

Business Model Exploration for Software Defined Networks

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Abstract. Business modeling is becoming a foundational process in the information technology industry. Many ICT companies are constructing their business models to stay competitive on the cutting edge of the technology world. However, when it comes to new technologies or emerging markets, it remains difficult for the decision maker to make an assertive choice. This paper aims to fill this gap by providing organizations with an overall approach to better design and develop business models in an innovative ICT market. The business model canvas is used to analyze existing players in the market. Moreover, a case study is made of Software Defined Networking (SDN): a business model template for SDN is proposed as a representation tool to bridge the business concept and the SDN functionalities. The models and methods are evaluated and enhanced by interviewing experts from key players in the SDN market. In addition, the method is applied to a case organization for further evaluation, which indicates that an average satisfaction score of 0.77 out of 1 to the model. Therefore, the approach of creating new business models in innovative ICT market in this paper is found to be appropriate and effective in analyzing existing SDN providers and reusing their business components of activities into a new SDN strategy.

Keywords: Software defined networking · Business model canvas · Software engineering · Quality attributes · Business model innovation

1 Introduction

Contemporarily, the software defined networking (SDN) concept has been becoming a buzz word in the networking industry. SDN subverts the traditional design of network device by decoupling the controller plane and data forwarding plane so that it enables an application - centric networking solution to replace the primitive all-in-one network device architecture [12]. The impact of SDN cannot be neglected. Foreseeing that SDN will play an essential role in the future networking industry, many networking providers have joined this emerging market. Without much experience in this new market,

managers and decision makers are uncertain which part of SDN they should focus on and which direction is the best-fit for the companies.

Accordingly, a business model template in the SDN domain is required to solve these problems. However, there is no previous evidence that a certain business model can match this new IT market.

1.1 Problem Statement

There exists a significant amount of literature on business models, all of which intend to define explicitly how organizations fulfill their missions and commercial activities [3, 15, 20]. According to [11], these studies vary in several aspects. For instance, some of them provided a set of tools and visualization methods to design business models [3], whereas some studies provided definitions and classifications of the business models [15], such as Brokerage, Advertising, Infomediary, Merchant, Manufacturer and Affiliate. Moreover, some studies [19] proposed the evaluation metrics to assess the success of the business model. However, those definitions or approaches cannot be directly utilized to analyze the booming SDN industry, because either some of the models are too complicated for the non-technical manager to use, or some of the definitions are just out of date.

Nonetheless, on one hand, as stated by [1], albeit business model unlocks latent value from technology, the business logic restrains the subsequent investigations for new, alternative models for other technologies. Since most business models are statically depicting the business strategy of an organization, it is difficult to catch up with the pace of a growing technology (e.g., SDN). On the other hand, there is a desperate need in the market, and companies are struggling to choose the best match SDN provider to upgrade their latent networks. In turn, network vendors (new entrants) are hesitating on what SDN strategy to follow and invest.

Additionally, little research has been done to solve those problems, which remains a barrier for companies to better design and develop new business models in an innovative ICT market. As stated by [13], the rapidly changing, competitive, and uncertain economic environment makes business decisions difficult and challenging. Surprisingly, the business model or software tools that can be utilized for strategic decision making are still scarce, because such tools could help organizations to better design and develop their business models. [5] also claimed that many companies found business model innovation difficult, as managers do not understand their existing business models, so they are unable to create an effective and efficient new business model. Accordingly, we present the following problem statement:

“When entering a new innovative IT market, it is challenging for companies to design and develop new business models, which leads to many failures and sub-optimal business models for organizations.”

1.2 Research Purpose

As a follow up for the problems we propose in the previous section, the research purpose, therefore, is set up to fill these gaps. The author believes that (1) by investigating the existing business models is an efficient way to establish new business

models in the ICT market. Additionally, [16] stated in their book that architecture is an approach to design business process. It follows four stages, from business silos, standardized technology, optimized core to business modularity. Thus, (2) A unified business model and architecture is an appropriate way to create a model that can be understood both by business and technical users. Therefore, to validate the above hypothesis, one case study was conducted to apply our SDN business model in practice, it validated the existing business model and further evaluated the unified business model for the SDN market.

