UPPSALA
UNIVERSITET

TVE-MILI 18035
Master's Thesis 15 credits
Augusti 2018

Business models based on IoT, AI and blockchain

Jin Liu

Master Programme in Industrial Management and Innovation

Masterprogram i industriell ledning och innovation

UPPSALA
UNIVERSITET

Faculty of Science and Technology

Visiting address:
Ångströmlaboratoriet
Lägerhyddsvägen 1
House 4, Level 0

Postal address:
Box 536
751 21 Uppsala

Telephone:
+46 (0)18 – 471 30 03

Telefax:
+46 (0)18 – 471 30 00

Web page:
http://www.teknik.uu.se/student-en/

Abstract

Business models based on IoT, AI and blockchain

Jin Liu

Every time the development of technology enters a new epoch, big changes in the business and society will follow. Especially for the entrepreneurs, it signifies both opportunities and challenges at the same time. In the next decade, IoT, AI and blockchain will be the main driving forces in the upcoming technological revolution and demonstrate great synergic potential. There is an old saying, "In a strong wind even turkeys can fly". The company who can seize this chance may become to the next GAFAs (Google, Amazon, Facebook and Apple); whereas those who completely ignores it may be rolled out of the market eventually. Business model canvas is a very popular method for startups to align the resources and formulate the strategy, which is also the framework used in our research. The main target of this thesis is to demonstrate a thinking method to converge these new technologies in the business models and evaluate the most significant elements in the business planning stage. It could help the future startups to take advantages of the opportunities and overcome the challenges in the new business environment.

Supervisor: Ase Linné
Subject reader: Håkan Kullvén
Examiner: Sofia Wagrell
TVE-MILI 18035
Printed by: Uppsala Universitet

Table of Contents

List of Figures

List of Tables

Chapter 1

1 Introduction

New technology is an important source for entrepreneurs to generate ideas for their own business. The upcoming technological revolution led by IoT, AI and blockchain will dramatically reshape the current economic environment and create countless new business opportunities. Recently, the first batch of 5G standard has been published by 3GPP, indicating the large-scale commercialization of IoT will arrive soon. At the same time, AI and blockchain are evolving very fast, drawing many investors' attention in the ICT industry. The synergy of these new technologies is huge, as well as the associated challenges. Under such condition, how to understand these new concepts and use them to build business models becomes a critical issue for entrepreneurs in the new business environment.

The goal of the paper is to introduce the IoT, AI and blockchain from the industrial economy point of view and set a bridge between commerce and technology. It could benefit not only for entrepreneurs who want to start a company but also for those who are looking for partnership or investment. Moreover, a thinking method is also presented in this paper by merging these new technologies into the business models. By conducting the interviews with relevant respondents in the ICT field, we target to pinpoint which part of the business model is more significant and influential in the business planning phase.

The methodology is a mix method by combining qualitative method, quantitative method and regression analysis method. The interviews were conducted in a compound form containing both semi-structured interview and structured questionnaire. Nine blocks format business model proposed by Osterwalder are the theoretical framework for us in modelling and analysis. The thesis is organized in five chapters as below,

- Chapter 1: An overview of the thesis;
- Chapter 2: Introduce fundamental knowledge about IoT, AI and blockchain;
- Chapter 3: Converge new technologies in the business models.
- Chapter 4: Determine the methodology and interview guideline.
- Chapter 5: Result analysis based on the empirical data.
- Chapter 6: Conclusion and future work.

Chapter 2

2 Background Knowledge

2.1 Internet of Things

The concept of Internet of Things (IoT) can be traced back to 1999, referring to the pattern that the computer controls various individual things (Ashton, 2009). The International Telecommunication Union (ITU) defines IoT as "a global infrastructure for the information society, enabling advanced services by interconnecting physical and virtual things based on existing and evolving interoperable information and communication technologies" (Series, 2001). Theoretically, IoT demonstrated the structure that physical objectives get connected by wireless network, so that they can exchange data and perform interaction. It is predicted that by 2020, 20.8 billion devices will be connected through IoT (Gartner, 2014), which is why many companies are busy with developing IoT products and services.

IoT application can be found in many industries, which are highly associated with our daily lives. The first notable application is the Smart City. In the future smart city, sensors on the road can help the city manager to detect the traffic jam and enable the real-time environmental control. The drivers will receive the latest traffic information through their automobiles. Sensors on the building will assist in energy saving and accidents forecasting. The self-driving car connected by wireless network will take up the roles in public transportation and delivery service. Sensor tags on the vehicles can also improve the security level with the help of real-time data analysis (Mathieu, 2016).

Smart home is another IoT application which is similar as smart city but with more user-oriented and regional limitation (Mathieu,2016). Smart sensors in homes can reducing the risk such as fire and flooding and reduce the operation costs by notifying the users the optimum usage of different devices (PWC, 2017). The temperature and light management can be automatically adjusted based on the internal and external conditions and the electricity price. Home devices can be controlled remotely and become smarter like human, such as fridges can order new food automatically when it is about empty (Mathieu,2016).

IoT can reshape the healthcare system as well. The body sensors are capable to detect and monitor the health condition of the patients and transfer the data to the responsible people before accident happens. It also helps to remind the patients to take the medication on time and adjust

the prescribed quantities based on the monitored metrics (Mathieu,2016). The physician can examine the patient remotely, by combining the robotic arm, high resolution camera and low latency 5g network. In this way, patients don't need to suffer from the long waiting time and get the treatment promptly.

Smart manufacturing is also an important application of IoT. In the future factory, industrial robots will be connected wirelessly and communicate mutually. Manufacture process is no more mechanic production but smart cooperation, including smart design, smart machining, smart control, smart monitoring, smart scheduling, etc. High customized mass production will become practical with lower cost, and production sequence will be adjusted properly according to the degree of urgency. The sensors on the machines can be used to predict the machine maintenance, reducing the cost from machinery breakdown.

2.1.1 IoT and 5G

With the current 4G network, some IoT concepts will only stop at blueprint stage because of the limitation on bit rate and latency. The reason is because that all the smart devices use very specific frequencies on the radio frequency spectrum, typically under 6 GHz. This frequency band is not enough to support all the IoT devices in the future, that's why we need 5G network to tackle this issue. 5G adopts the shorter-wavelength millimeter waves and expand the frequency band up to 300 GHz. According to the communication theory, the bandwidth of the wireless signal roughly equals to the 5% of the carrier frequency. In another word, the higher the carrier frequency, the wider the signal bandwidth. According to the Shannon theory,

$$C = B\log_2\left(1+\frac{S}{N}\right)$$

Channel compacity has positive correlation with signal bandwidth and signal-to-noise ratio, which means the data rate will increase dramatically in the 5G network. Compared with 70 ms delay and 1Gb/s data rate, 5G can achieve 20Gb/s with less than 1 millisecond latency (Yilmaz, 2016). Only such transmission quality is able to support high standard IoT appliance such as remote surgery or autonomous car. Full set of 5G standard is supposed to publish by the end of 2018 and 5G mobile network is expected to reach the commercialization level by 2020. By that time, all smart devices can share the ultra-wide bandwidth from 3kHz to 300GHz, releasing the full potential of internet of things. The drawback of millimeter wave is the high attenuation characteristic. It has low capability in penetrating the concrete and can even be absorbed by the foliage and rain (Yilmaz, 2016).

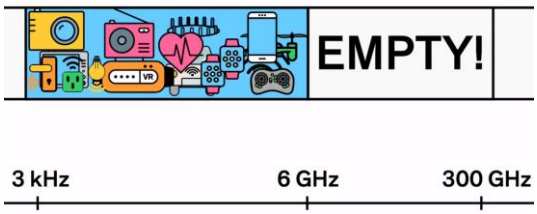

Figure 1. 5G spectrum

In order to overcome this shortage, 5G communications will adopt small cells instead of regular cellular network under some conditions. Small cells have a smaller radiation radius, ranging from 10 meters to a few kilometers, and they can improve the network capacity and spectrum efficiency greatly. In addition, massive multi-input multi-output (MIMO) antenna is another core technology in 5G. Compared with single-input single-output (SISO), massive antenna array uses spatial multiplexing to convert the high-speed data stream into a series of low-speed data steam, so that the data can be transmitted simultaneously on the same frequency band. It can greatly increase the data rate, spectrum efficiency, transmission range, and take the advantage of the channel fading effect caused by multi-path propagation (Rusek, 2013).

