

IMPROVING SERVICE INNOVATION PERFORMANCE THROUGH THE BIG DATA MANAGEMENT CLOSED LOOP COMPETENCE IN CHINA MOBILE

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The paper attempts to identify the impacts of five aspects of big data management competence in closed loop datafication system on service innovation performance and business performance in telecom industry in China. The research questions have been developed by integrating various theories (i.e. knowledge management theory, evolutionary perspective and resource-based theory) with the model of a telecom operator's big data management competence in its closed loop datafication system for service innovation in China. The industry giant China Mobile is featured in the case study to demonstrate the relationships in big data environment. The findings strongly suggest that several propositions serve to support the notion of using of five aspects of management closed loop competence to promote service innovation. Specifically, the integrated management closed loop competence poses positive impact on service innovation performance. In addition, four

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other management closed loop competences would lead to service innovation performance and subsequent business performance.

Keywords: Big data management; Service innovation performance; Business performance; Management closed loop competence; China telecom industry.

1. Introduction

One of the most challenging issues for service companies is to stay ahead of the business rivals in fulfilling the ever-changing customer demands. The concept of financial big data has emerged recently as the service companies deploy specialized technologies for data integration and analysis of large and complex datasets (Chen *et al.*, 2012). The emerging idea of datafication, which turns various aspects of our modern life into computerised data and associated new forms of business and social value (Cukier and Mayer-Schoenberger, 2013; Hayashi, 2014), enables service managers to embrace customer specifications and sustain successful service innovations (LaValle *et al.*, 2011). For instance, a leading Chinese messenger app WeChat improves and extends their service offerings by actively utilizing various data sources and allowing its users to take active roles in the service co-production process. As service companies find it important in predicting individual customers and fulfilling their heterogeneous needs, converting the big data values into service innovation performance is increasingly highlighted in new service management. Big data management competence, which is defined in our paper as the ability to access, diagnose, and integrate the necessary information gathered through various data sources and in various forms knowledge in order to identify and satisfy the existing and emerging needs of target markets, is of increasingly critical importance.

Believing the big data-driven world is an inspiring and reliable place for service innovation is based on the premise that the useful insights can be extracted from the heterogeneous sources of data in a new way (Weinberg and Davis, 2013). While there is no denying that the potential of big data is tremendous, we nonetheless wish to highlight the challenges arising from the big data. For instance, Lavelle *et al.* (2011) argued that companies which aim to improve their levels of big data management competence must overcome several key adoption barriers such as lack of understanding of how to move IT analytics into core business and operational functions, lack of management commitments due to competing priorities, lack of skills internally in line of business and lack of ability to gather data. Chen *et al.* (2012) highlighted the challenges associated with the overwhelming amount of web-based, mobile, and sensor generated data arriving at big scale and they proposed how each can be managed by developing new big data management competences. Davenport *et al.* (2012) emphasized that the critical challenges ahead in big data management are the difficulties in combining product development and data science into big data analytics, as well as developing the IT architecture into an information ecosystem, which is a network of internal and external services for information sharing, optimal decision making and generating new insights for business. Given all the challenges presented above, many organizations tend to be

under enormous pressure to engage in learning to develop big data competence in big data era to resolve the service innovation issues.

Based on the above discussion, there is an increasing consensus that the service management impact that underlies the objective of big data management may be based on the big data management competence. However, significant challenges of achieving big data success have been mounted as there is a rarity of research in competence in big data management and service innovation performance. This paper attempts to resolve the issues by exploring how big data management competence in a closed loop (controlled) datafication system, which is a data-driven, integrated management system that aims to facilitate a controlled base of both targeted service innovation and service development feedback from this management system, can improve service innovation performance and business performance.