The research method, including the BMC (business model canvas), unified quality model, and the SDN architecture are discussed in Sect. 2. A case study is introduced in Sect. 3, where we applied our SDN business model to a real business case to evaluate the theory. In Sect. 4, the contribution, as well as the limitation of this paper are discussed and in Sect. 5, we provided an overall summary and some recommendations for related future works.

2 Research Background

The business model canvas introduced in Sect. 2.1 provides a thorough business viewpoint to assist the business analyst alike people to gather business requirements, while the SDN architecture (Sect. 2.2) can lead the architecture people to map the business requirements to certain developing areas. In addition, the quality mapping (Sect. 2.3) in between helps to bridge this two viewpoints, and provides a quality attributes break down to help people understand the products deeper.

2.1 Business Model Canvas

The business model canvas has shown to be one of the most widely cited representation in the academic literature and was broadly applied in practice [21]. The concept has been used and tested around the world and is already used in organizations such as IBM, Ericsson, Deloitte, the Public Works and Government Services of Canada, etc.¹ It changes the way of the companies thinking from a product perspective to a business model perspective [11]. The canvas enables a shared language that allows us to easily describe and operate business models to build new strategies or improve the existing business models [14].

The business model canvas contains nine blocks that show the logic of how an organization makes profits (Fig. 1). These nine blocks cover four main areas of a successful business, which are customers, offer, infrastructure, and financial viability. It complies most of the components from the paper that Shafer, [18] have concluded. Furthermore, the business model canvas has been successfully applied in an innovative IT market. [11] summarize and share their findings regarding the business models canvas deployed in big data applications. They analyzed the existing big data application using business model canvas and taking into consideration of the fundamental

¹ <http://www.businessmodelgeneration.com/canvas/bmc>.

elements of business and illustrate how these applications make the profits by applying big data in their business. Moreover, [21] proposed a service business model canvas in their paper, which is established based on the business model canvas. They successfully applied the service business model canvas into the mobile payment service in the German retail industry.

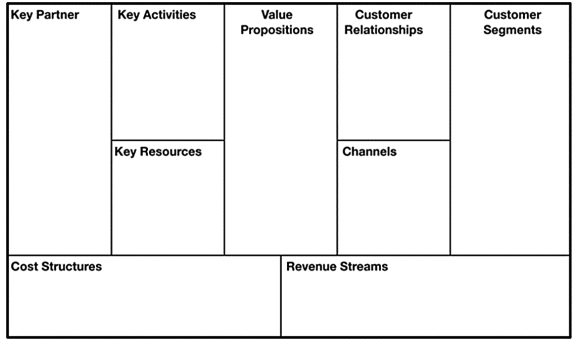


Fig. 1. Business model canvas

However, we could not find as many research papers of applying BMC in the IT fields as we found in other fields. Though some cases have shown its significant effects, we decided to apply it specifically in the SDN field to evaluate its effectiveness. Moreover, according to the study by [2], the ability of a firm to realize the benefits of new, external knowledge, assimilate it, and apply it to commercial ends is essential to its capabilities. Such capabilities are the absorptive capacity of the firm, which was suggested by the authors that it was a function of the organization’s level of prior pertinent knowledge. In other words, analyzing the current knowledge in a market is considered as an effective way to stay innovative. Therefore, the author investigated the existing SDN providers and model them with the business model canvas to create reusable business components. Those reusable business components were utilized later to cover the missing parts of the case organization’s business model canvas.

2.2 SDN Architecture

SDN is a business concept; its primary function is to decouple the data plane and the controller plane, and provide a network operating system to support various applications. However, the technical knowledge behind it is complicated. In this section, SDN is explained and simplified so that we can depict it from a business perspective. The SDN architecture (Reference Layer Model) was utilized to illustrate the essential SDN structures.

Researches have shown different designs of SDN architectures [7–9], but they all follow the three-layer model, i.e. data plane layer, controller layer and application layer. In the paper of [4], the SDN architecture is divided into three principal parts, the Application Plane, the Controller & Management Plane, and the Network Device.