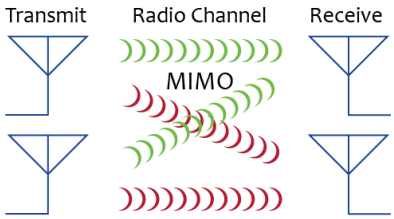

Figure 2. Massive MIMO antenna

2.1.2 IoT Architecture

The IoT architecture can be divided into 5 layers, perception layer, network layer, middleware layer, application layer and business layer, containing a set of IoT protocols (Vashi, 2017). The perception layer is similar to physical layer in Open Systems Interconnection (OSI) reference model. It consists of various types of sensors such as RFID, QR code, Zigbee or Infrared (Atzori, 2010). The main function of perception is to collect and identify the data, and the data can be different types based on the requirement of IoT devices. The perception layer connects with network layer to secure the communication of gather data (Vashi, 2017). The function of network layer is to transfer the gathered data to the upper layer and keep the transmission safe and confidential towards the central information processing system (Vashi, 2017) The transmission contains different paths such as Bluetooth, Wi-Fi, 5G depending on different technologies. Middleware layer is used to manage different types of service associated with diverse IoT devices. It also stores the lower layer information into the database, which can be used to retrieve when needed (Ara, 2016). Application Layer is used to manage the IoT

applications based on processed information from the middleware layer, and perform certain activities required by the business layer (Ara, 2016). Business Layer is used to create business models, flow chart and executive report based on the analysis of data received from middleware layer, so that essential for decision makers to make the correct business strategies (Vashi, 2017).

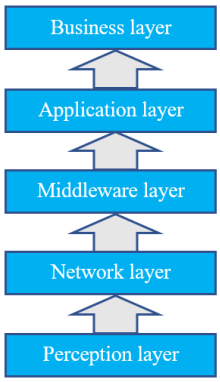

Figure 3. IoT architecture

2.2 Artificial Intelligence

The definition of Artificial Intelligence (AI) is very broad. Theoretically, it referrers to the technology that machine can think and act spontaneously without specifically programming for it (Shane, 2007). In such way, robots can work for human and be able to undertake different types of jobs. AI is the one of the revolutionary technologies which will bring great changes to the economics. Some AI applications such as video suggestions, production recommendations, spam filters and navigation system have already deployed in our daily lives, but they are only the preliminary AI application (Deloitte, 2017). Currently many companies are working on the research and development of more sophisticated AI system. As we can see from the case of AlphaGo, AI has already beaten the No.1 ranked Go player. AlphaGo can not only remember all the strategies in its database but can also invent some new tactics which has not been used by anyone before. Human-like robots like Sophia can communicate with human naturally in various language. However, her mindset sometimes is out of designers' control since she has announced many times to control the human. Chatbots such as Google Home and Amazon echo are very popular today. They can assist us in different kinds of task from managing the home to providing the latest information we concern. From the company side, they retrieve big data from the customers to foresee the market trend. Chatbots also have a great potential in the health industry. Patients can receive the treatment information and health-related services remotely and immediately (Reshmi, 2018). This can greatly lower the possibility of the treatment delay caused by long waiting time. AI also enable the automated supermarket to become true. Amazon Go just opened to the public on January 22, 2018, in which you can purchase products by only scanning your phone when entered the supermarket. The products you picked will be added up to your virtual cart and charge your Amazon account. The receipt is sent straight to

the phone app after you walk out of the store directly. The technology behind is borrowed from the self-driving car including computer vision, deep learning and sensor fusion (Wingfield, 2016).

AI is also the core technology in autonomous vehicle systems in terms of perception, prediction and decision. Perception indicates the environmental sensing of the self-driving car, such as the road, street light, road sign, etc. For example, in the winter of Chicago, the wind and snow are very heavily, sometimes totally covering the stop sign on the road. AI could help the self-driving car to identify the environmental sign in such extreme situation which is even tough for human drivers. Prediction is the process of forecasting the movement trajectory of the objectives on the road. With the help of data process technique of classification, the self-driving care can identify whether this objective is bush, human or other vehicles, and predict its movement status, velocity and uncertainties. Motion planning and decision making are the brain of self-driving car, allowing the vehicles to take the optimal route in the dynamic conditions. This part is very challenging because it involves huge amount of calculation and short reaction time in the fast-changing environment (Li, 2017).

2.2.1 Machine Learning

The core technology in AI is machine learning (ML). Intrinsically, ML is algorithms that can be applied to dataset to perform the tasks of clustering, classification and regression. Clustering is used to sort out the similarities of the data without knowing the structure of the data; classification is used to sort the new data based on the known data structure; regression is to find the correlation of different variables and build the prediction model to forecast the data trend (Athey, 2018). It is very similar as the tasks in Data Mining, but there is a slight difference. ML is more focused on the development of the algorithms so that the computer can automatically improve along with experience. However, Data Mining emphasis on the application of the algorithms and use it as tools to extract valuable patterns in the datasets (InnoValeur, 2017).

ML can be divided into two main branches, supervised and unsupervised ML. The difference is whether there are “labels” on the input data. The “label” here indicates the attributes of the objectives (Athey, 2018). For example, there are two types of human according to the gender feature, man and woman. Man and Woman are the 2 labels we use to distinguish them. Now we take an example to explain supervised and unsupervised ML. Before the final exam, students often need to do a lot of practice questions to prepare for it. Even though these practices are not the real questions appeared in the exam, students can master the method in solving similar issues and transplant it in the real exam. In this process, the answers to the practice questions are very important. If one student knows the practice answers and the other student don’t know

it at all, they will probably make a big difference in the real exam. The practice answer here is the “label” we mentioned, and this process resembles the two types of ML. ML is to train the machines to solve new issues. For supervised learning, the input data has both features and labels. The supervised ML is to map the features to labels, so that the data without labels can be recognized afterwards. For the unsupervised learning, the labels parts are missing, that’s why the accuracy of the unsupervised learning can not compete with supervised learning. It is worth to mention that the labelling process requires a lot of work and most data does not have a label. The supervised learning algorithms often contain classification and regression, and the unsupervised learning algorithms mainly focus on clustering. ML has a great impact on the field of economics. The algorithms can be applied to various economic issues and the regression serves as a prediction tool in the decision-making process (Athey, 2018).

2.2.2 Machine Learning Models

In this section we introduce two models in machine learning, artificial neural network and support vector machine. We target to provide a structural overview of these two models along with the respective business applications since they are typical, representative and classic among the machine learning approaches.

Artificial neural network and deep learning

Neuron is the basic unit in the human’s brain. It is used to process the information and transmit it the next neuron. The connection between different neurons form the human brain network structure. Artificial neural network (ANN) is the analogy to human’s brain, with which machine can perform the tasks of classification and pattern recognition.

Fig. 4 shows the example structure of the ANN in the supervised learning case. The picture with hand writing 2 is the input data and the label for this picture is label 2 for the machine to learn this picture. The final goal is to make the machine recognize the same type of pictures without label on it. It is a very easy task for human, however, it is a lot harder for machines. The picture will be transformed into a series of features based on the attributes of pixels on the picture, forming the first input layer. These values can be projected to the next layer by a linear function of weighted summation and adjusted by a constant bias. The projected values serve as the input of the activation function (Sigmoid function) on the second layer, so that the linear function can be projected into a non-linear dimension as the input of next layer. After several layers of propagation, the data will arrive the last layer called SoftMax, which is used to calculate the probability for different labels. If the predicted label is not true label, the backward propagation will be activated to update all the parameters (weights) in ANN (Silva, 2017). The layers between input and softmax layers are called hidden layers. Deep learning indicates the ANN structure with at least one hidden layer (Schmidhuber, 2015). The more the hidden layers,

the deeper the learning is. Complicated task often requires more than one hidden layer as well as more neurons in each layer. As we can see from the case of AlphaGo, it has 13 hidden layers and 192 neurons in each layer (Sakaguchi, 2017). Through this learning process, ANN enables the machine to recognize and classify the unfamiliar pictures and patterns automatically.

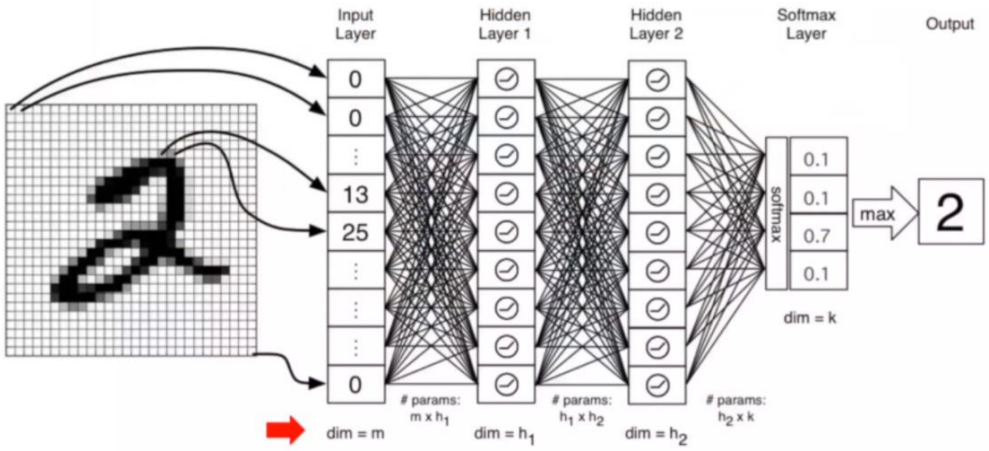

Figure 4. Artificial neural network structure

In the business dimension, ANN can use to segment the information without human or specifically programming for computer, especially for the high diversity of the dataset (Syama, 2018). It is also one of the core technologies in face perception, which will be widely used in the payment and other city management system. It also helps the companies to get an insight into their customers from these labels to optimize their strategies.

