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The digital transformation in HSSC from the perspective of patient co-creation

By Xiaoqian Xu

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ABSTRACT

This study purposed to explore the digital transformation in the healthcare service supply chain (HSSC) from the perspective of patient co-creation with the research question of how digitalization influences co-creation in the healthcare service supply chain. This aligns with literature gaps for service operations and digital healthcare management. First, the current service operation literature needs more clarity on co-creation in service supply chain (SSC). In particular, no literature has introduced or thoroughly explored the form of co-creation in SSC. Second, the study of co-creation literature leaves a significant gap in the study of conditions of co-creation, while the research on conditions of co-creation is vital and in line with the upgraded service concept for integrating resources in service provision. Third, in the field of medical management, with the development of patient-centered care and people's demand for refined medical care, PCC's solutions from the service operation field need to be explored.

To address the problem and fill the gaps in the literature, this study uses case study methodologies with examples from digital orthodontics practice, integrated primary care in internet hospitals, and chronic disease management. The digital development in these three cases has been tremendous in recent years and profoundly requires patient co-creation. To collect data, this study conducts interviews. A total of 45 individuals were interviewed in this study, each lasting between 40 to 70 minutes. The interviewees included doctors, product managers, IT developers, operation managers, nurses, and researchers.

Linking the research gaps, this study has both theoretical and practical contributions. The contributions in theory can be summarized mainly from three aspects. First, this paper proposes to

explore and explain three co-creation forms in the service supply chain, which are co-design, co-delivery in SSC from the service providers' perspective and co-delivery in SSC from customers' perspective, which helps researchers improve their understanding of SSC and co-creation phenomena. Second, this research creatively proposes a "conditions of co-creation" model and studies the co-creation phenomenon from four aspects: policy and social, patients, suppliers and digitalization. Finally, this research discovers and proposes the promotion of the service operation model of co-creation with digitalization in relation to the progress of medical management, especially PCC. To the practitioner, this research provides a solid theoretical foundation for current and future digital health platforms and operations managers and summarizes the direction for past, present, and future digital health trends. In practice, this research provides a solid theoretical foundation for current and future digital health platforms and operations managers and summarizes the direction for past, present, and future digital health trends.

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During the most significant four years of my life, I attended the University of Birmingham in the UK. I am grateful for the unwavering support and guidance from my supervisors, Professors Zhang and Ramirez, as well as my parents and friends. Despite living independently in the UK, the local community has shown me immense kindness and care, which I am deeply appreciative of. I want to express my sincere gratitude to everyone who has helped me along the way. Thank you.

During the past four years, I have encountered both moments of uncertainty and motivation in my academic journey. These experiences have allowed me to develop and gain a clearer understanding of the term "research." Additionally, this marks the first time I have ventured away from my hometown and travelled to the UK to pursue my studies. The recent pandemic has presented me with unique challenges, but has also enabled me to become more independent and mature in handling various obstacles that life may present.

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CHAPTER 1: INTRODUCTION

1.1 Research background and gaps

1.1.1 SSC in the healthcare industry

This paper chooses to research service supply chains in the healthcare industry. There are two manifestations of supply chains in health care. One involves the supply of equipment and materials used in health care delivery. The other supply chain consists of the delivery of health care itself, wherein patients supply their physical conditions, and service suppliers deliver healthcare services (Sampson et al., 2015). This research considers the latter supply chain, which mainly considers the healthcare supply chain as a service supply chain to deliver healthcare service.

There are three reasons this thesis is conducted in the healthcare industry. The first reason for conducting research in the healthcare field is that it is undergoing an unprecedented digital transformation (Papanicolas et al., 2018; Patrício et al.,2020). Traditionally, people considered healthcare services medical services performed in a hospital or clinic. Most of the research on healthcare service management and supply chain management is also concentrated on the scene inside the hospital, which is the arrangement of various materials, resources, and personnel (Frow et al., 2016; Bergerum et al., 2019; Khorasani et al., 2020). However, with the rapid digitization of health care services, there are signs of "out-of-hospital" care, from consultation to prescribing medication to post-treatment recovery. The digitization of healthcare services has also made optimizing medical service management and healthcare service supply chain management a critical

process to improve the regional and national healthcare levels and the quality of national healthcare care. Therefore, it is indispensable to carry out research in the field of healthcare services in this research.

Another reason is the complexity of the field of medical services. The stakeholders in the healthcare supply chain are complicated, including the patients, service providers, organizers, middle suppliers, and others (Mathur et al., 2018; Singh et al., 2006). As a result, relationship management within the supply chain is essential. The findings are validated in a complex service environment because of the complex nature of healthcare service compared to other service industries.

The third reason for conducting research in the medical field is the uniqueness of healthcare services (Mathur et al.,2018; Singh et al.,2006), as consumers occupy a critical position in SC management. The reason is that in the healthcare industry, service quality is not only related to the interests of service providers but also to the safety of patients since it works on the human body. Any inadvertent errors can cause serious problems. As a result, when considering increasing the efficiency of the supply chain, the service quality and customer significance must be considered first.

1.1.2 Digital background in the healthcare industry

Healthcare systems currently face significant changes and challenges worldwide, both in developing and developed countries, due to the contradiction of the shortage of healthcare professionals and increasing demand for high-quality healthcare services—demographic and economic changes cause the current situation. The changes are mainly based on the increasing

elderly population (WHO, 2016) and growing healthcare spending (Papanicolas et al., 2018) worldwide.

Additionally, in the healthcare sector, service providers have become more specialized, resulting in fragmentation, other laboratories, providers of insurance plans, and practices that are in competition. (Patrício et al.,2020). Advancements in medical technology can result in larger teams and more complex workflows. (Barjis, 2011). Current healthcare systems can suffer from communication and coordination breakdown between units treating a patient.

These challenges put increasing pressure on practitioners, who must adapt and cope with higher workloads. In the face of these challenges, digitalization is a great way to solve these problems. For example, some popular online medical activities such as online hospitals, online consultations, wearable devices, and daily medical indicators monitoring are all digital applications to reduce the burden on hospitals and increase service quality. To that end, applying digital technologies and telemedical solutions in healthcare is suitable to deal with the threat of undersupply and care delivery shortages, thus functioning as a catalyst for change through technological progress.

These digital technologies, like digital platforms and wearable devices, not only affect medical care and medical services but also profoundly affect the medical service supply chain. The application of technology in healthcare processes involves structures, routines, work and treatment environments, and different stakeholders. As patients, through technological innovation, they also contribute more intimately to this service provision process than ever before.

1.1.3 Digitalization in China

In China, in recent years, with the popularity of Industry 4.0 and digital transformation in different industries, researchers in operation management have also started to explore the change and innovation in this field based on digitalization. With the vigorous development of the digital economy, digital healthcare, as an essential part of the digital economy, has also achieved remarkable development and scale expansion in recent years. ("White Paper on the Development of China's Digital Economy",2022). Figure 1.1 shows the growth in the economic size of digital healthcare since 2005. It can be seen from the figure that since 2017, the growth rate of the digital healthcare economy has increased significantly, which represents that digital healthcare has entered a period of rapid development.

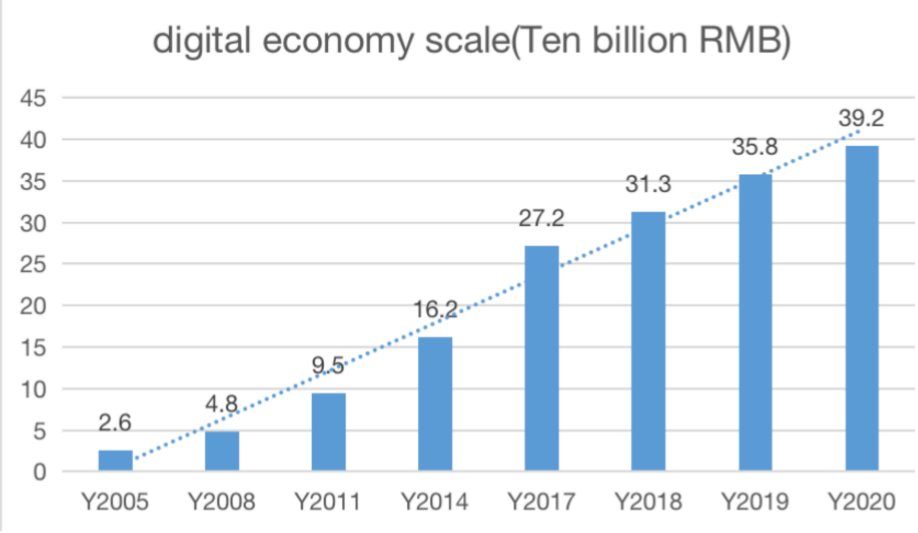

Figure 1.1: Digital Healthcare Economy Scale in China ("White Paper on the Development of China's Digital Economy",2022)

With the continuous development of digital healthcare in China and the widespread use of mobile phone apps, the scale of online healthcare users in China has also increased, which has extensively promoted the development of China's digital healthcare industry. According to statistics, as of December 2021, the number of online healthcare users in China reached 298 million, an increase of 83.08 million from December 2020, accounting for 28.9% of the total netizens (“White Paper on the Development of China's Digital Economy,” 2022).

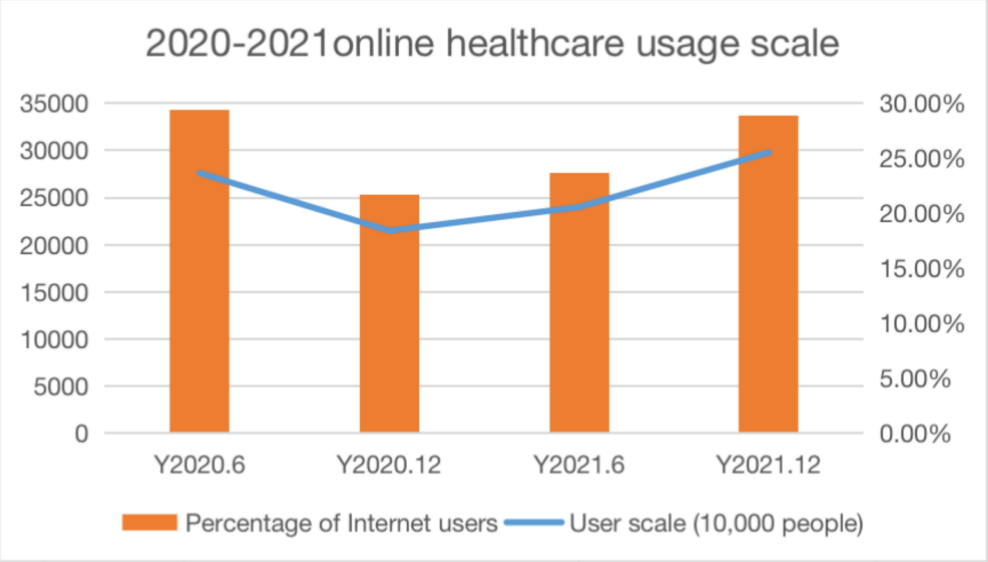

Figure 1.2: Online Healthcare Usage Scale (“White Paper on the Development of China's Digital Economy”,2022)

With the development of digital healthcare and online healthcare, it is undeniable that implementing and correctly applying these technologies have significantly changed the healthcare service industry and healthcare delivery. Both patients and doctors prefer to deliver some of their services over the Internet. In this context, the digitalization and innovation of the specific service supply chain are worth exploring and need to be studied. In the research on the digitalization of

supply chain management, researchers believed that the digitalization of SSC is not the digitalization of SC, and there is a significant difference between them (Mersha, 1990; Nie, 2009). This study should understand the digitalization of SSC more from the perspective of service and the perspective of service upgrades.