In the following section, we illustrate our framework, which has been formulated by integrating various theories (i.e. knowledge management theory, evolutionary perspective and resource-based theory) with the model of a telecom operator's big data management competence for service innovation in China. The industry giant China Mobile is featured in the case study to demonstrate the relationships of big data management competence (in terms of various management closed loop competences) and service innovation in big data environment. In the Research Method section, we explain why China Mobile has been chosen as our case study and how the case data have been gathered and analyzed. In the Case Analysis section, we will describe how China Mobile develops big data management competences in its closed loop (i.e. controlled) datafication system in order to achieve service innovation performance and business performance. Further analysis is conducted with a display of several propositions. This paper ends with a Conclusion in the last section.

2. Background and Research Framework

As summarized in Perunovic' *et al.* (2012), competence can be viewed as a bundle of skills, knowledge, know-how, systems, and technologies that enables an organization to better utilize and mobilize its assets in order to make significant contributions to its own benefits and its customer benefits (Amit and Schoemaker, 1993; Hamel and Prahalad, 1994; Peppard and Ward, 2004). Prahalad and Hamel (1990) stressed the importance of harmonizing streams of technology, organization of work and the delivery of value. As the types of data services are increasing and the content and applications are changing rapidly, it requires service companies to better decide where in the big data value chain they are to operate, and how to develop necessary competence in order to better leverage the big data for value creation (van der Lande, 2013).

From the resource based (RBV) theory, which stresses the importance on how the firm resources can be translated into new products or services and the subsequent competences (Zahra and Geroge, 2002), the big data management competence can be developed when the companies clearly identify the critical business processes that are impacted by big data and that enable the planned new data services, and apply the

appropriate big data assets (i.e. technological assets, human assets, financial assets, etc.) skillfully for new service innovations. In this paper, five key closed loop (controlled) management processes for big data management, including integrated management, user management, operations management, product management and marketing management, are identified through our case study to help companies plan, organize and direct the technical, operations and marketing resources and activities for better delivery of business values.

From the resource based theory, service innovation performance can be viewed as how well the competence can be utilized to respond to customer requirements in an innovative and fashionable manner. For instance, according to Oke (2007), a better performed company in service innovation is typically one of the first to market new product and services, more effective than competitors at taking and improving existing ideas, better than competitors at developing products and services to meet customer requirements, and perceived by customers to be more innovative and at the leading edge of innovation.

From the evolutionary perspective, which is discussed in Hodgson (1999) and Murmann *et al.* (2003), the business survival of companies hinges on the fitness for the particular selection environment (Aldrich, 1979). Since the challenges associated with new technology-driven business models and new competitors are enormous in China over the last few years, the selection process in various service markets is becomingly highly competitive (Levinthal, 1992). Therefore, the service companies operating in a previously non-competitive or less competitive service markets in China must develop their competences based on the knowledge accumulation and transfer to stay competitive (Nelson and Winter, 1982, Zander and Kogut, 1995). The big data management competence can be perceived as “internal routines” because many companies that aim for service innovation plan to use big data analytics for internal process improvement before providing service knowledge and technology for new data services externally.

The big data management competence can be well understood in the old story of blind men and an elephant depicted in Gao (2011), where service companies, portrayed metaphorically as old men, needed to leverage big data to better understand the entire picture of their service customers. Poor big data management competence can be viewed as inability to leverage big data for critical business decisions. Such incompetence typically results in deteriorating business relationship and poor internal control.

From the evolutionary perspective, business performance, which is perceived as the financial outcome of service innovations, can be manifested by market share, growth, profitability, cost, and etc., is significant to the survival of the service companies. The service companies, which are highly constrained by limited resources and big data competence in various aspects, including integrated management, user management, operations management, product management and marketing management, typically have lesser chance of business survival in the competitive service environments.

From the knowledge based (KBV) perspective, which emphasizes the role of knowledge as a critical resource and a source of competitive advantage (Kogut and Zander, 1992), the development of big data management competence can be considered a

creative destruction in which knowledge can be obtained from external sources including customers and competitors via big data service platform or it can be created within the service companies via data systems. The big data management competences of service companies are better used by the help of accumulated knowledge to fulfill new market needs and improve service innovation performance in various levels (Prabhu *et al.*, 2005).