Support Vector Machine

Support Vector Machine (SVM) is another supervised learning models and algorithms that are used for data classification and regression. Fig. 5 shows the basic concept of SVM. Blue and red represent two types of data. SVM is used to find one hyperplane that can separate two classes with maximum margin between them. Whenever new data is input, this hyperplane can still stay valid to perform the classification. The datapoints closest to the margin are the support vectors, which is the reason why this algorithm is called SVM. The hyperplane is in the middle of the maximum margin and have equal distance to the support vectors of both classes.

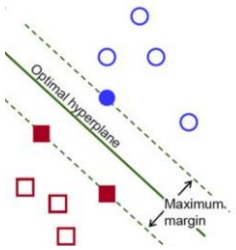

Figure 5. Support vector machine

The figure above only shows a very simple case because the hyperplane is linear. However, in a lot of complex issue in the real environment, we cannot find a linear hyperplane to separate the data belonging to different class. In such cases, Kernel method will be used. Kernel method is a class of algorithms for pattern analysis and recognition. It maps the data into a higher dimensional space in which it can be separated easily by a linear hyperplane. When this hyperplane is projected back to the original input space, it becomes nonlinear, such as the curve in fig. 6. The mapping function is called Kernel function. It serves as a bridge between two dimensions for the data conversion. One important thing is that the Kernel function is not used for feature space transformation, but to simplify the computation in the higher dimension, which is the reason why it is called Kernel tricks (Souza, 2010).

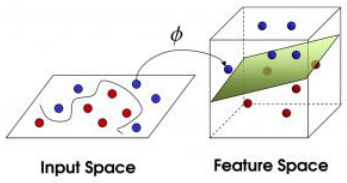

Figure 6. Kernel method (Kernel trick)

The variant of SVM can be also used for data prediction in the time series analysis, which is called support vector regression (SVR). With the help of Kernel methods, the nonlinear data in the lower dimensional space can be projected into linear data in the higher dimensional space, so that the linear regression can be done in that space. Compared with the traditional least square regression calculating the error function, SVR removes the limitation of input data's dimension. The application of SVM covers the classification of text, figures, handwritings and other types of data. Its potential application may involve sorting the target customers and their purchase propensity, as well as the forecasting in sales and inventory (Syama, 2018).

2.3 Blockchain and Cryptocurrency

Blockchain is a chain of blocks that contains information. The concept of block chain can be traced back to 1991 and it was originally designed for date tamperproof of the digital documents (Arvind, 2016). Blockchain starts to draw the public attention since 2009 when Satoshi Nakamoto use it to create the cryptocurrency Bitcoin. From the structure point of view, a blockchain is a distributed ledger that is synchronized by all the peers on the network. The information stored in each block is relatively very safe and very hard to tamper. Blockchain is the technology behind cryptocurrency. If we take the bitcoin as an example, each new block is generated roughly every 10 minutes consisting of 3 parts - hash, previous hash and data. The data stored inside the block varies depending on the type of blockchain. The bitcoin blockchain stores the details of the transaction information, such as the sender, receiver and amount of

coins. The hash can be viewed as the identity index. It is a sequence of values that is unique for each block and any changes inside the block will change the hash value. Previous hash is the hash value from previous block used to guarantee the security of the blockchain. The first block is called genesis block (Nofer, 2017). If one block is tampered, the changed hash value will be different with the previous hash value in the next block, so that all following blocks will become invalid. However, only using hashes is not enough prevent tampering behavior because computers these days can recalculate all the hashes values in a very short time to make the blockchain valid again. In order to solve this issue, a mechanism need to be added to slow down the creation of new blocks, which is the 10 minutes block generation interval we mentioned before. It is based on a consensus mechanism and we will explain it in the following section.

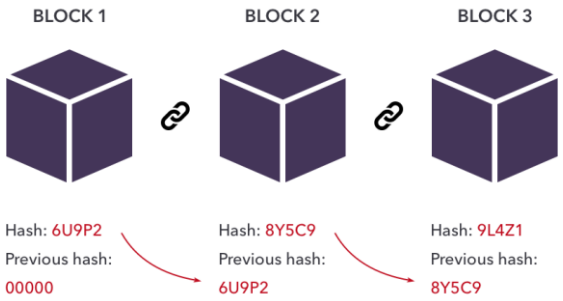

Figure 7. Blockchain structure

The revolutionary feature of blockchain is the form of decentralization. It is a kind of peer to peer (P2P) network that all the peers are connected directly without a central unit. The Email system intrinsically is a P2P network, because any two persons can send letter to each other even if they are using the different email service. In another word, there are no central email process unit to support such kind of communication worldwide. The difference between blockchain and email system is the uniqueness of transaction. When A send an email to B, both A and B owns this email simultaneously. However, when A send one bitcoin to B, only B owns this bitcoin. Blockchain is the technology behind cryptocurrency and it had experienced many hard forks during these years, such as the Bitcoin Cash, Bitcoin Gold and other variants of Bitcoin. The reason is due to the disagreement among peers towards the traditional blockchain protocols. For example, the original size for each block for Bitcoin is 1MB allowing the Bitcoin network to process roughly 7 transactions per second (Kogias, 2016). Some people want to upgrade the block size to 2 MB or higher to increase the throughput of transaction, however some people still want to maintain the same block size because it is easier for his hardware to store, synchronize, verify and transmit data. Because of the disagreement in the block size, the original blockchain is split into two new chains afterward, that is how hard forks happen (Eyal, 2016). The data on the old chain is still valid on the new chains, but the two chains themselves are not compatible with each other.

Currently central banks of many countries such as in Sweden, China, UK and Singapore are doing research on blockchain and legal tender digitalization. Even though block chain has a form a decentralization, it still has its own range, such as private chain, public chain and consortium chain. It is commonly believed that the process of currency digitalization is inevitable, just a matter of time. The more faith people have towards a certain type of cryptocurrency, the more market value it has. In conclusion, currency digitalization is a gaming process for different stakeholders such as government, consortium, etc.

2.3.1 Smart Contract and DApp

Blockchain is considered to be the most influential technology revolution since the advent of the internet. It is reforming many traditional industries and relevent the employment pattern. For example, it can be used to store the medical records; bank can use it to issue loans or offer automatic payments; insurance companies could use it process claims; tax office will use it to collect tax and reduce the numbers of staff required for taxation. The concept behind it is called smart contract stored in distributed ledger. The smart contract is a tiny computer program stored inside a blockchain and it will be automatically executed based on the agreed rules (Swan, 2015). In another word, smart contract defines the details and rule for cryptocurrency transaction. The tamper proof characteristic of blockchain can build the trust for all stakeholders and remove the role of third parties. It is considered to be distributed because the output of the smart contract is validated by everyone on the network. So far, the smart contract and blockchain application mainly focuses on the online digital part, the integration of offline activities such as blockchain based supply chain system should be very promising in the near future.

There are a number of blockchain platforms who support smart contracts. Ethereum currently is the biggest blockchain-based distributed platform to process the smart contracts. Smart contract also provides startups new crowdfunding method. Initial coin offering (ICO) can be viewed as cryptocurrency version of Initial public offering (IPO) (Swan, 2015). On the Ethereum platform, the smart contract can be used to create the token, manage the transactions and track people's balance. Startups only need put some Ether (cryptocurrency) into the smart contract to generate certain number of tokens, in exchange for legal tenders or other type of cryptocurrencies from backers. Startups can use this method to speed up the funding process and bypass the policy and geographic limitation. There is standard for ICO named ERC20 on Ethereum. ERC is the abbreviation for Ethereum Request Comments which can facilitate the exchange between different tokens. On the dark side, ICO generates a lot of scam possibility and many countries are modifying the relevant policy to prevent it happen. The programming language for smart contracts on Ethereum is Solidity which is very similar to Java. Last year a

new platform EOS was launched, and it differentiates Ethereum in terms of design philosophy, consensus mechanism and scalability. Scalability is one critical parameter to measure if the platform can be used for commercial level. It represents the potential capability of a system to handle increase number of demands by doing small modification or equipment upgrading. It is predicted that EOS could become the first commercial level blockchain platform because the Graphene technology behind can achieve 10k-100k transactions per second, which is at least 100 times higher than the Ethereum (Trogdor, 2017). Even though Bitcoin doesn't have any platform like Ethereum or EOS, it is still the first and most valuable cryptocurrency.

Decentralized Application (DApp) is another feature of blockchain. It is same as the traditional application with two distinctions. Firstly, there is no central server for DApp; secondly, DApp can achieve the transaction of cryptocurrency (Swan, 2015). The most famous DApp so far is CryptoKitties launched in December 2017, a virtual pets trading game with cryptocurrency. The DApp is an open-source software the backend of which operates on the blockchain architecture. The end users can communicate with each other without the medium of the third party. Here we take WhatsApp as an example, if it is switched to a DApp, the WhatsApp Inc. will not store and management the users' data, so that no third party owns the absolute authority of the DApp. Intrinsically, DApp performs the tasks supported by smart contact. The development of DApp is still in the preliminary stage and the potential market is considerable. It is widely believed that in order to achieve its commercial viability on the mobile devices, only relevant data will be synchronized instead of the full data set on the user side. The full data is stored on the blockchain which is accessible for the users when needed. The frontend of the DApp is the user interface for the end users to interact with, performing different kind of tasks depending on different type of business.