There are four layers (Network Services Abstraction Layer, Control Abstraction Layer, Management Abstraction Layer and Device and Resource Abstraction Layer) that exist between those three parts and connect them as a whole SDN architecture (Fig. 2).

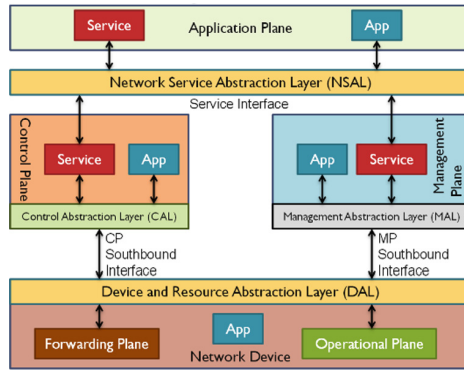


Fig. 2. SDN architecture [4]

In this paper, we will use this SDN architecture, together with other models to demonstrate the whole SDN business model. Although the SDN architecture is seen as a very technical model that is being used in representing the network, we are utilizing this model only to illustrate the SDN product (both software and hardware) within our SDN business model.

2.3 Unified Quality Model

Software engineering is a multi-discipline and complex field that connects a variety of processes and activities. All different phases in software engineering have developed their solutions to ensure the quality of the software products; however, those approaches are not well connected or integrated. Hence, [10] have proposed a unifying quality model to help software developers and managers to integrate all the processes and activities into one common foundation to assure consistency and continuity.

Our SDN business model is largely based on the unified quality model [10]. A high-level quality mapping model was built to interpret the unified quality model and modified it to fit our SDN case (Fig. 3).

The high-level SDN business model contains three parts. From left to right, there is requirement management, which is seen as the front end, the business part of the product.

As discussed in the previous section, the business model canvas can be utilized to analyze and present the business requirement, product value proposition, and other key blocks. However, in the SDN business model, we merely focus on the value proposition and customer segment due to the reason that we scoped the model from a software engineering perspective.

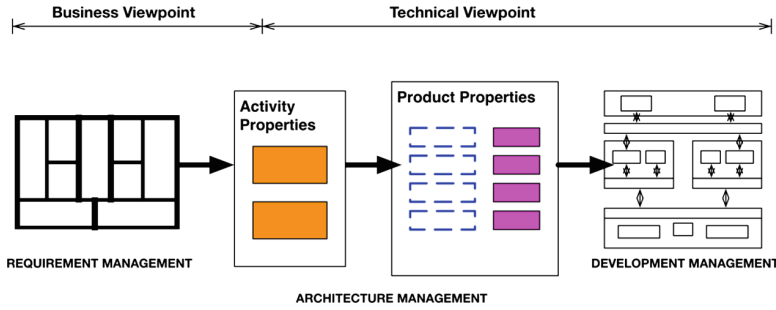


Fig. 3. High-level quality mapping model. This model represents from the business requirements to Activity Properties, Product Properties and finally reaches to the SDN architecture for Apps and service development.

In the middle part, stand the activity properties and the product properties segment. The former one lists all the activities based on the business requirements, and the latter one consists of two sub-segments: the product functionalities and the product quality attributes (QA). Product functionalities illustrate the functionalities of the software, e.g., network monitoring or security. The product properties play as an extension or an add-on between the business model canvas and the product functionalities. Although the business model canvas can be linked to the functionalities based on the requirements and propositions, however, it lacks the attributes of software behind the sense. In other words, the product attributes (QA) can contribute to helping the business analysts and software architect to better understand the requirements and software attributes.

On the right side, a product architecture is shown to connect the product attribute part to lead the business viewpoint to the technical viewpoint. In this paper, the SDN architecture is utilized as an “Appstore” to display the existing or “plan to develop” software for the SDN solution. Moreover, this “Appstore” can be further developed as a tool to exhibit the SDN eco-system to the customers. In Sect. 3.3, the “Appstore” concept will be further elaborated in the case of service chain example.

3 Case Study

According to [17], the structure and description of the case study is formed in Table 1.

