Business Model Canvas Perspective on Big Data Applications

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***Abstract*—Large and complex data that becomes difficult to be handled by traditional data processing applications triggers the development of big data applications which have become more pervasive than ever before. In the era of big data, data exploration and analysis turned into a difficult problem in many sectors such as the smart routing and health care sectors. Companies which can adapt their businesses well to leverage big data have significant advantages over those that lag this capability. The need for exploring new approaches to address the challenges of big data forces companies to shape their business models accordingly. In this paper, we summarize and share our findings regarding the business models deployed in big data applications in different sectors. We analyze existing big data applications by taking into consideration the core elements of a business (via business model canvas) and present how these applications provide value to their customers by making profit out of using big data.**

***Keywords*-business models; big data applications; business model canvas**

I. Introduction

A business model, as an institutionally constructed measure, is an aggregation of a set of underlying principles comprising an organization's overall strategy (depicted in Figure 1) that defines the extent to which the enterprise creates, delivers, sustains and even enhances different forms of value including, but not limited to, economic, social, cultural, technological, environmental or other forms of value. The term is used for a broad range of depictions, both informal and formal, to represent main characteristics of an enterprise, including its purpose, products and services, strategies, infrastructure, structures, practices, and processes and policies.

A significant amount of literature exists on business models, all of which intend to explicitly define and classify how companies realize their business mission and related activities [1], [2], [3]. These studies differ in several respects. For example, some studies provided definitions or classifications of what a business model is whereas some studies enhanced such comprehensible definitions by presenting conceptual approaches to business models (e.g., proposing business model elements). On the other hand, some studies provided a set of tools or graphical representations to design business models. Even in some studies, evaluation metrics that can be used to assess the success of a business model were proposed. Timmers's study [4] which described a business model as an architecture containing different elements such as product, service, information flows, and business actors is considered as the first study on business models.

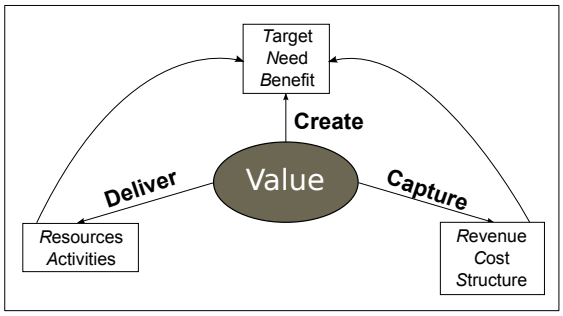

Figure 1. Value in the center of a business.

Osterwalder, based on his earlier work on business model ontology [5], proposed a strategic management template named as business model canvas in 2010 [6]. As shown in Figure 2, the business model canvas describes nine essential components of a business where the overall layout outlines how these pieces fit together. Since its introduction, the template and the underlying idea have quickly spread all around the world and leading companies like P&G and Nestle have started using the canvas in order to create new strategies for earning money. The canvas helped these companies to move to business model thinking from product centric thinking.

In today's world, big data is arguably important and often exploited for two main reasons. First, big data is utilized by companies for analytic purposes such as deriving useful insights about their businesses and supporting their higher-level decision making. Second, big data enables the development of applications and real-time services that leverage massive amounts of electronic data in order to present customers with value (e.g., intelligent services, efficiency, and entertainment) that would not be possible without the availability of such data. All big data applications have to be equipped with a number of capabilities such as visualizing and personalizing data, integrating different sets of data, and exploring and analyzing data in a timely manner.

In this paper, we explore the phenomenon of business models in big data applications and services such as location based services, medical services, and retail services. Our aim

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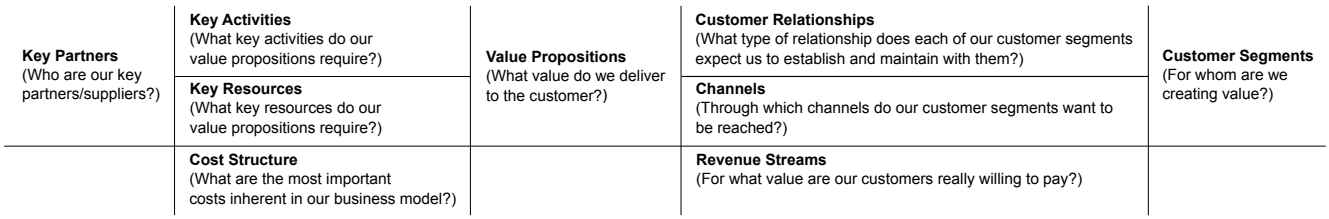

Figure 2. Business model canvas.

is to explain and draw attention to the impact of big data on deployed business models. We analyze a number of big data applications and focus on their business models from the business model canvas perspective [6]. For each building block of the canvas, we summarize the corresponding strategies and activities of big data applications. We believe that this analysis highlights several distinct aspects of big data applications as compared to traditional data applications.