2.3.2 Consensus Mechanism

Consensus mechanism demonstrates the way how new cryptocurrency can be generated. It can be viewed as a game rule and must be followed by all the peers on the network. So far there are three consensus mechanism, proof of work (PoW), proof of stake (PoS) and delegated proof of stake (DPoS).

PoS is the earliest consensus mechanism and used by Bitcoin. It makes all the nodes on the network to solve a cryptographic puzzle at the costs of electricity power. The puzzle is solved by miners and the first one to find the solution can get the miner reward. In another word, all the miners use their computing power to compete on bookkeeping right for the next block (Zheng, 2017). The desired hash is the goal of mining, and the difficulty of mining is adjusted automatically every 2016 blocks. In order to prevent the tampering behavior, a 10-minute interval is used for miners to calculate the required PoW, which is hard to calculate but easy to

verify by the system. The reward consists of two parts, the reward for adding a new block and transaction fee from each transaction. The reward for adding a new block is halved every 210 thousand blocks, and all the 21 million bitcoins will be mined out by 2140. The deflation currency policy of bitcoin has caused a lot of debate. The drawback of PoW is the high electricity consumption in the mining process. The miners with better mining equipment could get more bitcoin because they have a higher hash rate. The mining tools are changing very fast in the past years, from CPU to GPU to FPGA to ASIC, each new method consumes exponentially higher electricity to meet the increasing demand of hashing power. Some miners gather together to form a mining pool, so that they can combine their hashing power and divide the reward evenly. The blockchain is not 100% immutable and may suffer from 51% attack (Zheng, 2017). If several big mining pools merge together, they can have more than 51% of hashing power of the whole network, in which way they can start to approve fraudulent transaction and fabricate the rest blockchain.

In order to overcome these disadvantages of PoW, a new consensus mechanism PoS is proposed. In PoS, a random node is elected to validate the new block based on their stake amount and coin age on the network. The stake means a certain amount of cryptocurrency a node deposits into the network. In PoS, miners are replaced by validators. The more stake they have, the higher chance they are chosen to be the next validator. The validators will check the validity of the transaction in the new block and mint it to the blockchain, from which they receive a certain amount of cryptocurrency associated with each transaction (Zheng, 2017). The validators will lose their stake when they approve fraudulent transactions, and that's why the stake should be higher than the reward to secure this process. Like PoW, PoS may also suffer from the 51% attack, but in a different way. It requires one node has more than 51% stake of the whole network to enable this attack. It has a relatively lower chance to happen compared to PoW because 51% stake is incredible amount money which is almost impossible for one node to own it. In addition, PoS encourage more people to set up a node on the network because its low cost in equipment and energy. Ethereum plans to change the PoW into PoS in the future one or two years, and new cryptocurrencies are more likely to use PoS consensus mechanism.

DPoS is the latest consensus mechanism used in EOS. It is based on the PoS but the validator is elected by all the stakeholders on the network (Zheng, 2017). The nodes own more stakes are more influential in the voting process. In this paper, more detailed discussion about DPoS is not proceeded since its centralized form is still in dispute.

Chapter 3

3 Business Models

Business model is commonly used by entrepreneurs in the business planning stage. In order to define the business models based on these new technologies, the definition of business model must be clarified first. According to the concept proposed by Osterwalder, a business model is a conceptual tool that contains a set of elements and their relationships representing the business logic of the company. It defines the how the values are conveyed to the target audience, as well as the architecture and partnership in marketing, supply chain and cash flow (Osterwalder, Pigneur, 2005). The name of business model can be traced back to 1962 and often confused with the concept of business strategy. Along with the evolving of the definition of business model, the differences between business models and strategy were distinguished gradually. On one hand, the business model describes the rationale of how an organization creates value, whereas business strategy aims for how to beat competitors by being different. Compared with business strategy, business model focus on the process of value proposition and customers evaluation (Zott, 2011). On the other hand, business strategy belongs to the upper level of the organization defining the way in competition; whereas business model is performed at operational levels defining how to execute the strategy (Onetti, 2012). The proper use of both business model and business strategy is essential for the company to achieve the commercial success and maintain the sustainability. An appropriate business model could help the startups to align the resources to the customers' needs.

In the business model domain, different scholars have different research focus. In general, they can be classified into three categories but hierarchically linked to each other. The first category describes the concept of business model and the different components inside; the second category describe the different types of business model, along with the common and distinct characteristics, the third category describe the business model for a specific company and how to use the business model perspective to analyze it (Osterwalder, 2005). These three categories form three layers in the domain of business model research, from macro level to micro level. Moreover, the evolution of business model research has experienced five phases. In the first phase, authors suggested business model definitions and classifications; in the second phase, authors started to pinpoint the elements of business models. However, in this phase, the elements are more like the simple "shopping lists", the detailed description of these elements

are demonstrated in phase three; in the fourth phase, authors started to model and evaluate the business models; in the last phase, authors focus on the application of these models in the real business environment (Osterwalder, 2005).

An excellent business model should be simple, rational and logical (Morris, 2005). It should also involve all available resources, ranging from physical resources to human resources (Demil, 2010). The business model for a company is not constant but keep evolving according to the objective environment, such as the changes in sale volume, revenue growth or internationalization level. There are three main mistakes and obstacles in developing a business model. First, business model is not compatible with reality; second, business model only represents part of business strategy; third, business model only focuses on the value proposition but totally ignores the value capture (Shafer, 2005). New ventures are more vulnerable from these barriers because they greatly affect how successful the business model to be (Zott, 2007).

3.1 Business Model Canvas

Business model canvas is tool which is the most widely used in making the business model. Its usage can be seen in various scenarios from education to entrepreneurship simulation to real business planning. Osterwalder and Pigneur defines business model canvas as a tool for describing, analyzing and designing business models, containing nine building blocks that show the logic of how a company intends to make money (Osterwalder, 2010). The nine blocks represent four main areas of a business: customers, offer, infrastructure and financial viability. Business model canvas could help the entrepreneurs to identify their resources and capability and match them to the needs in the market. It also serves as a blueprint for achieving the business strategy. Fig. 8 shows the business model canvas mentioned in the book written by Osterwalder and Pigneur. In the following section, the explanation of nine blocks in business model canvas will be presented.

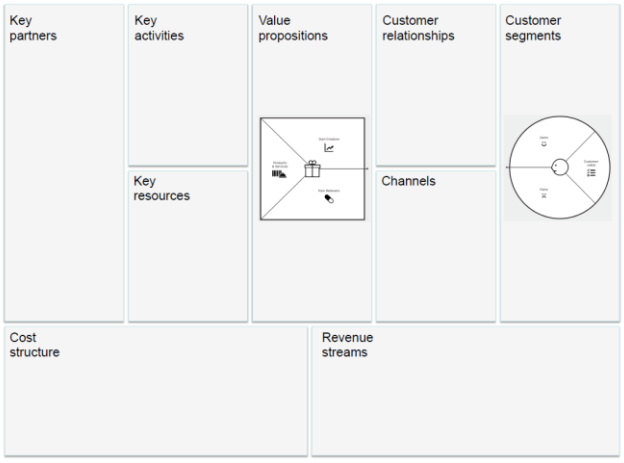

Figure 8. Business model canvas

1. Key partners: It describe the network of suppliers and partners required by the business. For example, some activities are outsourced, and some resources are acquired outside the company.
2. Key activities: It describe the most important things a company must do to make its business model work. It covers a wide range such as software development, supply chain management or consultancy, depending on different types of business model.
3. Key resources: It describe the most important assets required by the business model. It can be in different forms such as physical, intellectual, human or financial, depending on different types of business model.
4. Value proposition: It describes the core value of product or service that can be conveyed to the customers. Usually it demonstrates in which dimension one product or service can stand out among peers. The value here can be either quantitative (e.g. price) or qualitative (e.g. brand value).
5. Customer relationship: It describes the type of relationships a company establishes with customers. The way of interaction between company and customers deeply influence the user experience.
6. Channels: It describes the way how a company reaches its customers. It serves as interface between company and customers which plays a critical role in the user experience.
7. Customer segments: It describes certain groups of people a company wants to reach. The segmentation may be based on common needs, common behaviors or other attributes. A clear segmentation is essential for the enterprise to create value.
8. Cost structure: It describes most important costs incurred to operate a business model. Some business model is cost driven who focus on minimize and optimize the overall costs; whereas some business is value driven who aims to provide the premium user experience.
9. Revenue Steams: It describes the main revenue streams the enterprise receives from the business model. It can be either from one-time transaction or predictable revenue in the future. The difference between cost and revenue determines the profit of the business.

