called *business function*, for which tuples (Φ^-, Φ^+) represent either input or output functions. Finally, the tuple $B(O_b, \Phi)$ is called *business graph* and represents the *business model*.

Organizational units $u \in U$ can be of different sizes, ranging from company alliances to individuals. Business function Φ is a set of functions and represents all necessary functions, which are relevant for business models. These include but are not limited to analytics functions that prognose sales volume or alternative avenues of profit. The *business function* Φ, for which tuples (Φ^-, Φ^+) can represent the cost function, requirements function (quantity), revenue function or profit function. The plus indicates that the function is an output function of a business object and the minus the opposite: $\Phi^-(O_b)$ input business object and $\Phi^+(O_b)$ output business object.

Property of Business Graphs

This subsection covers the reasoning for our approach on multi-level modeling, which allows connecting high-level strategic business graphs to be linked with more operationalizable lower-level implementation-near business graphs.

Theorem 1: If element $e \in E$ is the object's only element, then the object is called an elementary object.

Proof: According to definition 1, given n=1 for element set E

i. $E=\{e_1\}$ and
ii. $U=(u_i \subset E)$ and $E=\bigcup_{i=1}^{n} u_i$ for n = 1

then the Hypergraph $O_b(E, U)$ is an elementary object, which matches definition 1.

Corollary 1: Business object $o_b \in O_b$ can contain another business object, which means objects can be used recursively.
Proof: According to Theorem 1, $\exists\ o_b \in O_b,\ e \in E \Rightarrow o_b \Leftrightarrow e$, when $o_b \in O_b$ is an elementary business object and $\{e\} \in o$).

Proposition 1: Given $B'(O_b', \Phi')$ as subgraph of $B(O_b, \Phi)$ with $B'(O_b') \subset O_b$ and $B'(\Phi') \subset \Phi$, we define B' as an elementary business object, which can be used in any business graph or subgraph. It is allowed to recursive use according to Theorem 1 and Corollary 1. This recursive use is called system in system.

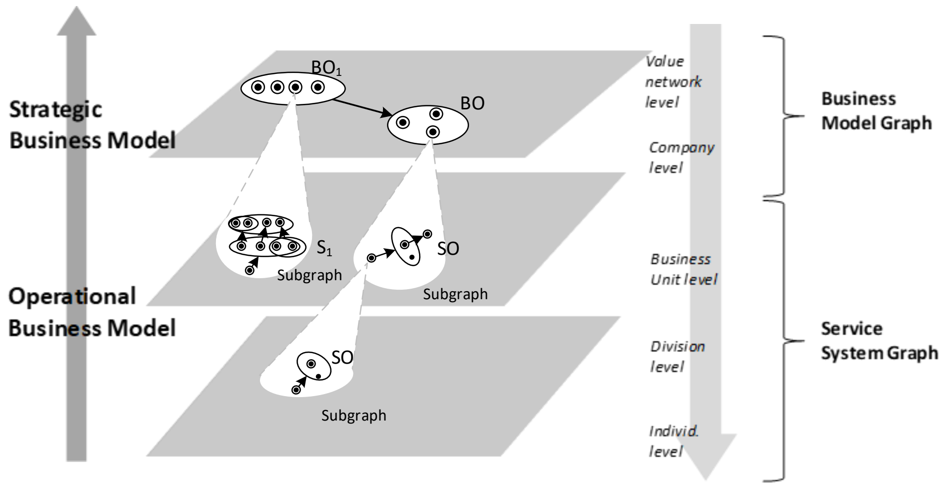
Based on corollary 1 we can model the required multi-level perspective, with subsystems containing more detailed information. The business model is hence modelled as a hypergraph-based network of value creation.

Business model at an operational level

Operational business models often play a dual role: they are used to model a detailed plan for business units to implement the strategic decisions but they are also technology-oriented (Wirtz *et al.*, 2016). On the one hand, they help concretize the strategy on an operational perspective, similar to the role of strategic themes (Kaplan and Norton, 2009). On the other hand, they are the interface between businesses models and information systems, such as ERP systems (van Putten and Markus Schief, 2012).

