

A Strategic Overview of Blockchain Applications in the Healthcare

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Abstract—This thesis focuses on the firm in blockchain applications in healthcare industry and includes a review of the research of blockchain applications in healthcare and market dynamics. The study analysis by applying an Innovation Intensive Service (IIS) model at firm-level. By interviewing and administering a questionnaire to experts in this field, we can elucidate the strategic position and the future development trend of the industry, and find out the key success factors (KSF) in internal value activities and externalities for the firms in this industry.

Study result shows that the present position of the blockchain business model in healthcare industry is “Product Innovation/ Generic Service”. In the next 5 years, it will shift to the position of “Structural Innovation/ Selective Service”. It is necessary to strengthen those KSF of these factors to develop this industry successfully.

Keywords—Blockchain Applications in Healthcare, Innovation Intensive Services, IIS, Value activities, Externalities.

I. INTRODUCTION

In recent years, population aging has become the most focused global issue, according to the report from UN, it is estimated that elderly population will increase to 2 billion by 2050, especially exploded in the age over 80. Basic on the World Population Outlook published by UNFPA, the gold cross of population aging will happen before 2020, that is, the percentage of the elderly population is going to exceed that of child population (under 5) after 2020 and the gap is getting bigger year by year. On the other hand, current health care system exists some problems like high cost, insufficient coverage, lack of medical source standard, health insurance deficit and the shortage of human resource, these weak point cause not only medical quality unable to improve but also a higher rate of medical negligence.

Due to the integration of medical service and information technology in recent years, revolutionary changes have happened in health care services. In order to deal with global aging population, the demand for health care is also increasing. Governments try to reach the goal of health care that not only decreasing medical costs but also rising quality of medical health care simultaneously. In addition, artificial intelligence and information industry are improving, many health care institutions consider to adopt Health Information Technology (HIT) in order to provide health care with more cost-effective and efficient. Through continuing information integration and

exchange, medical decisions are getting more efficient, besides, healthcare information platform is getting popular in the future and replace the existing healthcare business model. However, the platform is still operating by the third party because of limits on business, government regulations and technical. On the other hand, confidentially, privacy and integrity must be noticed in medical information transmission[1,2], therefore, how to ensure data reliable and not abusive is the most important term in developing medical information and application platform.

A. Introduction of Blockchain Application in Healthcare

The 6 applications of blockchain, include finance, government, insurance, medical and internet, the thesis focuses on medical healthcare application of blockchain[3].

B. Industry Chain of Blockchain Application in Healthcare Industry

The industry chain of blockchain application in healthcare is mainly divided into three parts: infrastructure and basic agreement provider, intermediary application surface provider, and downstream applications[4]. The manufactures of blockchain application in healthcare are mainly located at the intermediary layer of the industry chain, including technical service providing, software development environment, blockchain platform, application interface, intelligence contract, and so on. There are also many manufacturers cross to downstream industry applications by cooperation, so the operation models of this blockchain can be highly variable. The following table shows the industry chains of blockchain application in healthcare.

II. LITERATURE REVIEW

A. Blockchain Application in Healthcare-Related Literature

Medical records and private information of patients need to keep confidential, consider of information security, it is impossible to a centralized database. However, blockchain technology provides an available proposal, this solution can totally transparent but protect privacy during information sharing. For medical service, the most significant advantage is that blockchain technology can handle complex permission of multiple private keys at the same time, and must be authorized by every proprietor at the same time to be able to read or revise data. The combination of blockchain and medical service is a new experiment. As enterprises and medical institutions found the impact of blockchain technology on the financial sector,

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medical institutions will gradually promote and implement the blockchain technology in the medical field.

B. Analysis of Innovation Intensive Service (IIS) Models

Applying the blockchain technology to medical service industry make it into the scope of the Innovation Intensive Service(IIS) industry research model. By integrating the research of scholars, it emphasized on the connotation and theoretical basis of the Innovation Intensive Service (IIS). The IIS model proposed by Kellogg and Nie[5] makes the following distinctions: the degree of customization from low to high is "Generic", "Restricted", "Selective" and "Unique". Unique Service emphasizes that all service is customized while Generic Service provides modular and standardized service. Restricted Service and Selective Service are which position between the two services mentioned before.