By integrating various theories (i.e. knowledge management theory, evolutionary perspective and resource-based theory) with the model of a telecom operator's big data management competence in closed loop (controlled) datafication system for service innovation in China, we have developed the following research questions: how big data management competence in affects service innovation performance? How service innovation performance affects business performance? Our theoretical framework, which is presented in Fig. 1, will be justified in the following sections.

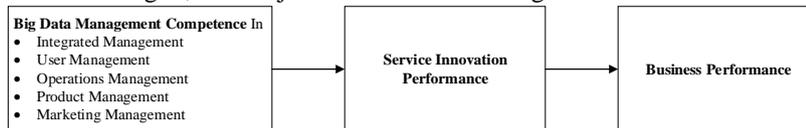


Fig. 1. Theoretical framework of big data management competence and the subsequent outcomes in service innovation and business performance

3. Big Data Management Competence and Service Innovation in Telecom in China

In this section, we will describe the service market in Telecom industry in China in the era of big data, and highlight the importance of big data management competence and service innovation performance in Chinese telecom industry.

According to a white paper conducted by CCIDC Consulting (CCIDC, 2013), the competitive landscape in the telecommunications industry has significantly changed over the past few years as a multitude of internet service providers, such as Google, Tencent, Alibaba and Qihoo 360, launched a range of application services via third party telecom operators to compete with traditional telecommunication big giants such as China Mobile, China Telecom and China Unicom. Following the decline of sales growth in existing voice services in China over the past few years, the above three traditional giants are needed to respond quickly in order to sustain the profit growths in the mobile data services and consolidate their existing market leadership positions in telecom industry in China. While the three giants attempt to innovate on their mobile internet and data applications services by utilizing their own marketing strengths in their vast telecom service network in more than 30 provinces, they face several big challenges, such as handling the co-opetition with internet service providers and the dynamic changes in the telecom industrial value chain, managing growing amount of data in various formats, and optimizing their internal operational capacities for more innovative and personalized data services and transforming their business models effectively.

Developing big data management competence provides Chinese telecom operators with the idea inspiration, market knowledge, and decision making tools to overcome the challenges that they encounter. As big data management competence is integral to the success of Chinese telecom operators in value-added data service markets in China, the three telecom giants have formulated different big data development strategies to improve their big data management competence. According to CCIDC Consulting (CCIDC, 2013), China Unicom attempts to improve its big data management competence by leveraging the Hadoop big data and mobile communications technology to enable service innovations within organization and system since the end of 2012. China Unicom further accelerated the 10 billion investment plan in Chongqing for data services and associated business innovations. Meanwhile, according to our interview with China Mobile, China Mobile has put much effort on identifying and cooperating with external partners for the service markets in mobile reading, mobile games, animation, music, and other mobile application services in China. Through the recent development of a competent closed loop datafication management (which will be discussed in details next section), China Mobile has successfully transformed itself from the “mobile communications expert” to “mobile information expert”. Its superior service innovation performance can be reflected by its high level of effectiveness of the internal operations, better competitive advantage in the telecom service market in China, and the effective data service development process.

According to CCIDC Consulting (CCIDC, 2013), China Telecom has long been aware of the mobile Internet era, and took strategic initiatives to handle with the challenges of the mobile Internet era since 2005. In the recent “smart city” development strategy and the roadmap for “internet of things” and big data management, China Telecom positioned itself to be a dominant integrated platform provider and content application service partner.

Overall, the development of big data management competence is an integral part of long term business strategy for the three Chinese telecom giants. By maximizing the big data potentials through the advances in technology, the three giants can stimulate and achieve significant service innovations in the mobile internet and applications service market in China.

4. Research Method

In responding to our research questions on how competence in various aspects of big data management competence affects service innovation performance and business performance, we will present a case study in Chinese telecom industry next section. The case study method is appropriate because in an uncovering area for research and theory development, such as big data management, the case study is an appropriate research method for systematic development of a new model and identification of the relationships among key variables (Voss *et al.*, 2002; Perunovic *et al.* 2012).