Table 1. Case study research process is divided into 5 parts according to [17].

Name	Description
Case study design & objective	To understand the effective of using SDN model in practical use cases. The details of case study design are introduced in Sect. 3.2
Data collection preparation	Procedure: (1) question design, (2) plan meetings, (3) collect data, (4) Analyze data Protocols: Face to face meeting, calls and emails

(continued)

Table 1. (continued)

Name	Description
Data collection	4 separate face to face meeting with 4 interviewees in their company, 1 meeting with another employee via call and follow up emails
Data analysis	For SDN BMC model, we design and calculate the scores according to [14]. For the SDN business model, each question is given a range of score, and we calculate the weight of each question to reflect the effectiveness of how our interviewees thought of the model. Section 3.2 will provide a more explicit view
Reporting	The results of SDN BMC are shown in a BMC model (Fig. 4) with marked score in each block. The results of SDN business model are shown in Table 2

3.1 Background of the Case Organization

The case organization is a multinational ICT service and equipment provider, which has already proposed their own agile network solution and a high standard SDN controller. However, they do not possess a complete and perfect ecosystem to sustain and improve their SDN service on a long term. For example, they cannot make a decision whether they should develop their Cloud orchestration platform or should go completely for an existing popular open source platform (e.g., OpenStack). In the meantime, their competitors, for instance, HP, have already built up their SDN products and the first industry SDN AppStore ecosystem. Thus, our case organization remains an immature status in developing the business in the SDN market. The main reason, according to the people from the case organization, is the lack of a business model that can capture the entire ecosystem of the SDN.

Scholars claimed that technological change can become market revolutions that incumbent firms must master if they want to survive [6]. Besides, [6] indicated that the experiences of an enterprise to respond to a new market are imperfectly understood, i.e., the managers do not have a mature way to tackle with the new technological wave. Similarly, the case organization was eager to build this capability to develop their business model for SDN.

3.2 Case Study Design

The case study was divided primarily into two parts, (1) the expert interviews for the business model canvas and (2) the expert interviews for the unified quality model on the service chain example.

The business model canvas of our case organization is based on two experts' reviews within the case organization. In addition, some existing SDN organizations' data were utilized to improve and polish the business model canvas of our case organization.

According to the book of "business model generation" [14], we interviewed the interviewees by using the SWOT evaluation method. Four criteria were evaluated,

(1) Strength, (2) Weakness, (3) Opportunity, (4) Threats. Based on the book “business model generation” [14], in Strength/Weakness, 78 relevant questions were proposed². Half of the questions are to evaluate strength, and half are designed to assess the weakness, e.g., the question to evaluate the strength: “Our value propositions are well aligned with customer needs”, the question to evaluate the weakness: “Our value propositions and customer needs are misaligned.” In the category of opportunity, 37 questions were created, and there were 21 questions in the category of threat. Each question has a score range of ± 1 to ± 5 , 4 and 5 represented the high impact, 1 and 2 stood for the low impact, and 3 was the normal impact. Exception for the combination table of Strength/Weakness, because it merely showed the 39 questions, which had been calculated (The score of Strength plus the score of Weakness). Thus, the positive number was a strength, the negative number was a weakness, zero meant no strength or weakness. Questions of strength and opportunity were set to positive and questions of weakness and threat were set to negative. Furthermore, each category was divided into four sub-categories, which were offer, finance, Infrastructure and customer. The nine blocks in business model canvas were subsumed in each group.

Regarding the SDN business model (unified quality model), which is mentioned in Sect. 2.3, we applied it to a real service provided by the case organization – the service chain product. The service chain model is a concept that connects all the network service (e.g., firewall, load balancing and routing) so that those services can collaborate more efficiently. Figure 5 displays the service chain model via the SDN business model we proposed in Sect. 3.3.

The interviews of the unified quality model were based on some specific SDN examples. The blocks of value proposition and customer segments of the business model canvas were focused and represented, because the authors only investigated the unified model from a software engineering perspective. Thus, blocks such as cost structure, key partners and customer segments are not suitable. Accordingly, the unified quality model was modified based on the business requirements and case organization’s circumstances.