II. Business Model Canvas

We surveyed a range of big data applications focusing on their activities from the business model canvas perspective [6]. The canvas enabled us to analyze the sustained business models in terms of elementary constructs such as key resources, target customers, and revenue channels. This section describes the building blocks of the canvas and presents our survey results that describe the money earning logic of big data applications.

A. Value Propositions

Value propositions can be described as products and value-added services delivered by a company to fulfill customer needs and are of value to customers. With the use of big data, many innovative and value-added applications have become possible that were unlikely to be imagined using traditional data paradigms. Many applications have started to emerge in the market ranging from transportation to health care. In this section, we present the value offered by big data applications in different sectors.

- Location Based Services:

The large availability of location data due to GPS enabled devices such as smart phones has made many innovative applications possible. Smart routing applications use big amounts of data from vehicles en route and other sources in order to estimate the traffic conditions and direct their users accordingly. Such applications have been increasingly utilized especially in large metropolitan areas that suffer from traffic problems. Some search engines (e.g., Google (www.google.com) and Yandex (www.yandex.com)) provide traffic-based map services. The Royal Institute of Technology of Sweden has developed an application which estimates how long it would take to travel from one point to another and gives driving directions to its users [7]. Other features of current smart routing applications include up-to-date information about scheduled roadwork, points of interest, and weather conditions. Waze (www.waze.com) is a community-based traffic and navigation application recently acquired by Google. Its maps are created by the community and its users share traffic and road information. The application provides its users with information about their friends who drive to the same destination as well as real-time driving directions.

Suggesting a form of transportation (such as taxi) is another use of big data applications in the smart routing domain. For example, CabSense (www.sensenetworks.com/products/macrosense-technology-platform/cabsense) uses tens of millions of GPS points from taxis in New York City to locate the best corner for finding a taxi nearby. Another innovative application is Street Bump (www.streetbump.org) which uses two sensors of a smart phone (i.e., GPS and accelerometer) during driving to automatically find and report potholes within the Boston city roads. Using this tool, the residents may improve their neighborhood streets and the governments may fix existing problems and plan long term investments.

With the use of smart routing applications, a lot of gain has become possible in terms of time, oil usage, carbon dioxide emissions, etc. The potential global value of smart routing in the form of time and fuel savings is expected to be around 500 billion dollars by 2020 [8]. For each traveler, the estimated savings are 10 to 15 hours a year. The total fuel savings are expected as 150 billion dollars which correspond to a reduction in carbon dioxide emissions of 380 million tones a year.

Some platforms for location-based ratings and reviews also leverage massive amounts of data. For example, Yelp (www.yelp.com) with about 100 million monthly unique visitors helps people to find local businesses such as dentists, mechanics, and restaurants and to read corresponding reviews provided by the community. Another example is Foursquare (www.foursquare.com) which enables users to check in at venues nearby and rate these venues. These applications are helpful for newcomers of a neighborhood in exploring points of interests as well as residents in selecting services. The side benefits of such applications include convenience, transparency, and entertainment.

- Health Care:

The increasing availability of health care data in the form of medical records, claims and cost data, R&D data from pharmaceutical companies, and other types of medical content has started to result in new types of big data applications, such as the applications that provide the analysis and aggregation of health care data as a service to third parties. These services can be used to improve clinal decision making, create preventive care programs, and help pharmaceutical and medical product companies in their R&D activities. For example, UFIDA Medical developed a medical information platform for a China city with a population of about three millions. The platform enables doctors to retrieve the medical history of patients including the treatments and prescriptions in real time [9] and provides data analysis and data mining solutions to its users.

Big data applications in health care also include online platforms. As an example, PatientsLikeMe (www.patientslikeme.com) provides a platform to the community to share their health related experiences and hence help patients with similar diseases. This data is also shared with the industry for R&D purposes. There are platforms for communities of physicians such as Medscape Connect (www.medscape.com/connect), Sermo (www.sermo.com), and DocCheck (www.doccheck.com/com/). These platforms allow doctors to network with their colleagues, ask questions, and share their own perspectives with others. Ginger.io (www.ginger.io) offers patients an application that collects their behavior data via a mobile phone and gives them a better understanding about how their behaviors impact their well-being. At the same time, researchers can use a platform for collecting such data which enables the identification of novel findings and the providers can use this platform for tracking the data of their patients.

In [10], new ways that big data can provide value in health care are described. Big data can help people in their own care and life style choices. The most appropriate and timely treatment and the right service providers can be selected with available evidence. With the exploitation of big data, the quality of services are expected to increase while the costs will decrease. As an example, more than $300 billion value per year is expected in the US with two-thirds of it in the form of reductions in health care expenditures [8]. It is foreseen that big data will trigger advancement in medicine and an increase in R&D productivity.