Value proposition canvas is integrated in business model canvas demonstrating the detailed relationship between the blocks of value proposition and customer segments. It makes the value proposition visible, tangible and easier to manage. In the value proposition canvas, value map is divided into three subsections, customer jobs, pains, and gains. Customer jobs describe the things that customers want to obtain or improve; gains describe how can customers benefit from these jobs; pains describe the cost, risk or barrier in doing these jobs. At the same time, customer profile is divided into three subsections as well, products and services, gain creators, and pain relievers. Products and services describe the things what company offers to the customers to satisfy their needs; gain creators describe how the products and services optimize the customers'

expectancy; pain relievers describe in which way the products and services can mitigate customers' pain (Osterwalder, 2014). When the value map matches with the customer profile, the value proposition canvas can achieve the fit status. Standing in the customers' shoes is critical for business planner to pinpoint what the customers care about most, so that the value of the products can be conveyed to the customers effectively and efficiently.

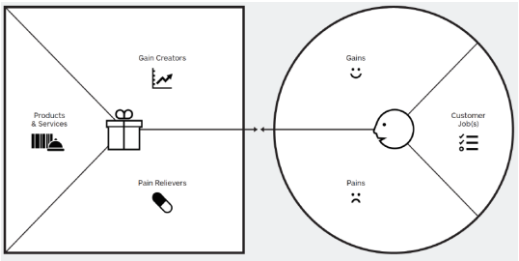

Figure 9. Value proposition canvas

3.2 Convergence of IoT, AI and Blockchain

The combination of the new technologies mentioned in the previous chapters give arises large quantities of business opportunities for the entrepreneurs. In this section we target to pinpoint the convergence of these new technologies in business dimension and explore the incision point for the future startups though a specific example of self-driving cars.

IoT solves the connectivity issue, by which means different smart devices in the future can get connected and exchange data with each other. AI greatly improves the automation rate of machines so that they can perform the similar task as human. The intersection of AI and IoT can no longer be underestimated and the synergy effect between them is very promising. Self-driving car is a representative integration of IoT and AI, requiring high level of connectivity and machine intelligence. Nowadays, many big companies such as Volvo and Ericsson have made a lot of investment in self-driving cars R&D, and the commercialization of self-driving car is estimated to take place in the future two or three years. Even though the self-driving car research is not practical for small-scale startup, it can be used as an outer resource for them to take advantage of in planning for the new business. Without producing the cars, the value can still be proposed to the customers if their needs are correctly pinpointed.

Sharing economy is becoming very popular these days. From the commercial success of Airbnb and Uber, the value of sharing culture is accepted and welcomed by more and more customers. From the service provides side, people are able to share out their spare resource when they don't use it. Some customers take it as their part time jobs to earn extra money, while some even set it as their main source of living. From the service buyers' side, they have better ways to obtain premium service without paying excessive amount of money. The differentiated and customized service can satisfy the customers with different tastes, providing more options in

diversity. For example, one person wants to take Tesla to work every day. On the Uber platform, he/she only needs to spend a little higher price than the traditional taxi way for a ride, instead of buying an expensive Tesla. The customer to customer (C2C) business mode in sharing economy is brand new compared with conventional B2B or B2C modes, serving a new trend in the future business models. The transaction leverage can be balanced automatically by the mutual selection process such as the rating and comment system. Simultaneously, it corresponds to the P2P pattern in the blockchain technology, which is the reason why we consider it as the incision point in generating our business model.

The blockchain based DApp could serve as a link between self-driving cars owners and passengers. They are both our customers in the C2C mode and our role is to pass on their needs to each other. The DApp allows the self-driving cars owners to share their vehicles when they don't use it in exchange for extra money. The passenger can also use the DApp to find the surrounding vehicles for a ride, even in some area hard to find a taxi. It is the blockchain version of Uber but there are a number of significant differences. Firstly, the DApp is totally based on blockchain platform so that no third party is involved in the transaction process. In the traditional way, the transaction if based on the trust of the third party, e.g. PayPal or bank, deferring the time for drivers to receive the money. The blockchain reform this pattern into a decentralized way, reducing the processing time without losing the security. Transaction can be proceeded directly between peers on the network, speeding up the transaction efficiency and reliability. Secondly, all the transaction records stored on the blockchain network is trustworthy because of the characteristic of blockchain. The transparent data is easier for different stakeholders to trace back the history when facing legal disputes. Thirdly, currency digitalization is an inevitable process and the blockchain will take a critical part in it. During these years, the increasing number of people believe in the value the cryptocurrency such as Bitcoin and take it as part of their asset. Our business model provides the customers a new way to spend them by connecting the online digital part with the offline activities. Fourthly, blockchain platforms such as Ethereum or EOS are totally opensource, facilitating the software development process and financial viability. Last but not the least, blockchain could speeds up the crowdfunding process though ICO in the business initial phase, bypassing the geographic barrier and limitation. The following figures show the business model canvas and value proposition canvas of the business model we proposed.

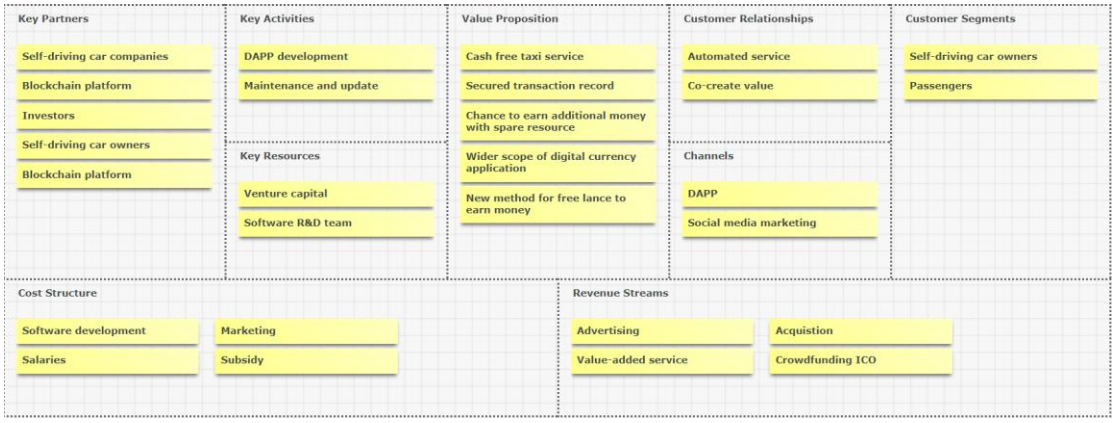

Figure 10. Business model canvas of self-driving car sharing service

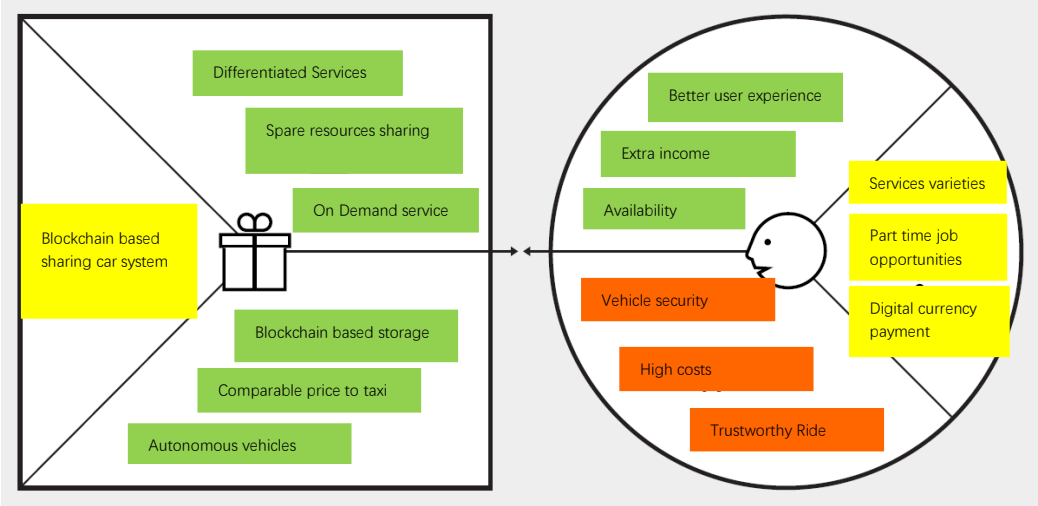

Figure 11. Value proposition canvas of self-driving car sharing service

In this section, we proposed a specific business model by converging IoT, AI and blockchain. It demonstrates an example and associated thinking method for entrepreneurs to accommodate these new technologies into the business model canvas and value proposition canvas. The cooperation of these new technologies will generate a great number of business opportunities in next technology epoch, waiting for new generation of entrepreneurs to further explore and discover. During this process, there is no fixed pattern or standard answer. One business model can be good to one startup but bad to another one, therefor finding the most suitable one by identifying the own resources and capability is the key to make the correct decision. Market is the ultimate way to examine the validity of the business model. Beside the correct decision, correct timing is essential as well to determine the result. Timing is critical in the product launching phase. Either faster pace or slower pace than the market maturity may result a failure, that is why first mover is not always the best dominator in many cases.