China Mobile Group is selected in our case study because China Mobile is the world’s largest mobile network provider and has made significant investment in big data

development for its world's largest mobile customer base. In multiple site visits, more than 15 senior managers and middle managers in various departments, including product development, sales marketing, IT and operations are interviewed. We have asked them with general questions, which are shown in Appendix 1 and 2, and follow-up questions regarding big data management competence and service innovation performance. Additional information has been gathered by reviewing internal company material and consulting reports from the Chinese telecom industry. In order to better comprehend the meaning of big data management competence in its closed loop datafication system and identify its impact on service innovation performance, we also interviewed with its IT vendor and internet service application partner. The whole case interview process lasted for three months in 2015.

5. Case Analysis

In responding to our research questions on how competence in various aspects of big data management competence affects service innovation performance and business performance, we will present a case study in Chinese telecom industry next section. The

In developing the big data management competence, China Mobile, as being the world's largest telecom operator, set up a closed loop datafication management system model, which is shown in Fig. 2, to maximize the value of big data and improve the performance in telecom service market. According to China Mobile, its closed loop datafication management system is a data-driven, integrated management system which aims to facilitate a controlled base of both targeted service innovation and service development feedback from this management system. Developing an effective closed loop datafication management system would suggest that all the service development activities such as integrated management, user management, product management, operations management and marketing management are led not just by big data analysts and a small product development team, but rather incorporates management feedback from the sustained operations from across various functional units within the China Mobile Group for new service development.

Under this model, big data analytical power, which is perceived by China Mobile as a critical "integrative" force in big data management, will be used to develop big data management competences in various controlled management processes or "close loops", including integrated management closed loop, user management closed loop, operations management closed loop, product management closed loop and marketing management close loop. China Mobile attempts to leverage the big data management competence through the above-mentioned five management close loops in order to represent the most advanced or innovative aspect of a telecom industry in a cost effective manner.

As the central parts of the entire closed loop datafication management model, which is presented in Fig. 2, the unified data platform and data analysis system enable China Telecom to develop management closed loop competence (i.e. big data management competence in a closed loop datafication system). Its unified data platform, called NGBOSS (Next Generation Business & Operation Support System), is a centralized

computing system for gathering, integrating and managing huge sets of structured and unstructured data from external and internal sources. Meanwhile, the data analysis system is a software application that enables China Mobile to create different types of tables and to estimate covariance analyses from the big datasets. As the data are often scattered in various management processes such as product development, operations and marketing, many companies only review the local data. To better view the entire picture of service operations, China Mobile has built its own unified data platform and data analysis system for big data scientific analysis and the applications of analysis results obtained from the closed loop datafication management system to the improvement of five management closed loops. By integrating the analytical power into the five management closed loops through the datafication management system, China Mobile has better access to multiple data sources, better opportunities to clean data and conduct effective multi-dimensional data analysis, such as user behavioral characteristics analysis, market performance analysis, product quality analysis and operations performance analysis.