The literature on service innovation can be traced back to the 1970s, and has increased rapidly in the past decade. For example "Kline and Rosenberg[6] Customer Communication Model", "Miles[7] Service Industry Characteristics", "Quinn[8] Service Management", "Gallouj[9] six service innovation models" and so on. This study uses Hauknes[10] degree of innovation classification to divide innovation into five projects: (1) Product Innovation (2) Process Innovation (3) Organizational Innovation (4) Structural Innovation (5) Market Innovation. Base on the strategy analysis method IIS matrix, this thesis research

according to the four services in the horizontal axis of the matrix and the five sources of innovation in the vertical axis of the matrix.

III. RESEARCH METHOD AND DATA SOURCES

A. Research Method and Participants

This paper is based on "Innovation Intensive Service (IIS)" which was published by Joseph Z. Shyu[11,12] in 2005 and analyzing data by both qualitative and quantitative methods. Focus on "blockchain applications in healthcare"[13] and target participants in blockchain application in healthcare institution from intermediary to downstream of industry chain. First of all, the model IIS summarizes model structures established by other scholars' theory[14,15,16,17], and emphasizes the concept in a qualitative way. Second, using the quantitative methods such as questionnaire statistics and factor analysis to construct details of the theoretical model, including key success factors of the enterprise internal service activities and external resource demand factors. Finally, appropriate factors are selected through expert questionnaires to determine the key development factors for industry developing. Then analyze the direction of corporate strategy from the perspective of intermediary manufacture in blockchain application in healthcare.

B. Data Source

TABLE I. INFORMATION OF THE QUESTIONNAIRES - ACCORDING TO THE SENIORITY

	5 years	6-10 years	11-15 years	16-20 years	Over 20 years	Total
Industry	14	5	3	4	1	27(82%)
Academia and Research Institute	4	0	2	0	0	6(18%)
Total	18(55%)	5(15%)	5(15%)	4(12%)	1(3%)	33(100%)

The questionnaire in this research is designed to investigate the innovation resources that needed by enterprise level. The five-point Likert[18] metric is used to divide the resources into [very low, low, normal, high, and extremely high] corresponding to the scores [1,2,3,4,5] for evaluation, 50

questionnaires were distributed and 33 valid questionnaires were collected, with a recovery rate of 66.00%, as shown in the TABLE I and TABLE II. The questionnaires are filled in by the experts from industry, research units, and academics. Their seniority and job categories are organized as follows:

TABLE II. INFORMATION OF THE QUESTIONNAIRES - ACCORDING TO THE WORK CATEGORY

	Medical insurance	Marketing and sales	Production and manufacturing	Purchase	Finance	Quality assurance	R&D	Management	Other	Total
Industry	2	4	2	1	1	1	9	6	1	27(82%)
Academia and Research Institute	2	0	0	0	0	0	2	2	0	6(18%)
Total	4(12%)	4(12%)	2(6%)	1(3%)	1(3%)	1(3%)	11(33%)	8(24%)	1(3%)	33(100%)

IV. RESULT AND STRATEGY SUGGESTION

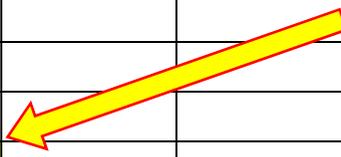
This thesis uses the Innovation Intensive Service (IIS) constructed by Joseph Z. Shyu to conduct a strategic analysis of blockchain application in healthcare. Through expert interviews and questionnaires, we evaluate and comprehensive theoretical analysis, then sort out results as follow:

A. Matrix Positioning and Target

From the expert questionnaire: currency business model of vendors of blockchain application in healthcare focuses on Process Innovation (P2) / General Service (G); And the future (5-10 years) strategy tries to move toward Structural Innovation (S) / Unique Service (U) as shown in TABLE III. It means that the development will in the direction of increasing customization in the future.