1.1.4 Choice of the region for this research

The medical industry is intricately intertwined with national policies, regional regulations, and insurance frameworks. Conducting a global-scale study in this realm would introduce considerable challenges in comparing and analyzing findings due to the significant variations across different jurisdictions. Therefore, for the purpose of investigating the medical service supply chain, this study maintains that a focused approach within a specific country and region is optimal. Drawing from the extensive digitization of the healthcare industry in China, the current research has chosen to concentrate its efforts within China for the following key reasons:

1. As depicted in Figure 1.1, China's digital healthcare economy has been expanding at an exponential rate in recent years. This research primarily examines the phenomenon of digitization within the healthcare industry. The rapid proliferation of digital healthcare solutions facilitates the acquisition of extensive case studies and data support throughout the research process. This is attributed to China's vast population base and robust market demand. As the country with the largest population in the world, China boasts a significant potential user base for digital health services. Furthermore, with the aging of the population and the rise in chronic diseases, the demand for digital health management tools and telemedicine services continues to surge.

The rapid development of digital health in China is also related to the rapid development of the Internet and digital technology. China has developed rapidly in digital technologies such as mobile Internet, big data, and artificial intelligence, providing strong technical support for digital health research. The high penetration rate of smartphones and the wide range of Internet applications, such as mobile payment and e-commerce, provide convenience for the promotion of digital health services (Ma et al., 2023).

2， China's policies and social factors also provide rich research space and research materials for this study. From the government perspective, the Chinese government attaches great importance to the development of the digital health industry and has issued a series of policies to encourage and support the innovation and application of digital health technologies. For example, the government encourages financial institutions to provide loans and financing support to the health industry, such as setting up special funds and providing low-interest loans. Government-led policies such as medical and health informatisation construction and Internet + medical health provide a good environment for digital health research. (State Council, 2016)。

In light of China's status as a developing country, there has been a growing focus on health issues among the Chinese population. With the rise in living standards, there is an increasing demand for health management. However, China's medical system is not yet fully developed, leaving ample opportunity for digital medicine to make a significant impact.

3. The decision to conduct digital health research in China is based not only on the previously mentioned factors, such as the scale of digital health, policy, and social support but also on the robust development of the digital supply chain. Since this study

is a study of service supply chains in the digital era, China, as the world's most important manufacturing, service and consumer market, continues to expand its digital supply chain market. It grew from RMB 8.25 trillion in 2018 to RMB 27.2 trillion in 2022, with a compound annual growth rate of 26.94% (ZIRI, 2023). This trend provides a broad market space and application scenarios for digital health research.

1.1.5 Research significance and gaps

With the development of the service economy, researchers and practitioners in supply chain management have started to pay more attention to the significance of service operations (Spring et al., 2022; Al-Omoush et al., 2023). the importance of co-creation was first stressed in the field of marketing research, as customer engagement generally appears to relate to the sale and after-sale processes. Soon, Researchers' comprehensive understanding and exploration of co-creation led to its gradual integration into the realms of service management and operations (Al-Omoush et al., 2023). Previous studies have stressed and proved the importance of co-creation research in supply chain management (Turhan and Vayvay, 2009; Zhang, 2015; Petri and Jacob, 2016; Gong et al.,2019; Al-Omoush et al., 2023). It helps to distinguish the service supply chain from the manufacturing supply chain (Nie & Kellogg,2009; Spring et al., 2022; Al-Omoush et al., 2023). However, as the cornerstone of research on customers in supply chain management, the research about different forms of co-creation in SSC are seldom explored by researchers (Hollebeek, 2019; Solaimani & van der Veen, 2021).

Research on co-creation in service operations needs to be given significant attention in solving service delivery challenges (Hollebeek, 2019; Solaimani & van der Veen, 2021). The research on

customer co-creation and cooperative relationships in SSC under the upgraded concept of service is blank and calling for exploration. In terms of co-creation research in the service supply chain, Sampon(2012) first stressed that the customer in the supply chain can also be significant and create value rather than being a “pure customer”. This innovation of customer comprehension in the supply chain is based on the distinction of the supply chain for service products from the manufacturing supply chain. Besides, in the study of co-creation in service operation, it is agreed that the most significant difference between the service supply chain for service products and the manufacturing supply chain is the customer engagement and collaboration phenomenon in the supply chain is also a research area worthy of attention in the service supply chain (Solaimani & van der Veen, 2021; Chernonog & Levy, 2023; Al-Omoush et al., 2023). In service industries, customers are able to be involved and contribute to the supply process, while they are usually not needed in manufacturing industries. Customers can also contribute to the service supply chain as an essential part of the service supply chain. Sampon(2012) also explained several customer roles in the SSC in co-creation, including component supplier, labour, design engineer, production manager, product, quality assurance, inventory, and competitor. The list of roles means that the customers can be regarded as one part of the roles in the service supply chain and service delivery.

However, the theory of co-creation discussed in SSC was mostly based on the understanding of service at that time, which regarded the service as a kind of “product” delivered by the service provider to the customer. This understanding of the concept of service has fallen behind the current research on service and service innovation ((Yazdanparast et al., 2010; Barrett et al., 2015; Sienkiewicz-Małyjurek & Szymczak, 2023).

With the development of service innovation research, researchers provided their opinions on upgrading service comprehension (Lovelock, 1983; Barrett et al., 2015). The highly influential“S-D logic model” brought out by Vargo and Lusch (2004, 2008a, 2008b) is widely accepted by researchers to build the new concept of service and service innovation, which will be utilized in this research to refresh the theory of customer roles and co-creation in SSC. According to the "S-D logic" model, service should be seen as a way of utilizing one's resources (such as knowledge) for the benefit of oneself or others rather than the traditional view of services as a single output. (like an intangible product)(Vargo and Lusch,2004, 2008a, 2008b).

An increasing number of research indicated that service can not only be regarded as a “product”; it should be given more significance and understanding in research (Barrett et al., 2015; Vargo and Lusch 2004, 2008a, 2008b; Miles et al.,2017). Therefore, this research will fill the gap and upgrade the new understanding of co-creation in SSCM in the healthcare industry.

The second direction of this research focuses on the PCC, which has also been a hot topic in recent years because the PCC requires high-quality service to patients and needs to cooperate with the patients.

The ground of the second direction based on the healthcare system and delivery challenges and digital transformation happened in the current healthcare industry in PCC (patient-centered care) demand, which lead to problems on how to implement the practice of the patient-centered care and telehealth(WHO, 2016; Papanicolas et al., 2018; Öberg et al.,2018; Patrício et al.,2020; Garagiola et al., 2020). Solutions have been discussed in the area of digitalization and service management (Kellermann and Jones, 2013; Roehrs et al.,2017; Zhou et al.2019; Deloitte, 2019; Patrício et al.,

2020; Borja, 2017; Huetten et al., 2019). However, no literature is found discussing this problem in the “service operation” area.

The concept of PCC and telehealth has been brought out to improve service quality and simultaneously reduce the burden on medical staff to a certain extent. The evolution toward people-centered and integrated care has still been hampered by traditional practices that view patients as passive receivers of healthcare and by a system that is fragmented and increasingly complex (Lee, 2010). Additionally, emerging technologies and data offer immense opportunities for healthcare, but the potential of new technology and data solutions remains largely unfulfilled (Kellermann and Jones, 2013). Therefore, to make the necessary transformation toward a new vision of healthcare, it is important to rethink current healthcare practices and turn them into a healthcare system suitable for PCC in a timely manner by integrating co-creation and digital technology applications.

Healthcare systems have faced challenges in recent years due to demographics (Granström et al., 2020; Öberg et al.,2018) and economic changes (Papanicolas et al., 2018). With the development of patient-centered care (PCC) and Telehealth, the requirements of patients/customers for the quality and efficiency of medical services are getting higher.

Under this circumstance, with the popularity of people-centered care(PCC) in the healthcare industry in recent years, researchers (Patrício et al.,2020; Borja, 2017; Huetten et al., 2019) in-service management areas were also starting to study the people-centered care service system to support the PCC practice and explore the management issue around people-centered service.

Huetten et al.(2019) first started their research on the impact of occupational stereotypes in human-centred service systems to respond to current service research priorities, attempting to

understand value co-creation in collaborative contexts like healthcare and address calls to investigate the changing role of healthcare customers therein. However, when they mentioned the relation between occupational stereotypes held by patients and patient participation in the PCC service system, they failed to specifically introduce the human-centered service system and analyze the operational transformation of co-creation in that system. By contrast, Borja (2017) briefly defined that the outstanding feature of a human-centered system in the area of service in artificial intelligence is that the system will collaborate with humans, not seek to replace them. These kinds of sociotechnical systems have human components as well as physical objects that have a type of intelligence and then interfaces on which parties (humans and machines) can exchange information and interact in new ways. As such, it will expand the concept of service system.

In order to develop a better PCC, scholars started finding solutions from digitalization and service management (Zhou et al.,2019; Bolton et al., 2018; Pinho et al., 2014; Patrício et al., 2020). However, the research on the PCC practice in service management is immensely unfilled (Patrício et al.,2020). With the concept of human-centered service, these papers above still could not specifically describe the PCC in service system practice until Patrício and his colleagues (2020) tried to associate PCC with service design and give solutions for PCC practice by leveraging service design. They concluded three approaches of service innovation to achieve PCC, which are the human-centred participation approach, the digitalization approach and the service system approach. It is the first to propose a way to assist PCC in the field of service management.

This research will provide patient-centered care practice through the service supply chain management perspective by exploring the digital transformation of collaborative relationships between patients and service suppliers.

In the existing literature, it is generally believed that the biggest SCM challenge for providing PCC is the coordination of multiple service providers (Meijboom et al., 2011; Sampon et al.,2015; Patrício et al., 2020). In the healthcare industry, the applicability of SCM in situations is complex because the treatment of patients requires input from multiple healthcare providers. The service supply chain cooperation between variable care providers is especially essential since the services they provide all work together on the patients and have an impact on the benefits of each other even though these healthcare providers do not know each other. This is also the difference between HSSC and additional service supply chain coordination.

However, the current way of coordinating could be improved. Sampon et al. (2015) raised the question of "who should initiate coordination and how it should occur under conditions of comorbidities." They compared three approaches to the healthcare service supply chain coordination. In the first scheme, patients are responsible for coordinating their own care. In the second scheme, physicians take on the coordination role. In the third scheme, a third-party coordinator manages care for everyone in the network. Among the three models, Sampon et al. (2015) believed that the most common case is the coordination between different SSCs initiated by patients. Most of the coordination between the various service providers worldwide is done by the patients. The third-party to manage coordination is relatively more effective but has certain limitations.

1.2 **Research objective**

With the development of the service economy, researchers and practitioners in supply chain management have started to pay more attention to the significance of service operations.