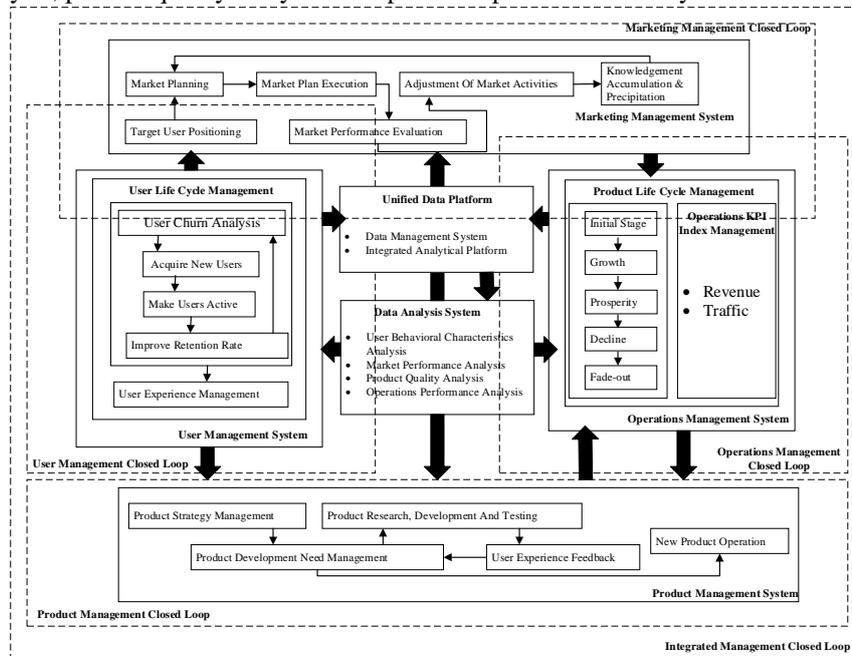


Fig. 2. China Mobile Closed Loop Datafication Management System

Under the China Mobile’s datafication management model, the five management closed loops are highly interrelated. The rationale behind the integrative process is that China Mobile needs to maintain all various management close loops in an “integrative” manner in order to better serve for target customers. While developing big data management competence in user management is important for understanding the user (i.e. service customer) characteristics and behavioral pattern, China Mobile, with the aim of being a mobile information expert, needs to demonstrate competences in other management closed loops in order to innovate on their new data services they offer to target customers, develop better operational plans and appropriate marketing campaigns.

In other words, integrated management closed loop, which represents the organic combination of four management close loops, is crucial in the service innovation process.

In fact, China Mobile has developed a three-tier implementation pyramid, which is presented in Fig. 3, to realize the explicit values (such as developing commercialized data services for external customers) and hidden values (such as improving internal operational efficiency for internal customers) of big data in its closed loop datafication management system. The pyramid consists of three levels: foundation level (which emphasizes unified data platform), knowledge accumulation and precipitation level, and application level for service innovation. By utilizing the power of unified data platform at the foundation level, China Mobile's cross-departmental new service development (NSD) team can identify the user characteristics and behavioral patterns and develop know-hows in the knowledge accumulation and precipitation level, thus improving the service innovation in the application level.

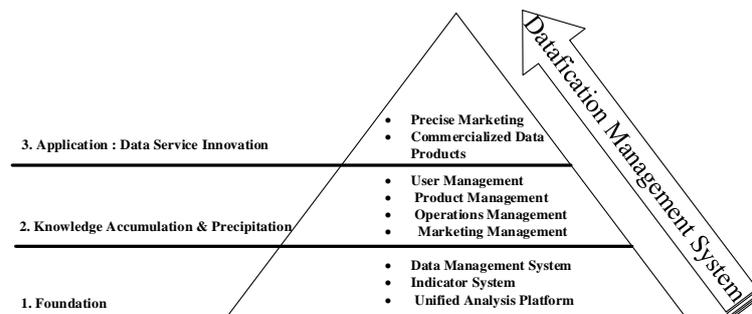


Fig. 3. China Mobile datafication management system implementation pyramid

The power of integrated management closed loop can be exemplified in the service development of its popular mobile internet application service: Mobile Market (MM), which is now the biggest online content delivery platform in China with more than 350 million registered users, 53 million monthly active users and over 17,000 different mobile games. Through the unified data platform, China Mobile NSD team identified that the user registration of Mobile Market (MM) declined in the first half of May and increased again in the latter half of May. In order to identify and solve the problems of declining registration rate, the NSD team compared and contrasted the detailed periodic data in the integrated management closed loop. New service development plans are formulated to drive service innovations of Mobile Market (MM). This leads us to give the following proposition:

Proposition 1. *Integrated management closed loop competence positively influences service innovation performance.*

In the user management closed loop, China Mobile divided the user life cycle into different stages and classified the users into new users, active users and old customers according to the different characteristics of users in each distinct stage. By conducting the

user churn (i.e. turnover) analysis through sophisticated business intelligence programs, China Mobile can identify the factors associated with the loss of target mobile internet customers in order to increase the user acquisition, activation, retention and subsequent sales revenue. In the example of Mobile Market (MM), China Mobile identified that in the recent marketing campaign, it could only acquire 5,000 new users, much below the original target of 5 million new users. By conducting active user and inactive user analyses, China Mobile found that the target customers should possess the following characteristics: (i) having a middle-end or high-end mobile phone, (ii) using more than 70 M internet data volume every month, (iii) sending more than 10 SMS messages every month, and (iv) paying more than \$10 RMB for added value data services.