Chapter 4

4 Methodology

In the following parts, we aim to pinpoint which elements in the business model are more important for entrepreneurs in the ICT industry. This thesis adopted a mix of qualitative, quantitative and data analysis research method. By conducting interviews with correlated respondents, first hand empirical data were collected for the next step analysis.

4.1 Research Sample

The research sample for this study included six interviewees from ICT industry. Only ICT field is considered because it is highly related to this subject. The interviewee from other sectors may have different mindset in building the business model, which could affect the accuracy of the collected data. Participants were searched either by author's social network or referrals from prior interviewees. All the interviewees locate in China so that the interviews language was Chinese. The interview layout is a mix of two types depending on the specific situations. The interviews with first three respondents were semi-structured form via WeChat. The respondents followed our pre-determined questions as general procedure by free adding any additional comments related to our subject. On the contrary, the other three interviews were purely in a structured questionnaire via Google survey form. It enabled us to reach the respondents out of our own social network and enlarge our sample capacity. By experiencing both methods, we found out their respective advantages. The semi-structured interview can dig the issues more deeply and bring extra information out of our interview guideline, which is good for qualitative analysis; whereas structured interview can surpass the network limitation and speed up the data collection process, which is very practical in quantitative analysis. By conducting both methods parallelly, empirical data were collected. The table below shows the overview of the participant profiles.

Respondent	Background	Relevant field to our study
Contact person 1	Technical profession	Blockchain
Contact person 2	Entrepreneur	E-commerce
Contact person 3	Entrepreneur	Internet
Contact person 4	Entrepreneur	Electronics
Contact person 5	Technical profession	AI
Contact person 6	Entrepreneur	IoT

Table 1. Profiles of respondents

The statistics regarding to the respondent background were calculated to interpret the overview of the sample. All interviewees are from ICT industry but demonstrating the variety in gender, experience, education and expertise, providing us more comprehensive data.

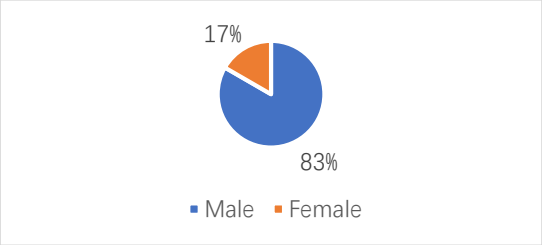

Figure 12. Gender distribution of interviewees

Among the interviewees, the gender distribution of is: male, 83%; female, 17%.

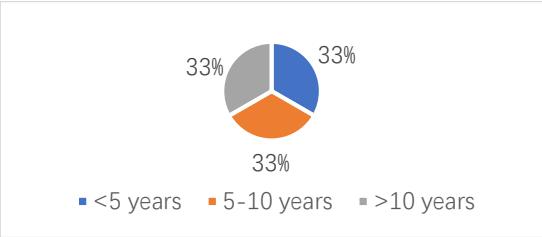

Figure 13. Experience level distribution of interviewees

The experience level ratio in ICT is: <5 years, 33%; 5-10 years, 33%; >5 years, 33%.

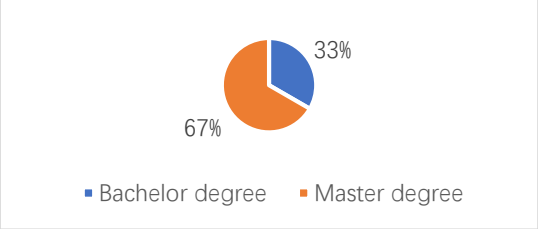

Figure 14. Educational level distribution of interviewees

The education level ratio is: Bachelor degree, 33%; Master degree 67%.

4.2 Research Method

The research contains both qualitative and quantitative methods. For the qualitative part, the questions were brainstormed and finalized based on the theories of business models, as present in the book “business model generation” (Osterwalder, 2010). We also referred to the questions in E-commerce and C2C business models in the book “Value proposition design” in the question forming process (Osterwalder, 2014). After the interview, the effective content was extracted from the empirical data and mapped into a matrix according to the matrix design method in the book “Qualitative Data Analysis” for the further comparison and analysis (Matthew, 2013). For the quantitative part, we were inspired by the concept of scoring method in the book “Product Design and Development” to process the small size sample pool (Karl, 2012). It enables us to determine which part of the business models plays a decisive role in

achieving the commercial success. Moreover, we also referred to the data analysis technique from datamining to explore the inner relationship between different variables. By mapping the data into the Cartesian coordinate system, a linear regression based on least square method can be generated to examine the validity of value proposition canvas. It is also a reverse checking method by using the empirical data.

The strength of this approach is the diversity. A composition of three methods enables us to discover the issue from different angles. Questions were pre-evaluated to determine which method to use beforehand, so that the optimal approach can be chosen to address each of them. Moreover, reserve thinking method is demonstrated. We not only investigate the application of the business models, but also use the empirical data to examine its validity. Such feedback loop allows us to analyze the issue more deeply and gain more insights towards the subject. The weakness of this approach is the size of sample pool due to the limitation on time and resource, indicating that the scalability of the research findings is not certain. This issue can be solved by enlarging the same pool in the future work.

In the next section, the interview procedure is presented. The way of proposing the questions was reviewed and refined after each interview so that more precise meaning can be conveyed to the respondents without ambiguity. The questions were structured in two dimensions. In the first dimension, we would like to discover which new technology is more attractive to entrepreneurs, which can be viewed as reference information for the future startups in searching for the business opportunities. In the second dimension, we want to investigate the respondents' experiences in using the business model framework to solve real business issues. It can be either positive feedback, negative feedback or any possible improvement. The result can be used to examine the functionality of business model canvas and pinpoint the significance level of each section in the business models.

4.3 Interview Outline

I. Opening

Greeting to the interviewee. Brief introduction about myself and purpose of this interview. Followed by the general description of the thesis work.

II. Introduction of business model canvas

Brief introduction of different sections in the business model canvas and its usage. It helps the interviewee to quickly enter the optimal status for the following Q&A session.

III. Interview questions

In this session, 5 structured questions are given out.

1) As it is known to us, IoT, AI and blockchain are the critical driving forces in the upcoming technology revolution. In your opinion, which technology or combination is the most promising for entrepreneurs to plan for their own business?
2) Do you have previous experience in using the business model canvas in the real business environment? If so, would you please elaborate.
3) Do you think the business model canvas is helpful for you in planning for the business? Or is there any drawback? Would you please elaborate.
4) Additional comments or advice towards new business in the following technical revolution?
5) Based on your experience, would you please rank the importance of nine components of a business model in achieving the commercial success. The importance level increases with numbers on a scale of 1-9.

Score	Elements
	Key Partners
	Key Activities
	Key Resources
	Value Proposition
	Customer Relationships
	Channels
	Customer Segments
	Cost Structure
	Revenue Steams

IV. Ending

Express my thanks to the interviewees for the participation.

Chapter 5

5 Result Analysis

5.1 Evaluation of New Technologies

The respondents can be classified two types, entrepreneurs and technical professions. Both of their opinions are considered to be valuable for our subject since they can view the things from different aspects. Entrepreneurs can share us the pain and gain from their past business experiences that are very useful for entrepreneurship; whereas technical professions can give us deep insight towards the technical trend which is very helpful in finding the business opportunity. This also resembles the composition of the entrepreneurs in the real business environment. Some of them is technological expert such as Jun Lei or Mark Zuckerberg, whereas some of them is business genius with little technology background such as Steve Jobs or Jack Ma. Regardless of what type of entrepreneurs they belong to, they have all built up very successful companies in the ICT industry. It also implies that technology background is not a must but an advantage in entrepreneurship.

Due to the diverse background and knowledge base of the respondents, they hold different opinions towards the most promising technology used for entrepreneurship in the upcoming technical revolution. According to the statistics, blockchain was ranked as the first place, followed by AI and IoT, which is shown in the figure below,

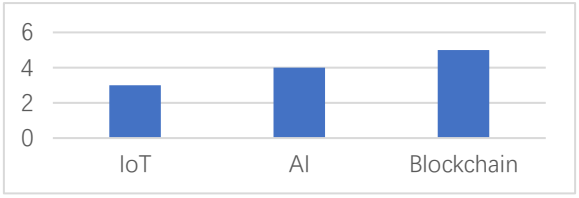

Figure 15. Potency level of new technologies

From the blockchain practitioner point of view, CP1 mentioned that blockchain would serve as the infrastructure for most sectors in the future and reform the current business logic to a large extent. The concept of blockchain is relatively easy but there is still a high technological threshold for the network speed and reliability. Even though blockchain is a very attractive theme drawing most attention and investment, the number of companies who own the real expertise is still a small proportion. It is worth noting that when looking for the blockchain partnership, the ability to distinguish the real and fake ones becomes very essential, requiring

high level of professional intuition and judgment. Nowadays, companies from almost all industries are doing research on the blockchain to prepare for the upcoming transformation. CP1 took his previous working experience in finance sector as an example. In China, Alipay, WeChat pay, and credit card are the most common payment methods used for transaction. Even though consumers do not realize there are third parties in this process, they indeed exist. Blockchain can remove all the third parties in the course of payment, lowering down the transaction costs and improving the transaction efficiency. An important challenge would be how to upload the physical assets onto the blockchain network so that all types of transaction can be supported by cryptocurrency. Even though some ideas have been proposed so far, the more detailed solution is still in the exploring stage.