In addition to the digitalization that researchers study in manufacturing industries, research in service industries is also particularly important, mainly because the SCM in service industries is structurally and managerially distinct from the SCM in manufacturing industries (Mersha, 1990; Nie, 2009). Therefore, while the economy of the service industry is prosperous and developed, the digitalization of service supply chain management also needs special attention. The core of digital transformation in services is to increase interaction between stakeholders, including organizations, customers, and suppliers (Ardolino et al., 2017; Chang and Choi, 2016; Lember, 2019). Therefore, research around customer engagement becomes essential in the transition process with increased interaction.

Positive relationships have been found in the customer contribution to service supply chain management. Boyaci and Gallego (2004) first discovered that the customer's service can benefit the service supply chain performance under competition from a service supply chain coordination perspective. In recent years, it has been proved that customer engagement is beneficial to SSC management and positively influences companies and organizations (Zhang, 2015; Petri, 2016). Gong et al. (2019) explained that when customer involvement awareness increases, the information environment within organizations transforms into a better situation, which helps organizations achieve their operational goals like sustainability goals. Therefore, the previous studies have stressed and proved the importance of co-production and co-creation research in supply chain

management. It helps to distinguish the service supply chain from the manufacturing supply chain (Mersha, 1990; Nie & Kellogg, 2009).

Nevertheless, the research on the co-production and co-creation practice could be more extensive. To specifically explore the variable forms of collaboration in the service supply chain, customer roles were first introduced in the service supply chain to identify their key features (Sampon and Spring, 2012). However, with the digitalization and innovation in understanding of service, the literature still calls for a greater understanding of upgraded customer roles, collaborative relationships, and customer co-creation in SSC under the digital age and service innovation. This research will explore digital transformation and innovation in the service supply chain from the co-creation perspective. I will mainly focus on the healthcare industry and healthcare service supply chain.

Under these circumstances, the thesis's primary research objective is to discover the digital transformation of co-creation in service supply chain management.

Three directions under this topic are explored in my thesis, which are “the types of co-creation,” “the conditions of co-creation,” and “SSC solution for PCC.”

1. Seek the types of co-creation in SSC under the digital environment

2. Find the requirements and conditions of these co-creations for these co-creations in SSC,

3. Find the way that the co-creation in SSC based on digitalization influences patient-centred care.

This thesis first explicitly inter these types of co-creation in service supply chain management in a digital environment because the service supply chain is significantly different from the industrial supply chain. In “service," customers are not only recipients of “products" but are more likely to participate in a series of processes that generate and supervise services. This also relates to the nature of the service itself, a process resulting from the joint efforts of service providers, consumers, and other stakeholders.

Second, after studying the types of co-creation in service supply chain management in the digital environment, this thesis continues to explore the conditions of co-creation in SSC to solve the practical supply chain management problem about how to achieve co-creation through stakeholders in SSC. This makes knowledge about co-creation in SSC more systematic and comprehensive.

Besides, this thesis also aims to study the supply chain management solution of customer-centered service, taking patient-centered service as an example. Through the study of co-creation in SSC, this study searched for a supply chain solution to realize and facilitate PCC through co-creation. This concept of customer-centered service also conforms to the new idea of “service." It does not regard customers as recipients of services in SSC but believes that SSC is built around customers. Customers can help achieve some complex and challenging goals for third-party organizations to succeed. This supply chain management solution is also the solution in the digital environment.

1.3 **Research questions**

The main research question is: **How digitalization influence co-creation in the healthcare service supply chain?**

Therefore, there are three research questions relating to the main research question as following:

Q1: What types of co-creation occurred with the application of digital technologies in the service supply chain?

The first research question is the cornerstone of this study, which helps this study understand the phenomenon of co-creation in the current service supply chain fundamentally and conceptually in the digital environment. This enables this paper to advance the following two questions.

Q2: What are the conditions for various types of co-creation under digitalization?

The second research is not just to study the contribution and conditions of co-creation in SSC but to better understand SSC from the research perspective of surrounding resources with a better understanding of the meanings of “service,” “customer," and “service supply chain.”

Q3: How does the co-creation in SSC in the healthcare industry under digitalization influence the achievement of patient-centered care?

The third research question is to summarize and study the medical field. With the higher demand for higher quality and more refined healthcare service by service users, what contribution can service supply chain managers make? This question can help build a bridge between healthcare services management and supply chain management. It can also inspire operation managers to improve service supply chain management to achieve better medical service results. the discussion of Q3 aims to 1) fill the gap and provide the patient-centered care practice in SSCM by exploring the digital transformation of the collaborative relationship between patient and digital platform, 2)

discuss the model of “DP(internet hospital) + patient participation” to help coordinate multiple service supply chains.

1.4 Key contributions

In terms of findings and contributions corresponding to 3 research questions respectively, this research has three findings and contributions.

Firstly, this research creatively explores and explains the co-creation phenomenon in the service supply chain and points out three types of co-creation in SSC in the healthcare industry. The thesis analyzes three kinds of co-creation in SSC, discussing their advantages, challenges required by digital technology, and how it promotes co-creation.

The second contribution is building the model of “conditions of co-creation” to illustrate the co-creation phenomenon in SSC under digitalization——including co-design, co-delivery, and co-delivery from the customer perspective by challenging the existing customer collaboration research in SSC(Sampon, 2012) which regards the service as pure product rather than multi-resources integrated process (Barrett et al, 2015; Vargo and Lusch 2004, 2008a, 2008b; Miles et al.,2017). The "conditions of co-creation" model can define the types of co-creation in a specific situation and show this state of patient, supplier, digitalization, and social support in more detail. These “conditions of co-creation” can also present the requirements from different parts of the service supply chain when the co-creation occurs, which conforms to the new understanding that service is not a product but a process, a collection of various resources. In this way, the role of the patient in

the service supply chain is not helping to deliver the service “product” but achieving its benefits and goals through external help and resources.

The last contribution follows the second contribution, which defines and explains co-creation in SSC, which is designed to supply patient-centered care and “big health.” This part of the contribution is an extension based on the findings of the co-delivery from the customer's perspective. It discusses the model of “internet hospitals + patient participation” to coordinate in three conditions: (1) multiple departments and hospitals collaborate in treating and helping patients with comorbidities. 2)The services of pre-illness consultation, treatment, and post-illness rehabilitation sometimes need to be provided by multiple medical institutions. 3) In chronic disease management.). In this case, an Internet Hospital is a service provider, delivery, and coordinator. Internet hospitals can unify the doctor resources of various departments and institutions nationwide on the same platform. From the PCC point of view, the patient establishes a connection with the physician and the third-party coordinator through the Internet hospital, thus forming a three-party integration model that helps service supply chain coordination, thereby helping to complete part of the goal of patient-centered care.

1.5 **Thesis structure**

This thesis is divided into two sections: theoretical chapters and empirical chapters. The theoretical chapters section contains four chapters that introduce the readers to the work and help limit the scope of the study. The need for study, extant literature, conceptual framework and research methodology adopted are presented. The empirical chapters are where this research

presents the facts, findings and the interpretation and discussion of findings. It occupies the core of the thesis.

1.5.1 Theoretical chapters

The section includes four chapters introducing the work and restricting the study's scope. It presents the need for analysis, existing literature, and research methodology.

Chapter One provides background and motivation for this study, highlighting the importance of service supply chain management, the digitalization of HSSC, research objectives, and critical contributions.

Chapter two has two parts. Part I reviews literature about service operation and customer research in SSCM, intending to set up the study context. Part II reviews “digitalization” literature to develop study constructs.

Chapter three introduces the conceptual framework of this study and proposes five hypotheses.

Chapter four discusses the empirical study's research methodology, including the researcher's philosophical position, the case study research design, and fieldwork in data collection and analysis.

1.5.2 Empirical Chapters

This section has six chapters and discusses the cases, findings, and contributions of this study respectively.

Chapter five describes three cases utilized in this research as this research is designed to apply case study methodology. These three cases introduce the transformation of service delivery caused

by digitalization in different healthcare sectors, which are digital orthodontics practice, integrated primary care in internet hospitals, and digital chronic disease management.

Chapters six, seven, and eight present the three findings of this research about co-design, co-delivery, and co-delivery from the customer perspective.

Chapters nine and ten conclude the study by discussing its contributions to knowledge, conclusions, and practical applications. The final section provides suggestions for future research and limitations.

CHAPTER 2: LITERATURE REVIEW

2.1 SSCM and customers

2.1.1 Service supply chain management

Service

To understand the service supply chain in health care, this study should understand the service first. In economics, a service is a transaction in which no physical goods are transferred from the seller to the buyer. Service management generally considers service concepts as activities that share no physical product from providers to service receivers (Lyttinen and Rose 2003).

Service has also been classified by Lovelock (1983) into four types. The first type is the services provided to customers' minds, like the training industry. The education industry offers services to enhance customers' knowledge level, which is also the first type. The second type is the service provided to the customer's body. Like the healthcare industry, the benefits are health consultancy, health treatment, and surgery, which helps customers restore their health. The third type is services provided to customers' physical possessions, like home appliance repair services. The last type is services, which are supplied to customers' information. Like financial companies, they provide optimal investment schemes to customers to help them manage their money. In this research, I mainly focus on the second type of service in health care in which customers attribute their bodies in the supply chain as suppliers.

According to the service product flow relationships, service can be divided into two parts concerning business. The first part is the service between companies and organizations, including intra-organizational and Inter-organizational services. The second part should be the personal service related to the customers, like the service in the healthcare/education/entertainment industries (Normann, 2002; Barrett et al., 2015). In this research about customer engagement, I will pay more attention to the personal service between individuals and organizations than between two organizations.

There has been a prevalent trend for companies to transform their business from providing equipment to providing service (Barrett, 2015). This is because the business scale of service has increased in the last decade. Many organizations and companies are trying to find ways to upgrade their business. For example, IBM was a company that provided computer equipment and software. After digital transformation, it successfully changed its model to provide IT services for companies (Spohrer and Maglio 2010). Service study will be an essential field for future research.

Tukker and Tischner (2006) identified three types of services in Product Service Systems (PSS), and each type has implications for supply chain management (SCM):

-Product-oriented services offer additional advice and consultancy services alongside the product.

-Providers offer use-oriented services by leasing assets to customers.

-Service providers use their resources to produce results, without a predetermined product.

SSC and HSSC (Healthcare Service Supply Chain)

Efficient supply chain systems rely on the seamless integration of crucial business processes and relationships, spanning from material suppliers all the way to end users. Baltacioglu, Ada, Kaplan, Yurt, and Kaplan (2007) defined a service supply chain system as “a network of suppliers, service providers, consumers, and other supporting units that performs the functions of transactions of resources required to produce services; transformation of these resources into supporting and core services; and the delivery of these services to customers.” According to Sampson (2000), a service supply chain is a dynamic two-way system that involves a customer, a service provider, and an initial service producer. It's an exciting and collaborative process that brings value to everyone involved. Demirkan and Cheng (2008) define an application service supply chain as a system consisting of three parties: the infrastructure service producer, the retail service provider, and the customer, which is similar to Sampson's (2000) definition.