3.3 Results

According to Sect. 3.2, the results of the case study are divided into two parts, (1) business model canvas, and (2) the SDN business model. Both of the results will be discussed below.

Figure 4 illustrates the results of the SWOT evaluation of the business model canvas. It concluded three main results in each block, (1) the strength/weakness assessment, (2) the opportunity assessment, (3) the threats assessment. For example, in the customer relationship block, the final score of the strength/weakness is 15, opportunity score is 22.5. Received a low treat score of -2.5 , it accomplished total score of 35, which indicate that the case organization has performed relatively well in the value proposition filed. However, in the cost structure block, the treat score is as high as -7 , which is close to the strength/weakness and even higher than the

² goo.gl/DTLS1h.

Key Partner (KP)	Key Activities (KA)	Value Propositions (VP)	Customer Relationships (CR)	Customer Segments (CS)
KP strength/weakness assessment 4.5	KA strength/weakness assessment 6	VP strength/weakness assessment 10	CR strength/weakness assessment 15	CS strength/weakness assessment 10
KP opportunity assessment 23	KA opportunity assessment 12.5	VP opportunity assessment 23	CR opportunity assessment 22.5	CS opportunity assessment 13
KP threats assessment -9	KA threats assessment -2	VP threats assessment -7	CR threats assessment -2.5	CS threats assessment -10.5
KP Total 18.5	KA Total 16.5	VP Total 26	CR Total 35	CS Total 12.5
	Key Resources (KR)		Channels (CH)	
	KR strength/weakness assessment 7.5		CH strength/weakness assessment 24	
	KR opportunity assessment 14.5		CH opportunity assessment 19.5	
	KR threats assessment -5.5		CH threats assessment -6	
	KR Total 16.5		CH Total 37.5	
Cost Structures (CS)		Revenue Streams (RS)		
CS strength/weakness assessment 8.5	CS threats assessment -7	RS strength/weakness assessment 21	RS threats assessment -11.5	
CS opportunity assessment 3.5	CS Total 5	RS opportunity assessment 20	KP Total 29.5	
Total: 197				

Fig. 4. SWOT evaluation results of the business model canvas from the case organization, which calculated the critical scores for each business model canvas block and exert a total score for future comparisons. The score does not necessarily indicate how well the case company has done, but is more considered as a benchmark to reflect and compare with the future evaluations.

opportunity score. Hence, it should raise more attention for the case organization. Moreover, a total score was given for the entire business model canvas. In our case organization’s case, it achieved a total score of 197. This score does not indicate the performance of the organization directly, but as a benchmark for the future evaluation.

To summarize, on one hand, the business model canvas was suggested as an effective and efficient way to analyze the existing SDN providers in the market, and then compare and reuse the business model components when creating a new business model canvas. On the other hand, the SWOT analysis was backed by data and provided a quick understanding of the status of each business model canvas block and indicated several critical parts that the case organization should pay more attentions. Both results provided strong evidence that our research approach and the business model canvas was of great benefit to the case organization.

In the SDN business model below (Fig. 5), it contains three primary parts. On the left side, the business model canvas illustrates the business requirements of the flexibility of arranging different network services and the value proposition of service chain model. In the activity properties, the author provided two examples, (1) Networking Service, and (2) Service Orchestration. These two activities connect to the several product functionalities of Traffic Acceleration, Security Service, Load Balance and Central Management on a business requirement perspective and are also extended into several quality attributes to reflect the product functionalities on the software engineering view. Additionally, the activities are linked with the OpenFlow environment, where the networking is based on. On the right side of the model, the author listed all the correspond SDN software from the case organization, which are listed in the SDN architecture to present the exact solutions from the organization. Those solutions are mostly networking apps that are built on the SDN controller, and the SDN controller itself. Thus, we consider and expect this part of the model becoming an Appstore - like platform.