To link the strategic layer to a more concrete operational level, in which "smaller" organizational units define "what they do" and "how they do it", we introduce the concepts of service system graphs and service object as being part of a business model graph. This references the definition that a service object is a type of business element. Business models therefore consist of service systems on an operational level (Li and Peters, 2018). This enables the link between higher-level business model graphs and more operational service system graphs. For example: If a high-level executive of a global organization requires information on a specific country’s production plant, one might require a specific business element of their total value offering for their customer, such as the total costs of a product. In Figure 1, the offering would be BO_1, with one business element representing the product costs. On a more operational model, the entire production cost structure and revenue stream are modelled via a service system graph, represented by S_1. Therefore, the strategic level information on the production costs of a product of BO_1 is linked to the operational level. In other words, the product costs come from aggregating detailed cost information from the product structure.

Figure 1: Service Business Model structure with BO=business objects and SO = service objects (own illustration).



DISCUSSION

The resulting business graph describes how value is created from a high-level strategic business model perspective, to a more detailed operational perspective, as illustrated in Figure 1. Conceptually, there are different levels of abstraction illustrated as planes. These planes are useful to make sense of a business model in the sense of an object representing either value networks, companies, business unity, divisions or individuals. Yet, their organizational distinction and borders are more gradual than absolute. Furthermore, on a high level of abstraction, we speak of business models, whereas the term service systems and service objects are used for a more detailed level. Additionally, Figure 1 shows how ‘lower’ level service systems and its service objects are linked to ‘higher’ level service objects, cumulating at business objects and finally at customer value propositions (Johnson *et al.*, 2011). Also, hypergraph-based service system graphs can model different “paths” or configurations in which value can be created (Li *et al.*, forthcoming), including a dynamic business model perspective for “decision makers to take a particular course of action for the organization, supported by an analysis of benefits costs and risks” […] (van Putten and Markus Schief, 2012). This means that strategic business models can aggregate information dynamically, depending on the chosen parameters that determine its paths.

Service logic stressed the importance of value networks (Camarinha-Matos and Afsarmanesh, 2005) and our approach can be used to link value networks to operational models at a business unit level across different companies. The network-centric mindset coincides with the importance for businesses to create value across multiple organizations (Turetken *et al.*, 2019), because companies increasingly operate in collaboration within a network of business partners to create value (Gawer and Cusumano, 2014, 2007). While many researchers acknowledge the importance of the networked-perspective, many investigate such networks from the perspective of a single focal company (Turber *et al.*, 2014). Our resulting model therefore can link operational models of each business unit to the overall value network.

More importantly, the mathematical mappings between service objects allow for different operational purposes (Li *et al.*, forthcoming). This allows for cost analyses and quantity analyses and even resource velocity (Johnson *et al.*, 2011). The functional purpose is also known as the profit formula, with projections being able to cover different formula component structures (Li *et al.*, forthcoming).

Our approach enables the graphical representation of such networks, links a high-level model to more detailed operational-level model (system of systems) and finally, it enables to represent the vastly heterogeneous factors (business elements) of business models, by allowing different functions to be applied to the mappings.

Future research could further investigate how the resulting business model graph and integrated service system graph can be the basis for information systems. Since business models and service systems have a strong standing in information systems research (Peters *et al.*, 2015; Böhmann *et al.*, 2018; Simmert *et al.*, 2018; Grotherr *et al.*, 2018), we believe that the mathematical model can be beneficial to interoperability among different enterprise systems or help with the structuring and aggregating data from operational sources to strategically useful information, by relying on the business logic of the introduced business model graph.

Furthermore, our research has several limitations: Although we introduce a systematic model for both a strategic and operational business model based on hypergraph theory and think that therein lies our theoretical contribution, the operational model by no means must be a service system graph. We chose to do so, since we deemed it prudent to use a highly versatile and mathematical model for service systems, because this would allow a holistic information system in the future. But proposition 1 does not limit itself to service systems and its implications for other approaches could also be interesting.

CONCLUSION AND LIMITATIONS

We argue that business models that are structured using a mathematical model are useful for organizations to implement and operationalize their value proposition. The resulting service system structures key resources, the responsible organizational units and mappings, which represent different functions, mirroring required processes. The service system can be modelled as a whole, while also revealing how different service objects have to work together to “get the job done” in an efficient way (Johnson *et al.*, 2011).

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