According to Wang (2015), A service supply chain includes two types: SOSC (service-only supply chain) and PSSC (product service supply chain). SOSC is a supply chain system where the "products" are pure services, and physical products do not play a role. The PSSC should be considered both a service and a physical product in supply chain systems. Like Figure 2.1, the telecommunication, finance, and Internet services belong to the SOSC. In contrast, the restaurant, food, and product design belong to the PSSC because the supply process relates to the physical product and service (Wang et al., 2015). The classification could also be established in the healthcare industry. Apart from the research on the supply of equipment and materials (Holmström, 2014), a study on the SOSC transformation is currently needed with increasing public attention to customer/patient service quality improvement.

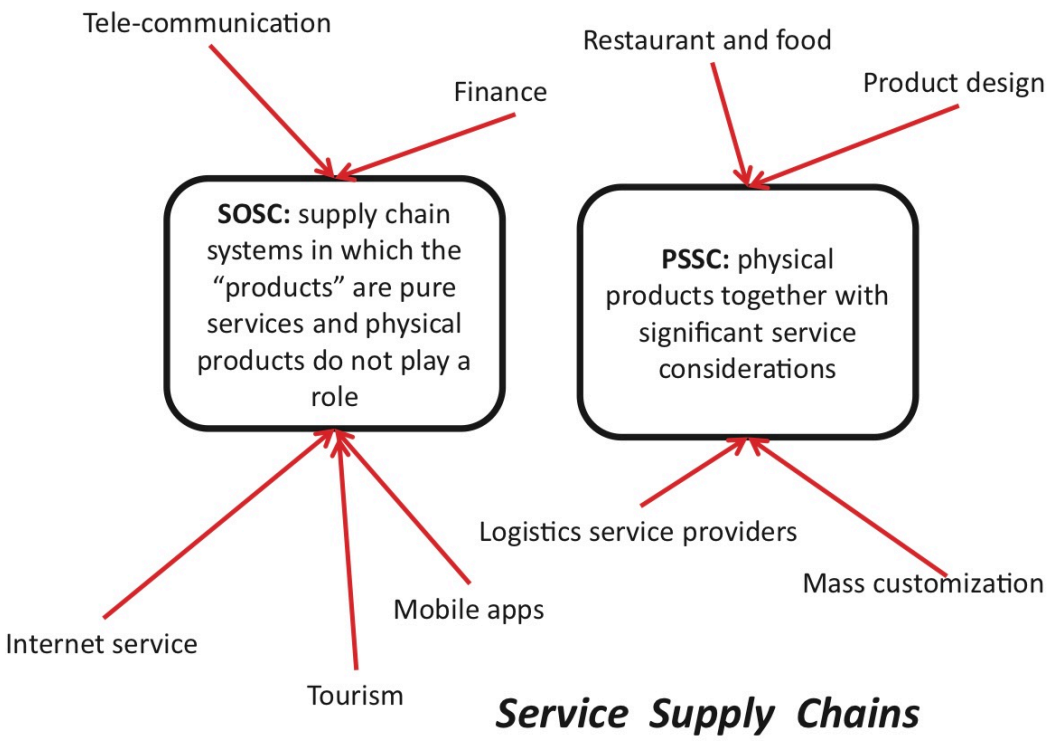

Figure 2.1 Definition of SOSC and PSSC (Wang et al., 2015)

In SOSCs, Managing the supply of services is crucial, especially when it is the only product. In such cases, the supplier often holds a significant amount of power. (Baltacioglu et al., 2007). It is advantageous to note that in the realm of service supply chains, suppliers can establish direct connections with customers, while retailers or distributors serve as valuable intermediaries. This setup allows for an efficient and streamlined process that benefits all parties involved. In the realm of Internet website hosting, the hosting provider assumes responsibility for server hosting and technical support, while the retailers function as service agents, catering to the needs of the clientele.(Wang et al., 2015). There has been a limited number of research studies conducted on supply management within this particular field, which may be attributed to the relatively short service supply chains. Furthermore, the management of supplier relationships appears to be

primarily influenced by the bargaining power of the service supplier, as well as the service re-seller, if applicable. While service supply chains are typically vertically short, they can involve multiple horizontal parties. That is also to say, while the length of the service supply chain is shrinking, service diversification is developing.

In the healthcare industry, there are also two kinds of supply chains. One of the supply chains illustrates the supply of equipment and materials in healthcare delivery. The other supply chain represents the “healthcare service” (Sampson et al., 2015). This view is consistent with the classification of PSSC and SOSC in the service supply chain mentioned above. Similarly, past research primarily focused on equipment and materials in HSSC but little on delivering "service" itself.

Healthcare companies and hospitals gather doctors, nurses, and other relevant suppliers in the healthcare service supply chain to generate service products like medical treatment, surgery, and healthcare consultancy. And then, they forward these service products to customers and patients. However, the service product in the health care industry differs from others because the service the hospital and company provide is usually a long-term treatment with a long-term trace. For instance, after surgeries, the hospital must also arrange several postoperative examinations for patients to ensure their average health. When dealing with an illness like uremia, the hospital must create a constant and continuous treatment plan to maintain their physical index. In addition, the supply chain contains the engagement of various stakeholders and different types of product flow. To ensure the quality and quantity of services in the supply chain, it is an excellent way to actively integrate stakeholders into quality and quantity management (Mathur et al.,2018).

Service supply chain management

The importance of the service sector in the global economy has led to a growing interest in service supply chain management (SSCM) research. However, the majority of the current supply chain management (SCM) literature predominantly focuses on the manufacturing industry. (Boonitt et al., 2017; Uusipaavalniemi and Juga, 2008). One key distinction between services and manufacturing is that services involve face-to-face communication between service providers and their customers. Additionally, a service supply chain (SSC) is specifically tailored to providing services, rather than just products (Maull et al., 2012). It has been noted by researchers Cai et al. (2017) and Schorsch et al. (2017) that human behavior is not always rational, as people place value on their relationships and are influenced by them.

Service products have distinct characteristics that set them apart from physical products made in traditional manufacturing. These characteristics can be summarized as IHIPCD: intangibility, heterogeneity, inseparability, and perishability (Hemilä and Vilko, 2015). Additionally, service products also involve customer participation (Aitken et al., 2016) and can be difficult to evaluate in terms of quality dimensions (Arlbjørn et al., 2011). When incorporating supply chain management strategies for customer-centric service supply chains, it is imperative to consider their unique attributes.

The focus of WSSCM lies in the realm of service-oriented supply chain management, which sets it apart from more traditional approaches that prioritize physical products (Hemilä and Vilko, 2015). Baltacioglu et al. (2007, p. 112) defined SSCM as “the management of information, processes, resources, and service performance from the earliest supplier to the ultimate customer.” Supply chain management in the context of services differs from its traditional counterpart due to the

unique nature of services. The commonly referenced characteristics of service supply chain management can be encapsulated in the acronym IHIPCD.

Boonitt et al. (2017) and Hemilä and Vilko (2015) have posited that services are intangible, yet their outputs may take a tangible form, such as the repair of a car. This view underscores the distinction between the conceptual nature of a service and the material output that results from its provision. Such a perspective is relevant to those operating in business or academic settings, where a clear understanding of the nature of services is important for effective decision-making and communication.

Services are heterogeneity. It's difficult to automate services due to their customization based on changing customer needs and business environment (Boonitt et al., 2017; Hemilä and Vilko, 2015).

According to scholarly research conducted by Boonitt et al. (2017) and Hemilä and Vilko (2015), it has been noted that services are often consumed and provided simultaneously.

Supply chain integration (SCI) is regarded as a methodical and pragmatic strategy for enhancing supply chain efficiency. (Huo, 2012). SCI is important in supply chain management (SCM) as it manages the flow of resources from suppliers to customers.(Hitt et al., 2016). SCI stands for Strategic Collaborations Initiative, which focuses on developing partnerships between firms within and across supply chains. (Liu et al., 2016). To achieve its goals, Complete SCI needs to prioritize its content and establish strategic partnerships for information and process integration. Such partnerships require shared thinking, decision-making, and planning for long-term benefits. Studies by Prajogo and Olhager (2012) and Liu et al. (2016) emphasize the importance of symbiotic effects in such alliances.Collaboration enables fast market access, economies of scale, and competency

development.The concept of information integration involves sharing important data throughout the supply chain to ensure efficient transmission and processing of information that is essential for making supply chain decisions (Prajogo and Olhager, 2012). Process integration, on the other hand, refers to the methods supply chain partners use to simplify and expedite supply chain processes (Liu et al., 2016).

Healthcare service supply chain management (HSSCM)

In supply chain management (SCM), people aim to coordinate all the information, materials, and human resources in a practical order. To coordinate all the labor in the supply chain to make them orderly and complete their work and increase the supply chain performance, relationship management, which focuses on “people” attracted people's attention. It has been proved that good coordination between suppliers and customers and good relationship management is vital in supply chain management, which could enhance an organization's innovation, flexibility, and speed (Turhan and Vayvay, 2009). Besides, supply chain integration knowledge could also be applied to solve the SCM questions and facilitate the supply chain. Supply chain integration is regarded as a way to collaborate all the recourses and crews on the supply chain to gain the best development and advantage, which is the central and essential part of supply chain management (Cao et al., 2015; Wang et al.,2018).

The supply chain management strategy in the healthcare industry is unique from other industries’ SCM (Mathur et al.,2018; Singh et al.,2006). There are two reasons for this situation. Firstly, the stakeholder in healthcare supply chain is complicated, including the patients, service providers, organizers, middle suppliers, and others. According to statistics, the healthcare supply chain only involves more than 650,000 organizations in the United States. As a result, relationship

management within the supply chain should be essential. Secondly, Consumers occupy a significant position in SC management. The reason is that in the healthcare industry, service quality is not only related to the interests of service providers but also to the safety of patients since it works on human body. Any inadvertent errors can cause serious problems. As a result, when considering to increase the efficiency of supply chain, the service quality and customer significance must be considered firstly. Efficiency management and quality management of supply chain in healthcare industry are consistent (Singh et al.,2006). Although people in many industries reckoned that efficiency management and cost control can damage the high quality, it has been proved it was not accurate (Pattanayak et al., 2019).

In addition, while supply chain management has shown efficacy in various industries, the healthcare sector has encountered difficulties in its implementation. The healthcare industry's supply chain networks present a notably intricate and complex landscape compared to supply chains in other fields. (Meijboom et al., 2011). Healthcare supply chains involve multiple partners functioning independently with undefined incentives and self-interest. This approach often results in sub-optimal linkages that lack integration and collaboration, leading to inefficiencies in the system.(van Raak et al., 2005; Billings and Leichsenring, 2005).In the HSC industry, communication, integration, information gathering, and processing pose significant barriers, leading to functional barriers and silos among chain partners (Schneller and Smeltzer, 2006; Boyer and Pronovost, 2010).

In summary, healthcare service supply chain management (HSSCM) exhibits the following key characteristics: Firstly, HSSCM encompasses a significant degree of complexity, stemming from the increasing diversity of stakeholders involved and the intricate interplay between the interests of service providers and the paramount safety of patients (Mathur et al., 2018). In addition, HSSCM

also has the characteristics of consistency of the efficiency management and quality management of the supply chain (Singh et al., 2006; Pattanayak et al., 2019). This is because the products of HSSC directly affect the health of consumers. Finally, compared with other SSCMs, there is an obvious communication problem between suppliers in HSSCM (Schneller and Smeltzer, 2006; Boyer and Pronovost, 2010).