- Other Sectors:

Innovative big data applications are also emerging in the retail industry. One type of application is price comparison services which offer pricing information on products from different retailers. Studies have shown that consumers can save an average of 10% when they shop using such services [8]. For example, RedLaser (www.redlaser.com) allows customers to scan the bar code of a product using their smart phones and obtain price comparisons for the product together with other product information. Other big data applications in the retail sector include web-based marketplaces such as Amazon (www.amazon.com) and eBay (www.ebay.com). These services offer searchable product listings from a large number of vendors. Such services give price transparency to their customers and provide marketing and sales opportunities for niche businesses [8]. A large amount of product information such as consumer reviews are created using these applications.

Big data applications can create value for several other sectors including the public sector, manufacturing, recruitment, etc. For example, WhereDoesMyMoneyGo (www.wheredoesmymoneygo.org) provides a web site for the analysis and visualization of data about public spending in the United Kingdom. In the manufacturing sector, data obtained from sensors in a product may be used to create after-sales service offerings such as maintenance services for automobiles [8]. Linkedin (www.linkedin.com) is a network of professionals with over 225 million members in 200 countries. It provides access to professionals, companies, and job opportunities in different sectors. Considering these initial applications of big data, it is expected that many innovative applications will emerge with unforeseen benefits for their users and the community.

B. Customer Segments

Customer segment defines the type of customers that a company wants to address and attract by offering value propositions. In general, location based big data applications target mass markets. Smart routing applications target users of GPS enabled devices such as smart phones. It is expected that the use of smart routing is likely to grow as the penetration of smart phones and the use of free navigation applications in these devices increase. More than 70% of mobile phones are expected to have GPS capability by 2020 [8]. Additionally, the number of other navigation systems are also expected to grow. A target segment of location based applications includes governmental entities which track the traffic and road conditions and take precautions.

Big data applications in health care sector target different customer segments including consumers, providers, payors, and manufacturers. Consumers include patients and people who aim to take an active role in their health. Providers include doctors and other health practitioners. According to a study [10], the majority of new big data applications in health care in the US target consumers and providers. With the availability of some big data applications, both consumers and providers have started to form large online communities. Governmental entities and hospital management units are interested in big data applications in order to manage and analyze the massive amounts of information and

to improve the efficiency of their systems. Pharmaceutical and medical product companies and researchers consider big data applications as a source of data necessary for R&D activities.

Some big data applications have multi-sided markets. As an example, platforms of patients need a large base of patients. They may also need pharmaceutical companies to perform R&D activities on the available data. Both segments are required for the success of such business models. Similarly, a lot of big data applications offer free services to customers and need advertisers for their revenues where a large user base is a necessity to attract advertisers.

C. Channels

Channels describe how a company gets in touch with its customers and delivers value propositions to them. There are several forms of big data applications. Location based services such as Yelp and Waze are usually provided as applications supporting at least one type of mobile operating systems (e.g., Android (www.android.com) and iOS (www.apple.com/ios)). Some of these applications also have web-based versions for desktop and notebook users. In some cases, mobile platforms are necessary for their functionalities; as an example, Ginger.io uses sensors of a smart phone to track patient behavior.

Big data applications may reach their customers through different channels. Web-based applications can be accessed through the product website whereas mobile applications are usually offered via one or more application stores such as Apple Store (store.apple.com) and Google Play (play.google.com/store). It is expected that many big data applications will be developed by entrepreneurs because application store model lowers the barriers to entry for innovative new players by providing ready sales and marketing channels [8]. Some big data applications targeting specific segments reach their customers through direct sales force.

D. Customer Relationships

Customer relationships refer to the relationship that a company builds and maintains with its customers. This can be considered as the lifeblood of a company's business activity. Big data applications targeting consumers usually provide a self-service interface such as a map on which the user can navigate to learn about the traffic information or categories of businesses that may be used to locate specific businesses. Automated services may recognize the characteristics of individual customers and offer information related to transactions. For example, an application in the retail industry may recommend products a user may be interested in based on the previous purchases of the user.

In some applications, companies co-create value with the community of customers. Examples include maps created by the community, community ratings for local businesses and health care information obtained from patient communities. The communities provide basis for these applications. At the same time, individual customers also benefit from the information created by the community that would not be possible without the formation of such a community.