CP2 mentioned how the traditional business are forced to become digitalized since they are facing new generation of customers and new business environment. His book business is a good example to demonstrate the issue. On one hand, young generations prefer the ways of online shopping instead of retailing stores; on the other hand, more and more books are totally electronic based instead of paper based. Under such circumstance, the traditional enterprises will have no room for survival if they refuse to change. He commented: "15 years ago, Dangdang was just a company with similar scale of my enterprise. Just because they shifted to the E-commerce promptly at the correct time, they became the best company in the China's book industry." In addition, CP2 emphasized the importance of AI and human-machine interaction. Some leading bookstores in China have introduced face perception technique and humanoid robot reception in their experience center. By scanning the face of the customers, the shopping recommendation can be provided to the customers based on their shopping history. It shows an efficient way to promote the new products by conveying the best matching value to the target audience. It also allows the company to make the optimum marketing strategy by having a deep understanding towards their customers.

There is also some negative opinion towards AI industry. CP5 deemed that AI is being overhyped to some extent. In some human-machine interaction case, the voice is even pre-recorded directly instead of coming from robots naturally. Moreover, many AI terms are just eye candies by renaming something old. There should be a significant difference between the concept of "learning" and "intelligence". We can make computers to learn much faster than human, but they can hardly create something new on their own. On the industry level, the development of AI is still in the initial stage, and most current investment is being focused on the voice communications, face perfection, driverless cars and electronic chips.

The importance of IoT had been addressed by several respondents as well. CP2 indicated the IoT based stock checking has been already deployed in some leading E-commerce companies

such as JD.com, saving the time and labor greatly compared to the traditional mode. CP4 stressed the potential in the telemedicine market such as the remote therapy or remote health monitoring, which has become one of their important company strategies in the following years. CP6 has discovered the business opportunity by combing the IoT with traditional agriculture to provide the digital solution for the farmers. Farmland information can be collected through drone and transferred to mobile devices, so that the farmers can monitor the farmland and take the corresponding reaction. Even though IoT is the 3rd place in the rank, its significance could never be underestimated since connectivity issue is the infrastructure for all the business in new economy. IoT can cooperate closely with other new technologies and the synergy effect is promising and tremendous. Most respondents believe the business opportunity is hidden behind such a compound pattern instead of a single element. As a result, to identify the application of these new technologies and their inner relationship is essential for entrepreneurs to pinpoint the business opportunity.

5.2 User Experiences with Business Models

After mapping the empirical data into the matrix, it is clear to see all the respondents have used the business model canvas method before in a direct or indirect way. It is interesting to see that new generations of entrepreneurs have more knowledge towards business model canvas. They like to follow a certain method to pinpoint the issue before starting the work. On the contrary, elder generation of entrepreneurs have limited knowledge towards the business model framework, but their intuition and rich experience made them conduct the very similar things in the business planning phase. This could laterally prove the validity of the business model canvas. CP2 felt that only part of the business model is necessary in his business transformation, omitting the blocks of key partner and customer relationship. It happens to fit the structure of lean canvas, which is a simplified version of nine blocks pattern. CP3 mentioned that to have a very formal business plan in hand is very helpful for him to build the trust with potential partners. He was benefited from it and received outer source support in the course of expanding his business. In addition, business model canvas helps the team to reinforce the cohesion and clarify that goal so that every team member can stand on the same platform. The entrepreneurs' experience and vision significantly determine how successful the business model can be built, which is the foundation for the following business operation.

Funding source is an important concern to most entrepreneurs. As CP6 stated, business model canvas helped them to analyze this issue in building the key partner block. It is worth mentioning that getting the fund from VC in China as an anonymous startup is extreme hard due to its unique business environment. Jun Lei, the CEO of Xiaomi, and Jack Ma, the CEO of Alibaba, have announced in many pubic occasions that they only invest friends and friends of

friends generally. Under such condition, a reliable funding source plays a vital role in the business model to make the whole system work. On the bright side, there are many new forms of funding source coming out during these years, such as ICO, crowdfunding or P2P lending. As we can see, many startups received their angel investment from kickstarter.com in the recent years, making the initial stage much smoother.

CP3 indicated that timing issue is another important element in making the business model. A different timing may lead to a completely different result. In order to achieve the commercial success, startup has to choose the correct timing to enter the market. In the ICT industry, market share becomes stable after the fierce competition between the first movers, leaving slim chance for the new comers. As we can see from the case of Uber, they adopted subsidy strategy to beat out the competitors in the beginning. However, all the subsidy was cancelled after their domination because no one can replace them easily any more. In addition, CP3 also commented that a good judgement is demanded since the company may face the acquisition request from larger companies. The CEO's judgement is very crucial here since it determines the company's destiny. Last but not the least, the content of business model should be dynamic instead of static. Entrepreneurs need to update it from time to time to make it valid constantly for the changing external environment.

Respondent	Main business	Experience with building business model	Feedback
Contact Person 1	Cryptocurrency mining	Have used similar method such as "Mind Map" to figure out how to conduct cryptocurrency mining from blank.	It makes my mind clearer and know where I should start. Sometimes writing down the things from mind is more systematic and comprehensive, and it is easier to find the error.
Contact Person 2	Chain-book store and digitalization	Have listed problem, solution and cost structure to analyze the issue in the book store's digitalization process. Don't know the business model canvas before but we were actually using a lite version of it. It figured what problems we need to solve and what I want my business to be.	It makes the transition phase a lot easier, especially when you are running a traditional enterprise and need a transformation. It helps you to identify whether the transformation is correct or not.
Contact Person 3	Website and international trade	Haven't heard about business model canvas but actually have used part of the model to pinpoint the resource, partners and revenue stream before building the website, just don't know the official term.	Have everything on paper makes you more confident of what you are doing and make it more professional and persuasive for your potential partners. Part of my business failure resulted from the lack of consideration in building the model.
Contact Person 4	Electronic therapy device design and manufacture	Have used value proposition canvas when planning for new products. It is a good method for us to pre-evaluate the issue and make the decision.	It allows me to stand in the customers shoes to think the problem, so that our new products can make our customers happy. It helps us to enhance the customer stickiness and customer loyalty. It brings me more income than my expectation.

Contact Person 5	AI engineer	Have used it during an entrepreneurship event. We were asked to form groups to make the business model canvas and pitch it to VC.	It gives the engineers like me the methodology about how to start my own business someday. It is critical for startups to attract the investment from VC.
Contact Person 6	Digital agriculture: collect data through drone and connect with mobile device	We used business model canvas as a guideline for our startups. We want to pinpoint our funding source through key partner and deliver the correct value to the correct customers.	A good business model is a good start of your business. Otherwise it will induce waste of resource or low efficient in cooperation. It helps me to identify my short-term and long-term goal in my business. I also need to modify it from time to time to meet the changes.

Table 2. Matrix of business model experience

5.3 Elements in Business Models

According to the statistics from respondents, it can conclude that value proposition and channel are the most important parts for entrepreneurs in making the business models. It is worth noting that the entrepreneurs with more traditional business background gave higher rank on the channel part. In the traditional sector, channel can be viewed as an important asset in the business operation. The company owning the premium distribution channel can be endowed with overwhelming advantages in the market competition, and such mindset will be inherited more or less in the following business activities. Unlike the traditional sector, the channel in the new economy is usually transparent. Just like in E-commerce or digital industry, internet is the medium for all the companies to reach their customers. Key resources, customer segmentation and key activities are ranked as the second significance level. They all determine how well the value can be conveyed to the customers. For the key partners and customer relationship, respondents hold very different opinions due to their respective working experience and environment. Respondents with traditional business background deem key partner is important since it often involves exclusive supply chain channel; whereas entrepreneurs with new economy background think it is not necessary because not all startups have the key partners in the beginning. The same thing happens to the customer relationship section. If we look at the Uber case again, they spent very little effort and resource in handling the customer relationship. In many Uber's service area, it is even hard to find a direct way to contact their local agency from the official channel. By removing these redundant blocks from business model canvas, lean canvas is generated to facilitate the users who don't want to take them into account. Cost structure and revenue streams stay at the bottom level on the chart. According to the answers from CP3, cost structure is not always the thing you can plan beforehand, especially for inexperienced entrepreneurs. Before he started his internet company, he thought the main expenditure would be the website maintenance. However, in fact, the salary for his 50 employees was the main burden for him after everything was on the right track, followed by the fees for advertisement, business cooperation and incentive mechanism. On the

contrary, maintenance only took a very small proportion, which is quite different from his assumption. As a result, running a website is a lot more expensive than he could ever imagine.