2.1.2 "Customer" in the service supply chain

Definition of Customers in SSC

in the service supply chain, customers could be different roles due to the involvement of suppliers. Customer is generally defined as the "service user" in the service supply chain, including B2B and B2C customers. In this case, for instance, downstream suppliers are customers of upstream supplier. In healthcare, hospitals could be customers of some middle supplier. The concept of "service user" can be widely applied to almost every character on SSC.

To distinguish the concept of customer in this research from the general conception of "service user", this study use the definition brought out by Demirkan and Cheng (2008) to separate the "customer" and other "service users" like B2B and B2C suppliers. Demirkan and Cheng (2008) deconstructed SSC into three parts: the service producer for infrastructure, the retail service provider, and the customer. In these definitions of customer, the customer is only the final receiver in SSC who does not intend to sell it to others at a higher price.

In my healthcare research, the customer definition can be more explicit by changing it to the patient because healthcare service is usually customised to one patient, which does not allow scalping by other suppliers.

In understanding the customer in the service supply chain, Maull et al.(2012) believed that if we want to study the central position of the customer in the SSC, we must understand the service supply chain from the customer's perspective. It has been proposed that there exists a distinction between the outlook of organizations regarding supply chains for manufacturing and those for service. For example, as described in Figure 2.2 (Maull et al., 2012), from the service provider's perspective, the SSC is a network that integrates multiple levels of suppliers (such as from supplier 1.1.1 to provider1) and materials and information. But from the perspective of the customer, this is not the case. the customer believes that SSC is generated around the “customer”. This is also to say multiple service providers make up the SSC and SSC boundary from the customer's perspective.

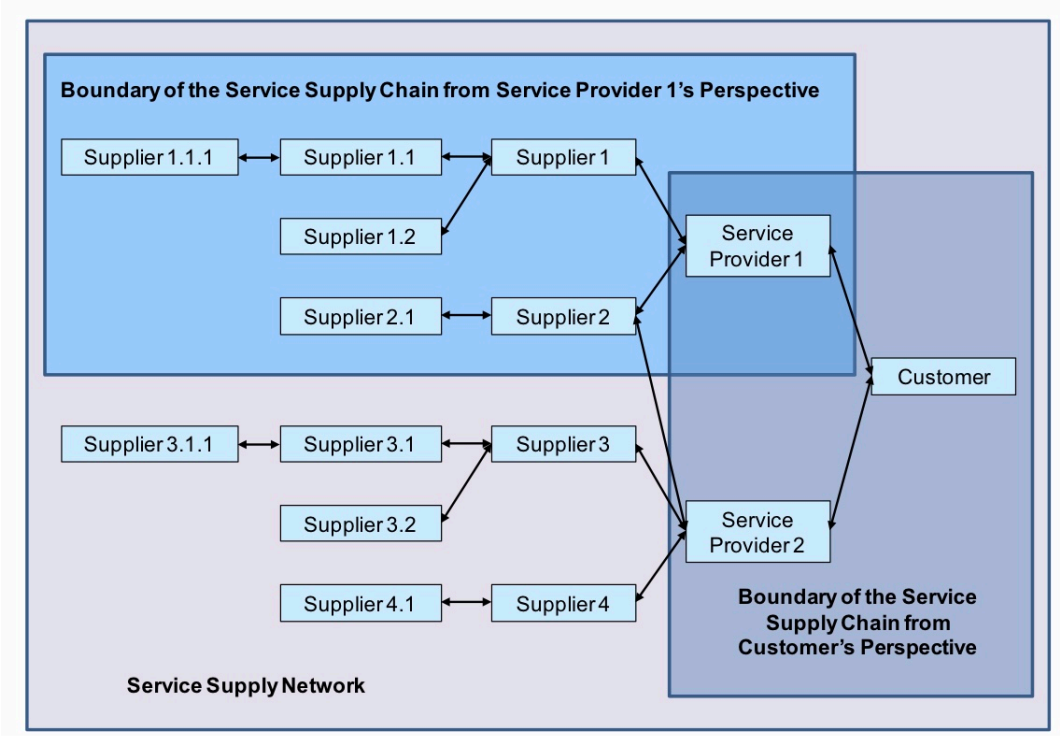

Figure 2.2 SSC from customer's perspective (Maull et al., 2012)

The way customers think about service has a big impact on both them and the service providers. In this scenario, the customer acts as either an operations manager for ongoing tasks or a project manager for one-time events. They choose who provides the service and are responsible for managing and coordinating their actions to ensure the desired outcome is achieved. This highlights the significance of an "intelligent customer," who is expected to possess or acquire adequate technical expertise regarding the services offered by various organizations. They should be capable of communicating their requirements to the service providers and effectively managing and coordinating the service provision without exerting excessive control or developing impractical expectations.

Customer roles and co-creation in the service supply chain

Customer co-creation, which helps enhance the depth of relationship management, is vital in supply chain management. It has been proved that good coordination between people, including suppliers and customers, and good relationship management is important in supply chain management, which could enhance an organisation's innovation, flexibility and speed (Turhan and Vayvay, 2009).

Customer roles were first brought out in the service supply chain to identify the key features of it. It helps distinguish the service supply chain from the manufacturing supply chain. According to Mersha (1990) and Nie (2009), the service supply chain is structurally and managerially distinct from the manufacturing supply chain. The most distinctive feature of the service supply chain is the breadth of customer involvement. Figure 2.3 below shows the traditional supply chain versus the service supply chain (Sampson & Spring, 2012).

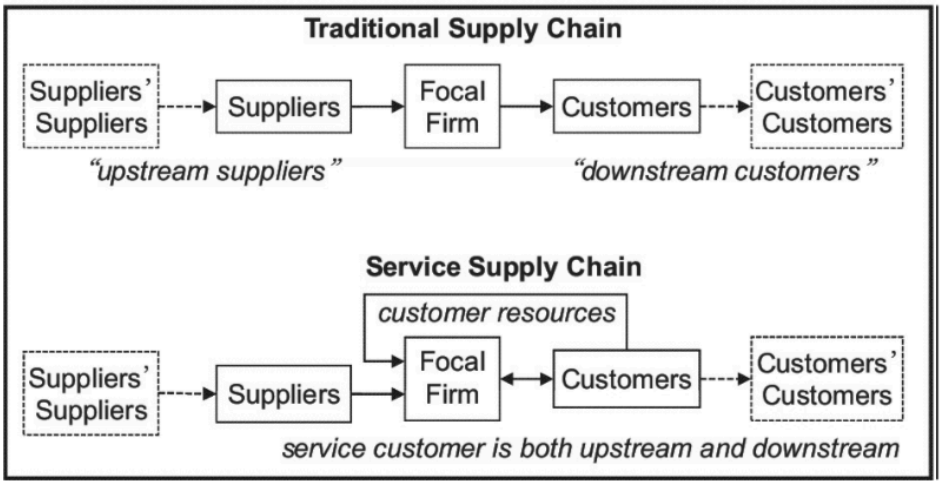

Figure 2.3 Traditional SC and SSC (Sampson & Spring, 2012)

Within the process of customer resources interference in focal firms, Sampson & Spring (2012) tested the customer roles in the service supply chain, which were divided into the component supplier, labour, design engineer, production manager, product, quality assurance, inventory, and competitor.

1. Component supplier: the service recipient usually provides part of the service that they need to receive the service. In the healthcare industry, a patient wants to restore their bodies health. In this case, the patient's body is the main component in the supply chain (Sampson, 2012). Therefore, the patients here are defined as component suppliers in the supply chain.

2. Labour: the customer is able to participate in the production activities with service suppliers. Some literature examined the concept of co-creation and co-production in the supply chain, manifesting that the customer can work as a labour in the service supply chain (Grönroos 2008; Zhang, 2015; Petri, 2016).

3. Design engineer: the customer is supposed to advise on the final product. Especially to those large-scale industrial customers, they have the right to speak and the ability to advise on product design. Chase et al. (1998) also described the situation that "Everyone is an expert on services. We all think we know what we want from a service organization and, by the very process of living, we have a good deal of experience with the service creation process."

4. Product: in this service situation, the customer who takes the service is the product of the service process (Lengnick-Hall, 1996). Like the first two types of service Lovelock (1983) classified, the service acts on the customer's body and mind. Therefore, optimising the customer's body and mind are the products in this situation.

5. Quality assurance: They have the right to return product and share their feedback about the service product. In this case, companies and service providers are affected to ensure the product quality and customer experience. Customers play the quality assurance role. However, not all customers are able to get involved in quality assurance. Like some students in the education industry and some patients in the health care industry, they can only accept the service schools and hospitals provide them (Sampson, 2012). This is problematic as patients can't always determine the quality in health care.

6. Inventory: the situation of the customer as inventory usually happens during the product's waiting time. Customers can help to keep the product before customer uses it or the next step to increase the efficiency of the service delivery process.

7. Competitor: when customers feel dissatisfied with services like food processing, they will think of doing it by themselves (Lusch et al., 1992; Maull et al., 2012)

Co-creation and customer engagement in SSC

Customer co-creation, which is defined as "a business communication connection between an external stakeholder (consumer) and an organization (company or brand) through various channels of correspondence" (Brodie et al., 2011), has been proven to be beneficial to SCM especially to SSCM by several researchers (Zhang, 2015; Petri, 2016). However, as the cornerstone of research on customers in SCM, the research about different forms of customer roles and customer co-creation in SSC is seldom explored by researchers. In business research, customer co-creation was widespread in marketing and service research because customer engagement generally appears to

relate to the sale and after-sale processes. Compared to “customer role”, “customer co-creation” includes varying degrees, whereas “customer roles” only can manifest two degrees of “yes” and “no”.

Besides marketing research, the concept of customer co-creation and co-production was gradually introduced into the field of service management (Brodie, 2011; Fonferek et al.,2019) and supply chain management (Mersha, 1990; Nie, 2009; Sampon,2012) With the prosperity of the service industry. Customer co-creation, which helps enhance the depth of relationship management, is vital in supply chain management. It has been proved that good coordination between people, including suppliers and customers, and good relationship management is critical in supply chain management, which could enhance an organisation's innovation, flexibility and speed (Turhan and Vayvay, 2009).

Jaakkola & Alexander (2014) thought, in service, The manner in which customers engage with a company has a significant impact on the resources they provide to the company and other stakeholders. This, in turn, can modify and enhance the company's offerings and influence the way in which others perceive, prefer, anticipate, or behave towards the company. When customers extend their resources more broadly, it results in a more inclusive framework for generating value. Establishing a customer engagement and value co-creation relationship is important, but this paper does not discuss its impact on the service supply chain.

Previous studies have also stressed and proved the importance of co-production and co-creation research in supply chain management (Turhan and Vayvay, 2009; Gong et al.,2019). Especially in the fact that the contemporary service industry accounts for more and more weight in the economic

world, the service studies on the collaborative relationship between consumers and service providers have become more inevitable (Boyaci and Gallego, 2004; Zhang, 2015; Petri, 2016). Nevertheless, the research on the co-production and co-creation practice could be more extensive. Most of the study emphasized engaging consumers in the final service-providing and selling processes (Kumar and Pansari, 2016; Zhang, 2015). Later, Fonferek et al.(2019) concluded that consumer engagement in service delivery, including engaging in medical consultant and healthcare decision-making, is good progress in this area. Sampon(2012) also described the co-production relations at that time by describing several customer roles in the service supply chain, including component supplier, labour, design engineer, etc. However, with the application of digital technologies like digital platform cloud computing, customer engagement in different areas was found to be motivated and grown (Saunila, 2019). Customers can participate in more service delivery links and become vital to the supply chain. Like the concept of PCC, in other words, the entire service supply chain is built around patients.