E. Revenue Streams

Revenue streams describe the incoming money stream of a company by offering value propositions. It outlines the activities and pricing of the offered values with which a company improves its revenues. Some big data applications, especially the ones targeting the community, are free for consumers (e.g., Foursquare and Waze). These services mostly rely on advertising revenues. As an example, Waze has an advertising program that allows businesses to give advertisements that could be shown to drivers approaching the location of the business (e.g., a pizza restaurant) on the map or searching nearby. Foursquare introduced a new advertisement model where the advertisers are charged by the number of customers that visit their businesses after seeing their advertisement (not according to the number of advertisements displayed). According to a study [8], location based services are expected to create a value of $100 billion or more for service providers.

Other sources of revenue include the provision of big data as a service to third parties such as the provision of health care data to medical product companies. In a community-based business model, individual consumers such as physicians and patients freely join the community, whereas the companies may be billed for the usage of data created by the community. It is expected that there will be a market worth more than $10 billion by 2020 for medical clinical information providers which aggregate data and perform necessary analyses to improve health care efficiency [8].

F. Key Resources

Key resources are inputs and capabilities that a company needs in order to deliver value to its customers. Tangibles, intangibles, and people-based skills are particular kinds of resources required for creating value propositions. Big data applications require scalable infrastructures and distributed platforms. They also need to adapt to the increasing usage requests. Applications may use in-house or cloud-based infrastructures. Middle class servers are increasingly used together with distributed computing platforms such as Hadoop (hadoop.apache.org). Applications also need to be developed in a distributed manner usually with real time processing capabilities. Data analysis and machine learning techniques are largely utilized in big data applications. There is a rising need for human resources specialized in big data technologies and data analytics, especially with a strong background in large-scale systems and data mining technologies.

Large customer bases and communities are becoming a key resource for big data applications. Communities that

create data are required for successful execution of several applications such as Yelp. There is a network effect where individual data provided by each customer creates benefits for both customers and the application providers over time. Besides, communities also have positive effects on the acquisition of new customers. The likelihood of a person to start using a particular application increases as more and more people in their social network start using that application.

Financial resources required to enter into big data application business have decreased considerably with the use of cloud-based infrastructures and the application store model. Lastly, as a key resource, the availability and transparency of data in electronic form has vital importance. For example, there is an increasing need for the conversion of medical records into electronic form.

G. Key Activities

Key activities describe the actions that a company performs in order to create, market, and deliver value propositions to its customers and make profit out of them. Businesses of big data applications need to continually develop and maintain their infrastructure, platforms, and applications. This is especially the case when the number of their users drastically increases and the underlying data gets much bigger along with increased access rates.

Businesses need to continually improve their services with innovation; that is, they need to find new solutions to customer problems and create value in their lives as new competitors enter the market. Due to the application store model, some businesses of big data applications do not need to perform much marketing and sales activities for individual consumers. However, such activities may be necessary for software applications with specific target segments.

H. Key Partners

Key partners refer to the voluntarily initiated cooperative agreement of a company with other companies in order to carry out activities related to value propositions. Big data application companies may need to develop partnerships for the acquisition of data. In some cases, the data is co-created with online communities. However, in some cases, partnerships might be necessary to obtain supplementary data (e.g., partnerships with map companies and governments). As an example, Waze has partnered with the Operations Center of the City of Rio de Janeiro to alert drivers about major road closures during significant events. Similarly, some companies realize partnerships with advertisement companies to display location based advertisements to their users.

Many big data application companies work with application stores for marketing and sales support. They may also need to work with companies providing infrastructures and platforms. As an example, UFIDA Medical partnered with Intel for hardware platforms and Hadoop-based big data software platforms that are used in their application [9]. Partnerships may also be necessary for the development of standards to combine data sets from different providers as in health care applications.

I. Cost Structure

Cost structure describes the costs incurred by a company for delivering value propositions to its customers and doing all other business activities such as building partner relationships and marketing. Big data applications usually have variable costs for infrastructure. The infrastructure costs increase as the applications get increasingly used (i.e., the data size and the number of requests per time units increase). These costs include costs of building and maintaining data centers (e.g., costs of servers, electricity, cooling, and the use of cloud services) and developing and maintaining the platforms and applications.

In some cases, there may be costs for acquiring data required by the applications. As an example, health providers may have to invest in deploying electronic medical record systems which is estimated as $80,000 to $100,000 per bed in the United States [8]. There may also be costs for acquiring supplementary data such as costs for keeping maps up-to-date in smart routing. Other costs include sales and marketing costs which have decreased in some applications due to the use of application store model. In general, big data applications that target communities have lower customer acquisition costs as a consequence of network effects.

III. Conclusion

This paper has presented our analysis of business models used in big data applications varying from smart routing applications to health care services. To the best of our knowledge, this work is the first to study business models of big data applications according to the components of highly-reputed business model canvas. For each building element of the canvas (such as revenue channels and partnerships), we have summarized the activities realized by big data application businesses in order to provide value propositions to their customers. Overall, our analysis has showed the impact of big data on business models of data processing applications.

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