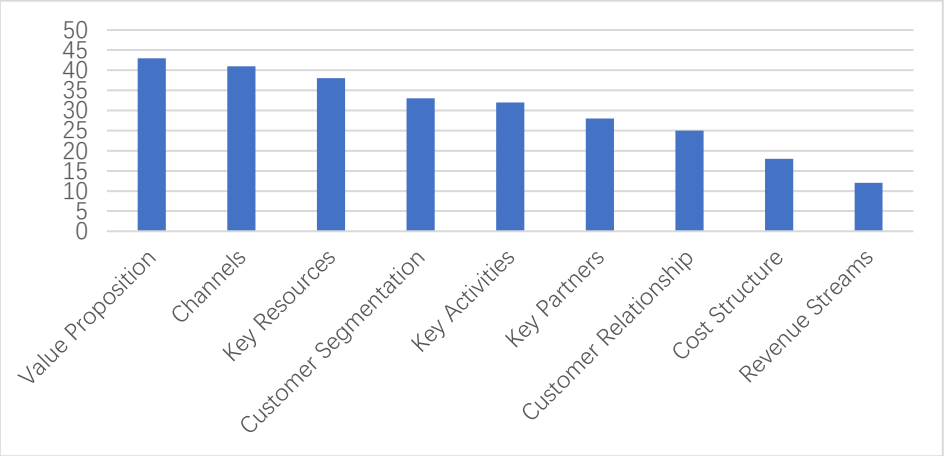

Figure 16. Significance level of elements in building business models

Fig. 17 shows the regression analysis for the elements in value proposition canvas based on lean square method. It is safe to conclude that the importance of value proposition achieves a positive relation with the importance of customer segments. In another word, when the one of them is considered to be more important in building the business model, the other one will follow the same trend. In this way, the matching status in value proposition canvas is examined reversely from this interview. Therefore, value proposition and customer segments should be considered as a whole when building the business models instead of modelling them separately. It could help the entrepreneurs to screen the business ideas and reduce the risk of failure. The team can also get aligned by leveraging the experience and skills from different team members in making the business models.

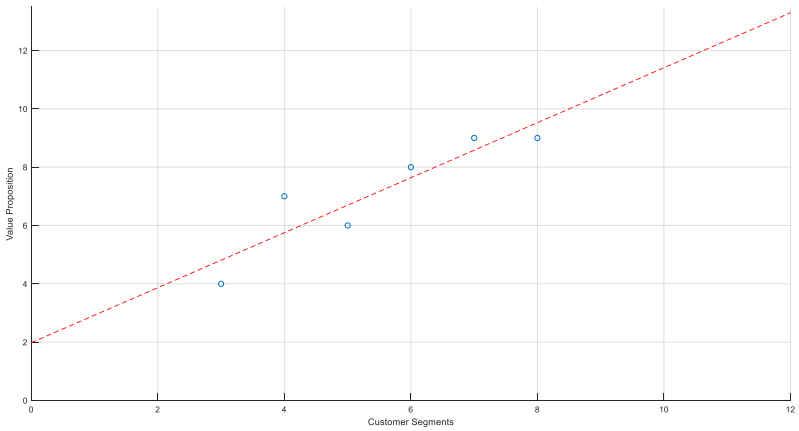

Figure 17. Regression analysis in value proposition canvas

Chapter 6

6. Conclusion and Future work

Business model based on IoT, AI and blockchain are successfully built and analyzed. It provides a thinking method for the entrepreneurs about how to utilize these new technologies in planning for new business in the upcoming technological revolution. By conducting the interviews and processing the empirical data, the following issues are pinpointed:

- Identify the potency level of the new technologies in generating the business opportunities.
- Examine user experiences of business model canvas in the real business environment.
- Demonstrate the significance of different elements in making the ICT business models.
- Verify the validity of value proposition canvas though regression analysis.

However, the blockchain-based supply chain is a topic that deserves future discussion. So far, the transaction on the blockchain are mainly used for digital products or cryptocurrency exchange. In order to enable physical asset transaction through the blockchain, a solution must be made to connect the online and offline resources, which is the core concept of blockchain-based supply chain system. Even though there are some hypothesis already, the final solution has not been discovered yet. Understanding such pattern could guide the entrepreneurs better in making the business model since blockchain will become the infrastructure for almost all the types of transactions in the future. Moreover, due to the limitation on time and resource, the sample pool is relatively small. Larger sample pool is preferred in the future work to achieve more accurate and comprehensive analysis.

References

ABI research. (2018). Small Cells: Outdoor Pico and Micro Markets: 3G/4G Solutions for Metro and Rural Deployments.

Alexander Osterwalder, Yves Pigneur. (2005). Clarifying Business Models: Origins, Present, and Future of the Concept.

Alexander Osterwalder, Yves Pigneur. (2010). Business Model Generation.

Alexander Osterwalder, Yves Pigneur. (2014). Value Proposition Design.

Ashton, K. (2009). "That 'Internet of Things' Thing". Retrieved 9 May 2017.

B. Mathieu. (2016). Towards the Usage of CCN for IoT Networks.

César Souza. (2010). Kernel Functions for Machine Learning Applications.

Da Silva, I.N., Hernane Spatti, D., Andrade Flauzino, R., Liboni, L.H.B., dos Reis Alves, S.F., (2017). Artificial Neural Networks.

Deloitte. (2017). AI and you Perceptions of Artificial Intelligence from the EMEA financial services industry.

Demil, Benoît and Lecocq, Xavier. (2010). Business Model Evolution: In Search of Dynamic Consistency, Long Range Planning.

EK Kogias, P Jovanovic, N Gailly, I Khoffi. (2016). Enhancing Bitcoin Security and Performance with Strong Consistency via Collective Signing.

F. Rusek, D. Persson, B. K. Lau, E. G. Larsson, T. L. Marzetta, O. Edfors, and F. Tufvesson, (2012). Scaling up MIMO: Opportunities and Challenges with Very Large Arrays.

Gartner. (2014). 4.9 Billion Connected" Things" Will Be in Use in 2015.

L. Atzori, A. Iera, and G. Morabito. (2010) “The Internet of Things: A survey,” Computer Network, vol. 54, no. 15, pp. 2787–2805, Oct. 2010.

Legg, Shane; Hutter, Marcus. (2007). A Collection of Definitions of Intelligence.

Liyun Li. (2017). Artificial Intelligence in Autonomous Driving.

I Eyal, AE Gencer, EG Sirer, R Van. (2016). Bitcoin-NG: A Scalable Blockchain Protocol

InnoValeur. (2017). The Data Science Puzzle Explained.

Karl T. Ulrich, Steven D. Eppinger. (2012). Product Design and Development.

Matthew B. Miles, A. Michael Huberman. (2013). Qualitative Data Analysis.

Melanie Swan. (2015). Blockchain-blueprint for A New Economy.

Michael Nofer, Peter Gomber, Oliver Hinz, Dirk Schiereck. (2017). Blockchain.

Morris, Michael, Schindehutte, Minet, Allen, Jeffrey. (2005). The entrepreneur's business model: toward a unified perspective.

Narayanan, Arvind; Bonneau, Joseph; Felten, Edward; Miller, Andrew; Goldfeder, Steven. (2016). Bitcoin and cryptocurrency technologies: a comprehensive introduction.

Nick Wingfield. (2016). "Amazon Moves to Cut Checkout Line, promoting a Grab-and-Go Experience.

Niladri Syama, Arun Sharmab. (2018) Waiting for a sales renaissance in the fourth industrial revolution: Machine learning and artificial intelligence in sales research and practice.

Onetti, Alberto; Zucchella, Antonella; Jones, Marian V and McDougall-Covin, Patricia P. (2012). Internationalization, innovation and entrepreneurship: business models for new technology-based firms.

PWC. (2017). Leveraging the upcoming disruptions from AI and IoT.

Reshmi.S, Kannan Balakrishnan. (2018) Empowering chatbots with business intelligence by big data integration.

Schmidhuber, J. (2015). "Deep Learning in Neural Networks: An Overview".

Shafer, Scott M., Smith, H. Jeff and Linder, Jane C. (2005). The power of business models.

Shivangi Vashi, Jyotsnamayee Ram, Janit Modi. (2017). Internet of Things (IoT) A Vision, Architectural Elements, and Security Issues.

Susan Athey. (2018). The impact of machine learning on Economics.

Tabassum Ara, Pritam Gajkumar Shah and M. Prabhakar. (2016). Internet of Things Architecture and Applications: A Survey.

Trogdor. (2017). EOS vs. Ethereum for Dummies.

Turker Yilmaz, Gokce Gokkoca and Ozgur B. Akan. (2016). Millimeter wave communication for 5G IoT Applications.

Y. Series. (2001). Global Information Infrastructure, Internet Protocol Aspects and Next-Generation Networks.

Yuu Sakaguchi. (2017). How AlphaGo Works.

Zibin Zheng, Shaoan Xie, Hongning Dai, Xiangping Chen, and Huaimin Wang. (2017). An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends.

Zott, C., Amit, R., (2007). Business Model Design and the Performance of Entrepreneurial Firms.

Zott, C., Amit, R., & Massa, L. (2011). The business model: recent developments and future research. Journal of management.