Some factors at the organisational level, such as communication, power, and reciprocity around customers, can also influence supply chain integration (Stevens and Johnson, 2016; Cao et al., 2015). Wang et al.(2018) examined three dimensions of interpersonal relations that influence SSCI in different ways: personal affection, personal credibility, and personal communication. Personal affection acts as an initiator, and personal credibility works as a “gatekeeper” and strengthens the confidence of interactive partners. In contrast, personal communication, a facilitator plays a more critical role in SSCI than personal affection and credibility.

According to Stevens and Johnson (2016), they pointed out that the connection between customers and service suppliers should be emphasised to benefit the service supply chain integration and increase the quality of service supply chain management. The situation manifests that the rational application of customer power can effectively improve the quality and efficiency of the service supply chain.

In the service supply chain, customer co-creation would also be described as the “co-production” effect, which manifests that the customer can be a supplier and producer to create value (Petri, 2016). customers’ and service users’ effects are essential because service and service products are implemented mainly around the customers. The suggestion and participation of customers can make the supply process smoother and influence product quality/service delivery to some extent (Sampson, 2012). For example, for some customised services like service in the healthcare industry, positive patient engagement can effectively alleviate the difficulty of data collection for doctors. Timely cooperation and understanding of customers can speed up the treatment process to help increase the service quality. The circumstances are similar in the education industry.

Some research also focuses on co-creation in service supply chain integration. Supply chain integration is regarded as an essential dimension in supply chain management (Hitt et al., 2016). In reviewing the research of customers in service supply chain integration, we can gain more experience on the SSCM and discover the importance of customers in SSC and the influence depth of customers on SSC.

Supply chain integration is defined as collaborating all the resources and crews on the supply chain to gain the best development and advantage. Therefore, supply chain integration research is usually

considered in supply chain management research. Interpersonal relationships, including customer relationships, have been discovered a lot in the field of supply chain integration (Cao et al., 2015; Wang et al.,2018).

Stevens and Johnson (2016) pointed out that the connection between customers and service suppliers should be emphasised to benefit service supply chain integration and increase the quality of service supply chain management. The situation manifests that the rational application of customer power can effectively improve the quality and efficiency of the service supply chain.

According to the research conducted by Wang et al. in 2018, there are three dimensions of IPRs that have varying effects on SSCI. IPRs have an indirect impact on SSCI where personal affection plays a role in initiating it, personal credibility acts as a "gate-keeper" to strengthen the confidence of interactive partners, and personal communication is the most important facilitator for SSCI compared to personal affection and credibility.

Patient engagement in the health care industry

Customer engagement in the healthcare industry, also called patient engagement, refers to the phenomenon in which patients help to plan, improve and analyse the healthcare process and help to increase healthcare delivery and quality (Hardyman et al., 2014).

To understand the customer engagement phenomenon in the healthcare industry, this study should know the specific processes that usually allow customers to participate.

Kofi and Nana (2017) classified the customer engagement process into three parts: clinical encounter process, consumption experience, and value outcomes to patients and doctors.

Patients and doctors should be cordial, interactive, and cooperative in the clinical encounter process. It is well-known in healthcare that patients who take an active role in their healthcare are better able to manage their illness or condition. This involvement helps patients feel more responsible for their healthcare journey. Encouraging patient participation is crucial and should be done whenever possible. Patients should actively provide helpful and accurate information about their symptoms to help a positive outcome. At the same time, the attitude of doctors and the doctor-patient relationship can also be found to influence the information-gathering process in the clinical encounter process (Kofi and Nana, 2017; Hardyman et al., 2014).

In terms of consumption experience and value outcomes for patients and doctors. Patients should be involved in the process with an emotional, cognitive, social and behavioural response. A positive reaction can effectively ensure the enabling environment in the service delivery.

However, patient co-creation should also be considered during service provision, besides the encounter process. This is because patients provide their condition in the first meeting with the doctor and update their condition if they need long-term treatment. In an SSCM perspective, researchers have discussed the customer roles in SSCM(Sampson, 2012). Like as a service supplier, patients have and control the primary data from themselves since they provide their health condition for the first time. As a result, patient engagement in more scenes is due to be explored currently.

Value co-creation in healthcare

The concept of value co-creation in healthcare management is relatively new in current literature. Recent studies show how patients can contribute to developing innovative services, decision-making procedures, and addressing dissatisfaction. (Yang et al., 2016; Hernandez et al., 2013;

Scholz et al., 2016; Olsson, 2016). The idea of value co-creation has played a significant role in the development of healthcare business models and open innovation, in addition to patients' involvement. Studies such as Wass and Vimarlund (2016) have made progress in comprehending the processes and interactions involved in value co-creation in healthcare settings.

The theory of value co-creation suggests that service innovation is supported by communicative structures and integrating processes. According to healthcare research, combining technology and service standards leads to innovative value co-creation. This is driven by changes in communication and inter-organizational interactions (Frow et al., 2016). Furthermore, when customers (patients) participate in value creation, it can impact healthcare organizations' internal and external capabilities, including innovation costs and time, service quality, and relationship dynamics (Hernandez et al., 2013).

2.2 Service innovation

2.2.1 The development of service innovation

With the development of the service and ICT application on service, researchers are increasingly concerned about the development and innovation of the service industry. Meanwhile, As people's living standards improve in both developed and developing countries, they start to expect and demand more personal services such as healthcare, education, and entertainment. This leads to growth in the personal services sector. However, as organizational structures become more complex and value networks span multiple organizations, there is a greater need for professional coordination services. These services can be provided internally by the organization (e.g. supply

chain management) or outsourced to specialized firms (e.g. supply chain mediation, third and fourth-party logistics, professional service firms). Globalization and government regulations have impacted economic and environmental compliance.

Therefore, with the continuous development of services, research on service innovation has gradually come to the forefront of everyone's mind. Firstly, ICTs have long been recognised for their ability and importance in stimulating service innovation(Barras 1986). ICTs have traditionally been seen as technological tools that aid in the delivery of services. This approach to service innovation aims to increase the productivity and efficiency of service firms, which could eventually result in the emergence of new markets or service categories (Barras 1990). Some scholars have challenged the idea that innovation in service industries is fundamentally different from innovation in manufacturing. They argue that all economic transactions involve services, and that information and communication technologies (ICTs) are crucial in transforming and improving service innovation. (Lusch and Vargo 2014; Vargo and Lusch 2004, 2008a, 2008b). Information and Communication Technologies (ICTs), in conjunction with requisite expertise and knowledge, facilitate the transportation and repackaging of information, thereby generating novel opportunities for innovation and service exchange (Lusch and Vargo 2014; Klinker et al, 2019). According to research on digital infrastructure (Tillson et al., 2010), digital technologies (Henfridsson and Byzstad, 2013) possess a generative quality that can enhance service innovation (Yoo et al., 2012). The use of information and communication technologies (ICTs) alone does not solely drive service innovation. Instead, the combination of various digital technologies, information, and other resources results in this enhancement.

In addition, a large part of the research on service innovation is devoted to distinguishing service innovation from product innovation in the manufacturing industry (Damanpour et al. 2009; Miles, 2008). They argued that the current understanding of product innovation based on technological advancements is insufficient for explaining successful innovations in service organizations. First, Barras' (1986) model on the reverse product cycle demonstrated the innovative patterns of the service industry and acknowledged the crucial role that information systems play in this process. He argued that compared to the product innovation, the process of generating service innovation led by ICTs is "reverse" in the service sector. Studies have been conducted on service innovation across various industries such as healthcare, education, and entertainment. Open standards and architecture in public sector services enable service ecosystems, allowing for disintegration and reaggregation (Fishenden and Thompson, 2012). In the legal services sector, Sako (2010) investigated the impact of digital innovation on global value chains, specifically how firms use modularity or break down their value chain with the rapid growth of new service providers.

Researchers have also made many efforts to depict and pattern service innovation. Den Hertog (2000) and Miles (2008) have identified four essential dimensions of service innovation, namely, service concept, client interface, service delivery system, and technology. It is often observed that many service innovations involve a combination of these dimensions. When a new service is introduced, it may require a new system for delivery and updates to the client interface. Innovating a service in one aspect can also lead to necessary changes in other aspects within and between companies in a particular industry. According to Miles (2008), the concept of service innovation should be approached as emergent, interactive, and dynamic, given that services are performed for specific customers under particular circumstances. This approach also requires a high level of

knowledge and information as communication flows between service providers and their customers. Hence, it is crucial to recognize the importance of communication and understanding in the process of service innovation. Sako (2010) examined how law firms decide which services to outsource or retain. Professional services rely heavily on information and communication technologies, which affect the structure and culture of law firms and their institutional practices.

Certain scholars posit that the differentiation between products and services may lack significance given that products necessitate service and services involve tangible objects (Bryson et al. 2004; von Nordenflycht 2010). Cloud computing involves selling computing services instead of physical computers to clients. Servitization strategies enable organizations to shift from selling products to offering integrated product and service solutions.

While scholars argued about the distinctions between service innovation and product innovation, Vargo and Lusch (2004, 2008a, 2008b) have brought out an alternative, transcendent, service-centred logic theory —— service-dominant (S-D) logic. The S-D logic approach involves reimagining service as a resource-driven process that benefits oneself or others, rather than the traditional view of services as intangible products or units of output. This means that knowledge and other resources are utilized to provide assistance and support to others in a meaningful way. (Vargo and Lusch,2004, 2008a, 2008b). After the S-D logic theory, it quickly gave rise to service innovation by understanding and recognizing it in a new way.

Therefore, based on a new definition and understanding of service (SDL), whether researchers' understanding of the development of service innovation is accurate and whether it is in line with the current digital transformation environment are all worthy of attention. At the same time, the issue of patterning service innovation is still essential in today's rapid development of the service industries.

2.2.2 Service innovation and service-dominant-logic (SDL) model

In order to figure out the innovation in patient roles in HSSC, the service innovation should be first identified in this research. Because the whole study is based on the concept of service, the acquaintance of the service innovation can help this research to find a scope from the definition of service and healthcare service to the judgement of innovation.

In economics, a service is a transaction in which no physical goods are transferred from the seller to the buyer. Service management generally considers service concepts as activities that transfer no physical product from providers to users. Information systems are considered information services that aid in innovation of administrative, technological, and integrated processes. (Lyttinen and Rose 2003). There is a prevalent trend for companies to transform their business from providing equipment to providing service (Barrett, 2015). This is because the business scale of service has increased in the last decade. Many organizations and companies are trying to find ways to upgrade their business. For example, IBM was a company that provided computer equipment and software. After digital transformation, it successfully changed its model to deliver IT services for companies (Spohrer and Maglio 2010). Service study will be an essential field for future research.