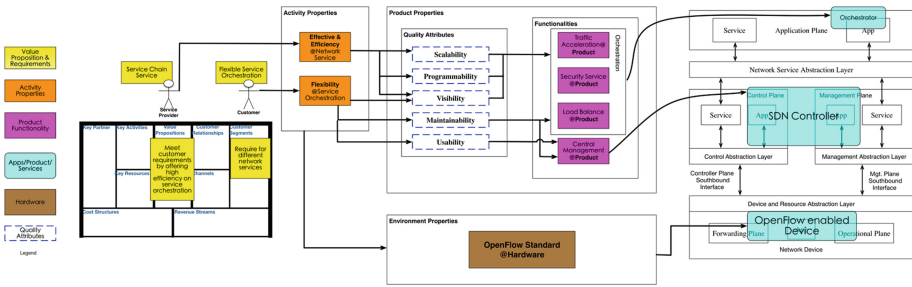


Fig. 5. Unified model of Service chain example - SDN business model as a whole representation of our proposal for the use case. It explains how we model the SDN use case from the business model canvas on the left for business requirements gathering to the middle part of activity property, product property and environment property of the product, and finally a software solution/proposition on the right side of the SDN architecture.

The above SDN business model was constructed and evaluated with five experts, who were from networking or marketing field in the case organization. The interview followed a time glass³ way of asking questions, i.e., the author started with general questions (e.g., “What do you think of this model?”, “Do you have similar model to handle these tasks in your daily work?”) to have a high level overview of the situation of the case organization. After that, some detailed questions were asked and evaluated. For instance, “Does the BMC well reflect the business requirements from the customers?”, “Do you think it is important to combine the business side with the technical side?”. Such questions were scored from 1 to 5, and was listed in the following table (Table 1). On one side, the table indicates that except interviewee C, interviewee A, B, D and E all provided a very positive view of the SDN business model. On the other side, each scored question has shown a score from 64% to 80%, which is seen as a positive view as well. Therefore, the SDN business model we proposed should be seen as an appropriate solution for SDN.

3.3.1 Summary of the Results

The former one provided a benchmark score for SDN organization’s self-evaluation, and the latter one illustrated an example to show how the unified quality model had been used to help the SDN organization to bridge the business and architecture part. In general, both the business model canvas and SDN business model have shown their effectiveness in tackling with the difficulties to establish the business model in the SDN field. Table 2, shows the interview results of the SDN business model.

Though the SDN business model was evaluated and proved to be beneficial to the SDN business, it remains immature in many areas. This section concludes the contributions in Sect. 4.1 as well as the limitations of the SDN business model in Sect. 4.2.

³ http://www.cse.chalmers.se/~feldt/advice/runeson_2009_emse_case_study_guidelines.pdf.

Table 2. Interview results of the SDN business model

Interviewee	Question score						Avg. (Interviewee)	Percentage
	Q1	Q2	Q3	Q4	Q5	Q6		
A	4	4	5	4	5	4	4.33	0.87
B	4	5	4	4	5	4	4.33	0.87
C	3	3	2	3	4	2	2.83	0.57
D	4	5	4	3	4	3	3.83	0.77
E	4	5	4	3	4	3	3.83	0.77
Avg. (Question)	3.8	4.4	3.8	3.4	4.4	3.2		
Percentage	0.7	0.8	0.7	0.6	0.8	0.6		
	6	8	6	8	8	4		
Interview questions								
Q1	Does the BMC well reflect the business requirements from the customers? (1-5)							
Q2	Is the BMC a good tool to brainstorm with the customers and the colleagues? (1-5)							
Q3	Does the unified quality model well represent the customer activities, the product and the environment and the functionalities of the service and applications? (1-5)							
Q4	Does the SDN architecture illustrate a clear image to you the overall SDN service and apps from in your company? (1-5)							
Q5	Do you think it is important to combine the business side with the technical side? (1-5)							
Q6	Does the SDN solution model solve the problems in your current work? (1-5)							

4 Discussion

4.1 Contribution

In regard to the research results, the most noteworthy discovery is the use of the combination of the business model canvas, unified quality model [10], and SDN architecture on modeling and designing a business model for the SDN market. (1) The business model canvas was applied in a new way, and we proved that this modular tool was effective and efficient in modeling and designing business models in an innovative ICT market. Although the new model does not cover the full set of SDN features and SDN quality attributes due to research limitations, (2) it proposed an industry-first theoretical concept to combine the business model with the technical architecture for SDN solution/product’s design and development. As such, (3) this paper can also be seen as a validation for application of the BMC in a certain domain. Last but not least, (4) the overall research approach also delineated an appropriate way of conducting similar research for the future.