After improving the user acquisition for Mobile Market (MM), China Mobile shifted its focus on how to make users more active and increase the user retention rate through the competent user closed loop management. By leveraging the user management experience gained from big data analysis, China Mobile improved service content, application, service content appropriateness and service costs for individual MM users. This leads us to give the following proposition:

Proposition 2. *User management closed loop competence positively influences service innovation performance.*

The closed loop operations management is mainly composed of two parts: the product life cycle management and operation KPI (key performance indicator) index management. In the product life cycle management, China Mobile would develop different operational goals, such as customer operation goals, cash operation goals and content operation goals for various kind of service products according to the product life cycle – comprising initial stage, growth, prosperity and decline fade-out.

In the initial stage, China Mobile pays more attention to the user retention rate and the marketing efficiency. Content operations are highlighted to make sure that there are adequate market channels and data service items for existing and new mobile internet users. In the growth stage, much attention has been given to customer operations, such as the growth of new user registration, the volume of business and the user activation. In the prosperity stage, China Mobile focuses on cash operations, such as profitability of China Mobile and external partner and the sustainability of service products. In the decline stage, China Mobile focuses again on user retention through loyalty programs. In the fade-out stage, China Mobile will introduce existing users to try new replacement services. In order to achieve various operation goals at different product life cycle stages, China Mobile develops the KPI index system for better identification of the critical operations problems of the service products and for ongoing service quality improvement.

In the example of China Mobile's 139 Mailbox, China Mobile made initiatives to re-innovate the mailbox service in its product decline stage. To briefly introduce, 139 Mailbox is a China Mobile's free email service that allows registered users to either use the mobile phone number or user name suffix for free email service. While the 139

Mailbox had more than 10 million users in its prosperity stage, it experienced product decline in recent years due to the explosive growth of instant messaging such as Wechat and Whatsapp. Against this competitive background, the user churn rate of 139 Mailbox increased significantly. To improve the content operations and customer operations, China Mobile collaborated with Fetion for developing and maintaining the 139 Mailbox terminal, and introduced new email services such as multiple terminal e-mail sharing. Such operational initiatives would not be successful if the closed loop operations management was not competent. By carrying out the operational initiatives, the user churn rate of 139 Mailbox has been controlled, and China Mobile has a high expectation to enjoy the “second spring” of 139 Mailbox. This leads to the following proposition:

Proposition 3. *Operations management closed loop competence positively influences service innovation performance.*

In the closed loop product management, China Mobile leverages the information gained from other aspects of closed loop management to improve the service product functions and user experience. The closed loop product management comprises four aspects: product strategy management, product development need management, product research, development and testing, new product operation and user experience feedback. Specifically, in responding to the development of product strategy, China Mobile builds a service development roadmap for differentiation after gathering sufficient market knowledge gained from the industry segments. Service prototype is developed according to the product strategy, and the product development needs are developed. Product research, development and testing are carried out. Product operations are evaluated and the user experience is identified through the analysis of big data. The product management close loop is formed as there is a controlled base of targeted service innovation, as well as the user and internal feedback from this product management system.