However, there are still arguments about the nature of "service". Vargo and Lusch (2004) proposed that 'goods are distribution mechanisms for service provision' and that 'economic exchange is fundamentally about service provision'. Gummesson (1993) proposes that customers don't purchase goods or services, but rather they acquire offerings that provide services and generate value. These offerings are commitments from service providers that can be exchanged in the market.

Vargo and Lusch presented a new perspective called 'service-dominant logic' based on certain arguments. According to this approach, services are a fundamental aspect of both services and products. The viewpoint suggests that goods are not the ultimate goal, with value inherent in them. Instead, value can be augmented by improving or increasing certain characteristics that the customer can benefit from during the exchange process(Vargo and Lusch, 2004). Every product or good serves a purpose, and the value it provides is determined by the context of the service it offers. The fundamental goal of business activities is to provide a service, which is defined as the utilization of competencies such as knowledge and skills by one party to benefit another. (Vargo and Lusch, 2004).

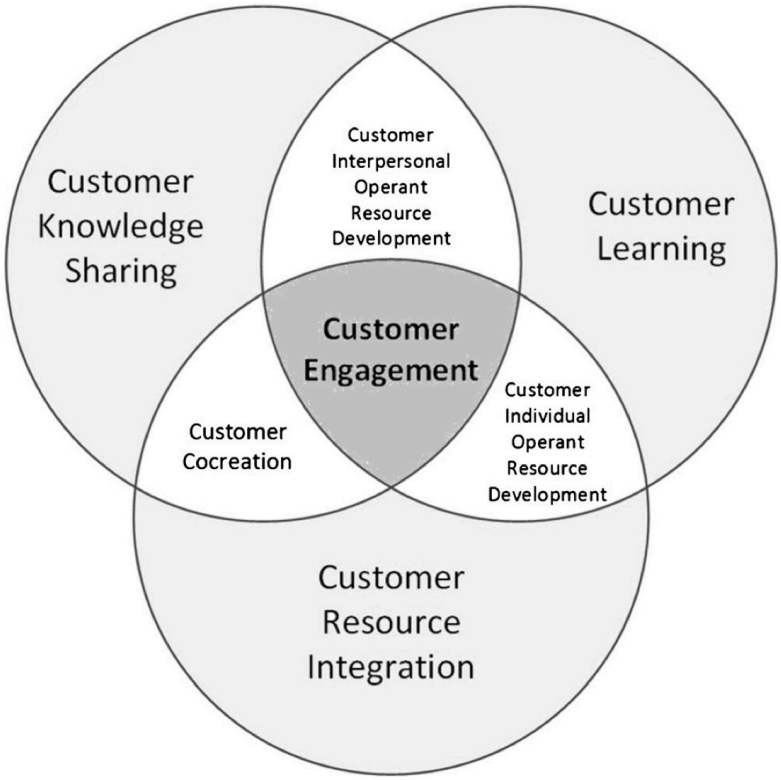

Figure 2.4 SDL and customer engagement

With the upgraded understanding of service, In the SDL model, service is considered as a process that gathers the resources of all parties and Stakeholders to achieve. Unlike the traditional understanding of services, SDL believes that customers are essential to services. Therefore, the importance of the customer in the process of service and service delivery is also emphasized. Hollebeek (2019) established the S-D logic–informed framework of customer engagement (figure 2.4) to describe the relationship between customer and SDL. As shown in Figure 2.4, Hollebeek (2019) believed that only the customer-related process that satisfies customer knowledge sharing, customer learning, and customer resource integration could be called customer engagement. This model also provided the most detailed and rich definition of the customer's performance in the service. The specific concepts are shown below:

Customer engagement: “A customer’s motivationally driven, volitional investment of focal operant resources (including cognitive, emotional, behavioural and social knowledge and skills), and operand resources (e.g., equipment) into brand interactions in service systems (Vargo and Lusch 2016; Hollebeek et al. 2014).”

Customer resource integration: “A customer’s incorporation, assimilation and application of focal operant and operand resources into the processes of other actors in brand-related utility optimization processes (Vargo and Lusch 2016).”

Customer knowledge sharing: “A customer’s communication of specific perceived brand knowledge (including information- or experience-based knowledge) to other(s) in their network for the purpose of creating value for themselves, the recipient(s), or both (Kumar and Pansari 2015).”

Customer learning: “An iterative process that involves a customer’s development of mental rules and guidelines for processing relevant brand-related information, the acquisition of new brand knowledge or insight, and ensuing behavioural modification based on new brand knowledge or insight gained (Mena and Chabowski 2015).”

There are also several scholars who study the SDL in the healthcare industry. Nyende (2018) applied the S-D logic model to his study. He explained that the active participation of patients in healthcare alignments with the service-dominant (S-D) logic in which customers are co-creators of value. He et al.(2016) also stressed the underlying idea of S-D logic: humans apply their competencies to benefit others and reciprocally benefit from others' applied competencies through service-for-service.

Similarly, in healthcare service delivery in this research, the healthcare service could not be recognised as a product created by institutional organizations. It should be interpreted as a process that integrates professionals’ knowledge, equipment from the institution, digital technologies applied, and patient cooperation. As a result, with the understanding of S-D logic in the health care industry, the patients in service delivery are not only the party who accepts the product but also the coordinator for their own requirement of healthcare service. In this situation, patients should be recognized as healthcare managers, consistent with the concept of patient-centered care(PCC).

2.3 Digital transformation in the healthcare industry

2.3.1 Digital transformation

The definition of digital transformation is a change and improvement to SSC efficiency and quality because of the acceptance and application of transformational information technology (Lucas et al., 2013). For the digital transformation of service, evidence could prove that the transformation has occurred in many industries and companies. For example, with communication technologies in the healthcare industry, hospitals can collect feedback from social media platforms, increasing contact with the patient and also helping the hospital improve their service quality (Noveck 2015; Zhang et al. 2015). Additionally, with information processing technologies like big data and cloud computing, IBM Watson first and creatively brought out the plan, which uses big data and cloud databases to process an extensive range of data. Data analysis and knowledge will generate personalised treatment solutions in more healthcare scenes(O'Driscoll, Daugelaite, & Sleator, 2013).

Digital transformation is based on the improvement of digital technologies. Information technologies are regarded as essential technologies to service transformation. And IT(information technologies) was considered the main factor that triggered the digital transformation in service (Hirschheim and Klein 2012).

To conclude, the above technologies are classified by scholars as technologies that can be widely used in the field of service improvement (Ardolino et al.,2017). These technologies are often related to information processing upgrades. Meanwhile, the quick and effective information collection and processing can vastly enhance the information interaction between organization, supplier and

customer. In this case, customer interaction under digital circumstances is valuable to discuss further.

Digitalization and digital transformation

In the digital age, "Digitalization" and "Digital Transformation" are two frequently mentioned concepts, yet they vary in terms of definition and scope. Below are the primary distinctions between the two:

By definition, "digitalization" refers to the process of converting physical or non-digital information, processes, and objects into digital form. It focuses on converting data and information into digital formats so that computer systems can understand, process, and store them. In simple terms, digitalization focuses on converting existing business processes, documents, information, and assets into digital form to be more easily stored, managed, and processed (Zaman et al., 2022). ”Digital Transformation" is a broader and more strategic change process that involves rethinking the entire business model, organizational structure and culture to adapt to the changes in the digital age. It is not just a digital process but also about reshaping the business through digital technology. Digital transformation focuses not only on the digitization of data but also on the application of advanced digital technologies inside and outside the organization to drive business innovation, increase efficiency, improve customer experience, and maintain competitiveness in the market (Creazza et al., 2021)。

In terms of scope, “Digitalization” focuses more on the technical level, focusing on the digital representation and storage of data. It is one of the basic steps in digital transformation, but it only stays on the conversion of data formats (Zaman et al., 2022). “Digital Transformation” is broader

and involves changes at the entire organizational level. It requires organizations to adjust in multiple aspects, such as strategy, culture, and operations, to adapt to the challenges and opportunities brought by digitalization (Creazza et al., 2021; Tana & Chai, 2023).

Based on the above analysis of the differences between "digitalization" and "digital transformation", this article mainly analyzes the impact of digital technology applications on service supply chain and service operation. Therefore, it is more reasonable to apply the concept of "digital transformation" in this article.

2.3.2 Digital transformation in healthcare

A recent report by the World Bank suggests that implementing digital technologies can enhance health systems, improve health financing and public health, and broaden coverage of underserved populations. The study revealed that digital technology and data prove beneficial in the prevention and management of chronic diseases, provision of care for both young and elderly populations, and readiness for future health crises and hazards arising from climate change. (The World Bank, 2023).

According to the literature about digital transformation described above (Ardolino et al.,2017; Hirschheim and Klein, 2012), interaction abilities are one of the most critical functions of digital innovation. With the involvement of communication technologies/processing technologies, increasing interaction makes more information exchange during the supply process. The application of this interaction might be helpful in healthcare. A lot of research has been conducted to explore this issue.

The introduction of digital innovation across various industries has become a powerful force for transformation. Although most industries are going through evolutions due to digital technologies,

the severity of digital transformation in each industry differs. The healthcare industry is currently experiencing a digital transformation. It is paramount to thoroughly evaluate and elucidate these changes, given the considerable investments involved and the potential consequences (Burton-Jones, 2020). The advent of digital transformation offers a unique opportunity to elevate the healthcare sector's performance through reducing costs and enhancing care quality (Burton-Jones, 2020).

Many countries' healthcare systems struggle to maintain quality care as their populations age (Granström et al., 2020; Öberg et al., 2018). However, the demand for high-quality healthcare services is increasing with the shortage of healthcare professionals worldwide. Patient engagement was introduced under this circumstance to resolve this contradiction between the demand for high-quality care and the healthcare professionals shortage (Granström et al.,2020; Öberg et al.,2018). In healthcare, patient-centered care(PCC) and telehealth have taken advantage of patient engagement to solve the problem. This allows patients to complete part of the work in the service supply chain and reduces the burden on medical staff. The dynamic between patients and healthcare professionals has undergone significant changes, thereby necessitating the establishment of novel forms of collaboration.

Telehealth and digital transformation

Telehealth and digital healthcare utilize technology to support remote healing (Leite et al., 2020). Hakim et al. (2020) have observed that telephony, video, instant messaging, mobile applications, and messaging services offered by the health system are utilized to oversee and monitor vital patient metrics. Telehealth is a medical practice that utilizes digital technologies, such as smartphones,

computer tablets, and video conferencing, to facilitate remote medical care. This includes services such as diagnosis, treatment, monitoring, and advice. By leveraging these technologies, healthcare providers are able to provide high-quality care to their patients without the need for in-person visits. This approach has become increasingly popular in recent years, as it offers numerous benefits, including increased access to care, improved patient outcomes, and reduced healthcare costs. Overall, Telehealth represents a promising and innovative approach to modern healthcare delivery. Much of this growth is attributed to the benefits of telemedicine, including reduced travel, fewer missed appointments, and shorter wait times. Telemedicine also improves cost management and provides convenient and readily accessible medical information (Beaulieu & Bentahar, 2021).