TABLE III. BLOCKCHAIN APPLICATION IN HEALTHCARE VENDORS' IIS MATRIX POSITIONING

	Unique Service(U)	Selective Service(S)	Restricted Service(R)	Generic Service(G)
Product Innovation(P1)				
Process Innovation(P2)				Current strategic positioning
Organizational Innovation(O)				
Structural Innovation(S)				
Market Innovation(M)	Future strategic positioning			



From the IIS model: integrate the results from enterprise internal and environmental external resources, the future strategy from experts is Structural Innovation (S) / Unique Service (U). In fact, innovation difference of overall result is high, therefore the strategy is difficult to achieve. It will be available through find out insufficient key success factors and

strengthen by investing enough resources, that is, this strategy positioning is basically correctable. The revised strategy of blockchain application in healthcare is positioned in Organizational Innovation (O) / Selective Service (S) which the difference is the smallest of all, as shown in TABLE IV.

TABLE IV. INNOVATION INTENSIVE SERVICE(IIS) ANALYSIS (OVERALL)

	Unique Service(U)	Selective Service(S)	Restricted Service(R)	Generic Service(G)
Product Innovation(P1)	S1=1.752	S2=1.752	S3=1.775	S4=1.783
Process Innovation(P2)	S5=1.753	S6=1.876	S7=1.704	S8=1.704
Organizational Innovation(O)	S9=1.813	S10=1.683	S11=1.747	S12=1.747
Structural Innovation(S)	S13=1.792	S14=1.751	S15=1.739	S16=1.739
Market Innovation(M)	S17=1.718	S18=1.718	S19=1.773	S20=1.773
$\mu S = 1.756, \sigma S = 0.042, \mu S - \sigma S = 1.714$				
strategy selection point value selection criterion: $\mu S - \sigma S \cong 1.714$				

B. Strategy Suggestions

The value of internal service emphasizes market development capability and product access management. To successfully implement the blockchain application in healthcare service industry, grasping trends of medical market and policy is an essential factor. Also, requirement and supplement of medical data from the client can help design multiple customized solution for the client to select a suitable solution. On the other hand, after-sales service and supportability of the company are also very important, not only provide better user experience but also offer appropriate legal and technical advice for evolving blockchain technology. The knowledge-based promotion of blockchain medical services can also accumulate potential customers at the same time.

In terms of external resources, blockchain technology is gradually mature in recent years, and the strongest superiority is that modern cryptography can ensure interests and privacy of data owners and provide multiparty data exchange at the same time, the enterprise can also enhance social brand image through this superiority. However, medical data management will become an important service balancing mechanism in the future. It is necessary to establish a data sharing system based on ethical norms and medical solutions by regulators, medical personnel and enterprise. Therefore, collection, storage and sharing of data which are involved in privacy protection and data security will

be one of the core value of the blockchain application in healthcare service industry.

V. CONCLUSIONS

In summary, the blockchain application in healthcare industry should move toward Organization Innovation (O) / Selective Service (S), even though this positioning is slightly different from the positioning Structure Innovation (S) / Unique Service (U) which provided by experts. The difference between Selective Service and Unique Service is that some parts of service in Selective Service are customized and optional some few parts are standardized. In Unique Service, most parts of service are optional, customers have negotiation space and right to choose the type of service. The difference between Process Innovation and Organizational Innovation is: Process Innovation emphasize the process design and the executive ability of innovation in integrating selling process: Organizational Innovation emphasis on database integration, information analysis and processing, and mutual cooperation which derived innovation applications from organization's internal information flow and authority control.

Blockchain technology is the best solution for healthcare data storage and sharing because of its decentralization, unable to tamper, low cost and also ability to manage complex permissions. However, amounts of applications of blockchain

healthcare are still in experimental and the number of experts of this professional field is limited. On the other hand, it is still a small sample study, so it may not be comprehensive in data collection, research depth and expert opinions.

The following points should be noted for the development of the blockchain application in healthcare industry: First, security and privacy protection system should be more complete in blockchain application in healthcare industry. Second, establish application criteria of blockchain to strengthen supervision and prevent risk. Third, rationality and privacy protection of data applications should keep in reasonable balance in blockchain application in healthcare industry, and also establish a data sharing system based on ethical norms and medical solutions. Finally, using modern cryptography reasonable can realize the value of multiparty data exchange and collaborative computing.

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