In a joint venture between China Mobile and an anonymous company for the development of an online game in the Mobile Market (MM), China Mobile conducted in-depth URL (Uniform Resource Locator) analysis to understand the user behavior such as the time to start and quit the game, the stage of game being completed, the frequency of payment and the amount of money paid for the game, and etc. Based on the big data analysis, China Mobile identified that most online game users could not complete a particular stage. The online game was modified and subsequently it became one of most innovative and popular games in the China Mobile’s Mobile Market (MM). This leads to the following proposition:

Proposition 4. *Product management closed loop competence positively influences service innovation performance.*

The closed loop marketing management is composed of six parts, including target user positioning, market planning, market plan execution, market performance evaluation, adjustment of marketing activities, and knowledge accumulation. Before planning any marketing activities, China Mobile will use big data analytics to identify the characteristics of target users, and leverage the power of internal user management system to invest on the suitable marketing activities. To increase the chance of success of marketing activities, China Mobile will learn from previous sales and marketing experience and adjust the marketing activities to fit for the dynamic market conditions and high user expectations. After the completion of the marketing implementation, China Mobile will evaluate the marketing performance results and develop the know-hows for future marketing activities.

In the example of Lingxi, which is the in-vehicle mobile voice assistant that allows users to subscribe or unsubscribe to mobile services using voice control, China Mobile leveraged the power of closed loop marketing management to design, implement and control the marketing campaign for the FIFA World Cup Brazil in 2014. In the campaign, China Mobile targeted at the office workers and car owners based on big data analysis. In order to attract more users to use Lingxi, China Mobile provided users with some innovative and relevant mobile online games, such as speaking out the correct names of different soccer players. By leveraging the power of closed loop marketing management, China Mobile successfully incorporated the innovative free online game services into its existing Lingxi services. Thus, it gives rise to the following proposition:

Proposition 5. *Marketing management closed loop competence positively influences service innovation performance.*

In China Mobile, the goals of managing different closed loops are to increase user traffic, user numbers and number of app store downloads, and subsequently get revenue. Such objectives cannot be achieved without improving the retention rate and user activation. From the China Mobile perspective, user retention and activation can be improved if the service encounter experience and service quality are satisfying both the old and new users. Based on previous case examples, China Mobile successfully translates the user expectation into innovation services, subsequently improving the user retention and activation. Given that the revenues of China Mobile's MM are growing fast, its market reputation is excellent, and the customer satisfaction level is high, it is safely assumed that service innovation performance poses positive effect on the business performance. Thus, it gives rise to the following proposition:

Proposition 6. *Service innovation performance positively influences business performance.*

The above observation is based on the in-depth interviews with 15 senior managers and middle managers in China Mobile Group. New research involving other industry giants in China and internet application providers could improve the generalizability. It

would be exciting to conduct a larger scale study that incorporates more feedback from both management and users. A summary of six propositions is presented in Fig. 4.

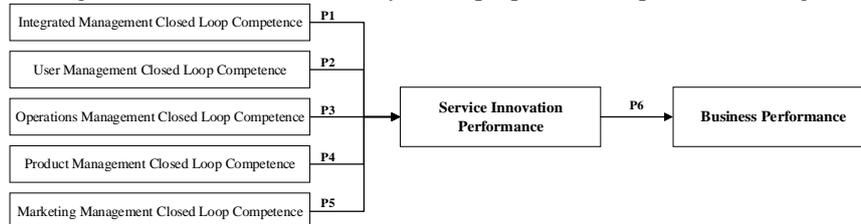


Fig. 4. A summary of propositions in the research model

6. Conclusion

In the big data era in China, telecom operators have utilized the big data management for service innovations. Service innovation would lead to the business improvement in user traffic, user numbers and number of app store downloads, subsequently increasing the revenue. In order to master the big data management competence, it is important to investigate on how the big data oriented thinking would lead to the effective service innovation and business performance. Big data oriented thinking is not only a tool and means, a management mode, but also an innovative idea for advanced management. Through the closed loop datafication management system, China Mobile can manage a controlled base of both targeted service innovation and business performance and service development feedback from this system. Under this closed loop management system, China Mobile can incorporate management feedback from sustained operations from across various functional units within the Group for new service development.

Based on our case findings in China Mobile, several propositions are strongly suggested. Specifically, the integrated management closed loop competence poses positive impact on service innovation performance. In addition, four other management closed loop competences would lead to service innovative performance and subsequent business performance.