4.2 Limitation

Due to the fast growing nature of the SDN market, every organization is proposing new products, new services in every single day. Thus, (1) the data we have retrieved we used in this paper may not be suitable in the future due to its rapidly change nature. (2) Another limitation of the SDN business model is its applicability in different

enterprises. As the validation was conducted only in one case organization, the generosity of the model is limited. (3) The quality model did not use the full blocks of the business model canvas, it only analyzes the model from a software engineering perspective, which may lead to the incompleteness of the model.

5 Conclusion

The following sections summarize the final conclusion and the indications for the future research. Specifically, this chapter introduces a research summary that concludes an overview of the entire research story, and lastly, puts forward some opportunities for future researches and authors' vision for SDN business model.

5.1 Research Summary

In this paper, we propose to utilize the business model canvas as a method to model existing SDN providers in the market and summed up an SDN quality model to capture essential SDN features. The business model canvases of the selected organizations were compared and validated by interviewing experts, and their business components were stored in a dictionary for reusing in creating a new business model for the case organization. Moreover, based on the SDN quality model and business model canvas, we proposed an industry-first SDN business model that combines the business model with the technical architecture via a unified quality model.

Both the business model canvas and the quality model were evaluated through case studies. As a consequence, the business model canvas was proved to be efficient on analyzing an innovative IT market, which, in our case is SDN. Meanwhile, by connecting the business viewpoints and the technical viewpoints, the quality model provided a holistic view on the entire SDN business ecosystem, which was evaluated to reach a 77% satisfaction rate in the case organization.

5.2 Future Work

Throughout the method design, data collection, modeling and interviewing phases, it revealed many potential opportunities for future research. The recommendations listed in this section are divided into two parts. One is the business model canvas, from a business model perspective, and the other focuses on the SDN side. Both parts of opportunities are based on the limitations we have confronted, and the suggestions from the expert reviews.

5.2.1 Business Model Future Work

Regarding the business model, especially for the business model canvas methodology, there are tons of opportunities for future studies. Literature revealed that there was relatively a small number of researches have been done on the business model canvas in an IT field. Thus, (1) more researches and case studies need to be conducted to further validate the efficiency and effectiveness of business model canvas. Those results can strengthen the theory of applying business model canvas into innovative ICT

studies. Moreover, (2) the evaluation methods could be enhanced by future research to improve the accuracy of the evaluation process.

Furthermore, there is a sister model of business model canvas called value proposition canvas. It expands the value proposition and customer segment blocks of the original business model canvas. Thus, it can zoom in the critical needs of its customers as well as the values and products that a company can serve its customers. From a value proposition perspective, (3) further research can provide a holistic analysis of the business requirements and map them to the quality attributes to enrich the applicability of the model.

5.2.2 SDN Future Work

Focusing on a business model scope, this paper provided an in-depth view of how to design and develop business models for SDN. However, a fast growing market like SDN deserves wider attention. Suggested by the business model canvas experts, the business model analysis should not only focus on the quality model or SDN architecture part but also needs to cover the whole SDN eco-system to make the deliverables valuable to the commercial ends. (1) A full SDN eco-system may inspire research on the topics of SDN revenue chain, SDN provider network analysis, Open SDN system collaboration, innovation, etc. Moreover, the SDN architecture part of the SDN business 3-layers model generates future opportunities to create a holistic Appstore solution to help customers to choose the right networking apps and services.

In addition, from a technical point of view, (2) future research can dive to analyze the SDN features to provide an explicit list of critical features or functions an SDN product must have. For example, suggested by one of our interviewees, it is worth doing a research on how to rank the capabilities of the SDN features, such as malicious activities detection & mitigation, i.e., to what extent or level can an SDN product fulfill that function. In other words, SDN network capability testing may become another fruitful business in the future.

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