Our paper has significant implications to service companies in China in the era of big era. First, based on our case of the closed loop datafication management system in the world largest telecom China Mobile, the service companies can better understand how to improve the quality and efficiency of enterprise operation through the development of the integrated management closed loop and four other management closed loops.

Second, the implementation of closed loop datafication management system for service innovation is one of the most important steps for China Mobile in this context, which is also the best solution to cope with the challenge of Internet companies. The studies of data-driven service innovation can not only provide effective policy for the transformation of telecom operators, but also can provide train of thought for other traditional industries when suffering the Internet impact.

Our paper has implications to researchers as well. As big data is a significant and new phenomenon to study, it is important to build and test the theory for research

development. By integrating various theories (i.e. knowledge management theory, evolutionary perspective and resource-based theory) with the model of China Mobile's big data management competence in its closed loop datafication system for service innovation in China, our case model framework may help build the theories in the area of big data management.

The telecom operators would promote business model innovation through a variety of ways. For instance, China Mobile has recently provided the data space rental service to meet the needs of corporate users and individual users for massive information storage. In addition, China Mobile has recently promoted precise marketing. As service innovation is now customer driven and data driven, it is important to understand how the change in customer behavior affects the service innovation in the era of big data. Equally important, the relationship between service innovation and business model innovation for new data services is unexplored.

Our model framework proposes several propositions for hypothesis testing. It is exciting to develop the measure for each proposition, and investigate on how management culture affects the relationships among several variables. Equally important, it is interesting to further investigate each aspect of management closed loop competence.

Acknowledgments

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Appendix A. General interview questions for capturing big data management competences – modified from Andriessen and Tissen (2000) and Perunovic' et al. (2012)

- What are the unique big data management skills that you have in China Mobile?
- What aspects of big data management are you good at?
- What are the unique areas of big data knowledge and skills in the Chinese telecom market?
- What value does the China Mobile's mobile internet customers get from these?
- What big data systems and technologies does China Mobile have which allows it to supply its existing and new data services?
- Which of these technologies is critical to getting new or keeping existing customers?
- What handbooks and operational procedures are used within China Mobile for big data management?
- What are the unique intangible assets of China Mobile's assets that most of your competitors don't have?

- Think about things you have inherited from the past which have made China Mobile it is in the era of big data in China.
- What value do these have in the eyes of your mobile internet customers? How important are they to the success of China Mobile in capturing the mobile internet and applications service market in China?
- What core values are shared throughout China Mobile for big data success? What norms are derived from these? How do you measure value? How much of this is noticed by the mobile internet customer?
- How would you describe the style of big data management in China Mobile?
- What does big data management consider its prime objective?
- What are the key management processes in user management system? Please provide an example to demonstrate how China Mobile improves the user management processes.
- What are the key management processes in product management system? Please provide an example to demonstrate how China Mobile improves the product management processes.
- What are the key management processes in operations management system? Please provide an example to demonstrate how China Mobile improves the operations management processes.
- What are the key management processes in marketing management system? Please provide an example to demonstrate how China Mobile improves the marketing management processes.

Appendix B. General interview questions for capturing service innovation performance & business performance – modified from Oke (2007), Jian and Zhou (2015), Voss et al. (1992)

- What are the number of new data services developed over the past two years and the average costs of developing new data services?
- Think about an amazing new data service in China Mobile. Describe the time of service investment, time to develop new service model, time from development of new service model to entry, and time needed for service customers to apply the new concept.
- Compared to major competitors, how fast do you think about China Mobile in new data service launch?
- Compared to major competitors, how effective do you think about China Mobile at taking and improving existing ideas?
- Compared to major customers, how effective do you think about China Mobile in leading service innovation?

- Compared to major customers, how well do you think about China Mobile in exceeding the originally established market share, sales, and growth targets, and achieving competitive advantages?
- Compared to major customers, how well do you think about China Mobile in championing its service quality, service experience, reliability, and user friendliness?

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