Recent years, with the wide application of digital tools, the healthcare self management and telehealth are able to expand their advantages in a larger scene. For example, There is a healthcare service co-delivery model in telehealth being applied by a company called "Smile Direct Club" to help improve patients' teeth conditions and smiles. This company was established in 2014 and has achieved significant success by effectively utilizing digital technologies and enhancing customer engagement (Taulli,2019). It successfully uses customer engagement to reduce personnel costs and material costs in the process of service provision. In addition, This transformation also make customers convenience, reduces the time for customers when visiting a doctor, and reduces the economic burden to customers.

In telehealth from “Smile Direct Club”, patient collaboration is essential. The patient first needs to pay attention to and monitor his condition regularly according to the instructions of the system. Secondly, they still have to upload physical information on digital platforms by taking pictures or

using other medical equipment. After their doctor checking their condition, they need to follow their instruction in the next process. This process can be illustrated as follows (figure 1). Apart from the first two steps, which are meeting doctors and getting medical solutions, other steps of this telehealth delivery model can happen outside of the healthcare institution. The patient assumes the responsibility of the nurse to check, record the report, and upload the report to the doctor, which largely solves the problem of tight medical resources. Although this model is currently only suitable for certain diseases, the advantages and transformation of healthcare service delivery are stupendous (Taulli,2019).

Digital transformation in medical data management

Medical data usually include "medical records and images, doctor's notes, test results, e-prescriptions, insurance claims and policies, as well as the huge volumes of information generated by IoT devices"(Haggerty, 2017)

To write and organize medical data, doctors usually need put a lot of effort on it. The medical record, which is provided by patients and handed by other healthcare staff like nurses and doctors and filed in the data system, relates to a complicated collection process. Each of these steps will affect the quality and efficiency of medical data collection. It has been a long-time hot research topic to figure out how to increase the quality and efficiency of the medical data management process (Free, 2013; Niemöller et al., 2017; Klinker et al.,2019). In supply chain management, the situation is similar as an efficient supply system will relieve the caregivers of the duties and stress associated with supply function, allowing them to focus on what they do best (Singh et al., 2006)

Especially for some treatments that require a long time to be traced, every step of data collection must be repeated. Like in orthodontic treatment and other general dental treatments, after dental treatment, many corrections and inspections are often required (Kravitz, 2016). In this case, the patient must rebook a diagnosis meeting with the nurses and dentists multiple times to provide them with more information about their current state to help them formulate the next step. It wastes a lot not only patients but the healthcare givers and healthcare institutions. Digital technologies bring life to this stalemate. Researchers recently started to find solutions with more digital technology applications.

M-health technologies to help improve the health service process (Free, 2013). It showed that there was a significant relevance between the acceptance of mobile technologies and communication between doctors and nurses after reviewing trials in these areas. M-health technologies were also helpful in reducing the correlation between diagnoses and mobile technology photos. Although M-health technologies like the smartphone could be beneficial in making the communication process fluent to some extent, hospitals and caregivers still have not accepted them on a large scale (Czuszynski et al., 2015).

Klinker et al. (2019) examined the application of smart glasses in hospitals, confirming that doctors preferred to adopt them daily.

According to the literature review in this section, this study found that digital transformation in healthcare services has the following characteristics:

1. Patient-centered smart services: Digital transformation improves patients' medical experience, making the medical process more convenient and faster through online appointment

registration, information reminders, mobile payment and other functions. With the help of mobile phones or computers, patients can achieve remote medical consultation, remote monitoring and other services, reducing medical treatment time and transportation costs (Granström et al.,2020; Öberg et al.,2018).

2. Medical informationization and intelligence: The introduction of an electronic medical record system to digitize patient information and medical records makes it easier for doctors to find and share patient information, thus improving the efficiency of medical services (Niemöller et al., 2017; Klinker et al.,2019).

3. Telemedicine and balanced medical resources: Using telemedicine technology, medical resources can be extended to more remote areas and places, solving geographical limitations and uneven medical resources (Taulli,2019).

4. Improve the efficiency and quality of medical services: Digital transformation improves the efficiency and quality of medical services by reducing the waste of medical resources, increasing the accessibility and appointment availability of medical services, and improving the efficiency of doctors' diagnosis and treatment (Hirschheim and Klein, 2012; Ardolino et al., 2017; Mertens et al., 2017).

2.3.3 Healthcare supply chain and digital application

Within the healthcare industry, there are two distinct types of supply chains. One of these involves the dissemination of equipment and materials that are used for the provision of healthcare services. The delivery of healthcare involves patients providing their physical conditions and service providers delivering healthcare services (Sampon et al., 2015). This research considers the latter supply chain which mainly considers the healthcare supply chain as a service supply chain to deliver healthcare service.

When it comes to digital transformation in healthcare, hospitals tend to focus on implementing traditional technologies like enterprise resource programs (ERP) and electronic data interchange (EDI) to integrate their supply chain (Bentahar and Benzidia, 2019). Studies show poor collaboration between internal and external SC players, due to fragmented information systems in the sector (Schneller, 2018). Recent studies have highlighted the advantages of implementing innovative technologies like RFID, AGVs, and IoT in hospitals. These technologies have been found to have numerous benefits, as documented by Bechtsis et al. (2017) and Morenza-Cinos et al. (2019). However, these studies have not focused on the impact of these technologies on supply chain management.

Research is currently being conducted on the digitalization of supply chain management in healthcare. However, previous studies on healthcare supply chains have primarily focused on the hospital as the central point of consumption and the ultimate point of uncertainty (Forrester, 1958; Christopher, 1998). Beaulieu & Bentahar (2021) studied the digitalization with the hospital as the

center. Markarian (2019) explored digitalization by simultaneously embracing all links in the supply chain. Rubbio et al., (2019) focused on the digital transformation of movement of patients in the hospital, While this research from the perspective of digitalization of patient roles in supply chain.

Beaulieu & Bentahar(2021) concluded the current digitalizations in healthcare supply chain management and their impact in the following chart (figure 2.7). They introduced the healthcare institutions were upgrading their information system to manage stocks, manage medical suppliers, improve the internal supply chain and make logistics networks more dynamic.

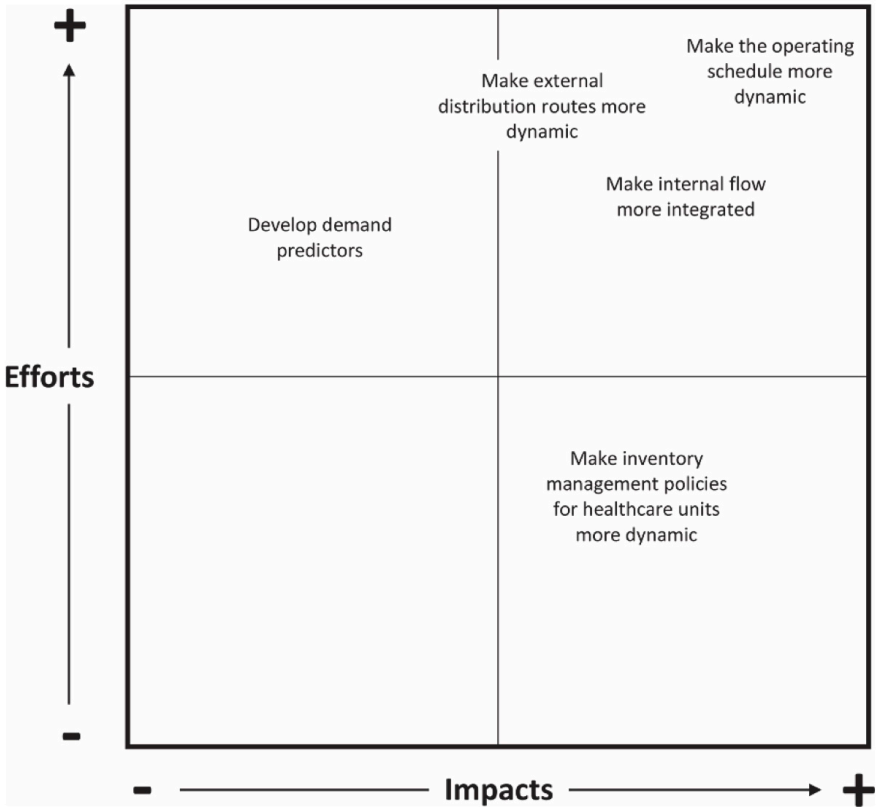

Figure 2.7 Digitalization in HSSC and impacts

As can be seen from figure 2.7, the left side from bottom to top refers to the digital efforts made by the healthcare institution, and the bottom side from left to right refers to the impact on the healthcare supply chain under different efforts. As can be seen from the figure, in terms of develop demand predictors, more efforts will bring fewer impacts, and in terms of make inventory management policies for healthcare units more dynamic, fewer efforts can bring more profound impacts. The other three aspects in the figure correspond to more effort and higher impacts, respectively (Beaulieu & Bentahar, 2021).

Digitalization is helping disperse healthcare facilities, such as clinics, rehab centers, and specialized surgery centers in HSSC. The dispersion of healthcare services is largely driven by demographic trends, with healthcare network managers striving to provide patients with access to medical care in the comfort of their own homes. This approach is aimed at improving patient outcomes and overall satisfaction levels. Garagiola and colleagues (2020) highlight the importance of delivering health services closer to patients, which has been shown to have a positive impact on patient health and wellbeing. By bringing healthcare services directly to patients, healthcare providers can help to reduce the need for hospitalizations and other medical interventions, while also improving access to care for those who may face barriers to accessing traditional health services.

New information technologies highlight telemedicine, which physically disconnects patients and doctors (Beaulieu & Bentahar, 2021). Basic vital signs can now be checked remotely with the new generation of telemedicine, allowing for long-distance diagnosis and dispersal of healthcare providers to workplaces. However, healthcare services must be more flexible for the SC to distribute necessary pharmaceuticals and medical supplies after consultations.

A Canadian healthcare facility entrusted a supplier to deliver medical supplies to a vulnerable client with limited mobility and intellectual disability. To cater to small batch distribution, the supplier had to improve its logistics infrastructure, which involved setting up a pick-up zone, using a delivery fleet that was better suited to the task, and adapting their customer service to provide answers to specific queries. This chain must coordinate with new clinical partners who are not traditionally included in the logistics chain (Beaulieu et al., 2018).

2.3.4 Key characteristics of the digitalization of service supply chain

It has been acknowledged that effective value creation requires companies to engage customers' knowledge in the service supply chain under digitalization (Boyaci and Gallego, 2004; Zhang, 2015; Petri, 2016; Gong et al., 2019). Especially for digital businesses, customer relationships are at a crossroads, as new technologies are more often used to empower and engage customers (Straker and Wrigley, 2016). The discussion on the digitalization of the service supply chain needs to pay more attention to the impact of digital technology applications on "service" compared to manufacturing products. Therefore, customer collaboration and customer co-creation are the key characteristics of the digitalization of the service supply chain, which are also the main content of this paper (Solaimani & van der Veen, 2021).

Specifically, in customer co-creation, the key characteristics of the digitalization of service supply chain include the following aspects:

1. Establishing direct interaction: In service provision, it is necessary for customers and (employees within) organizations to be in contact. This does not necessarily have to be face-to-face contact (indeed, the added value of new technologies is often exactly in removing the need for it), but there should be the opportunity for direct interaction. One of the difficulties at the time was to know who the potential co-producers were and how to get in touch in them. Even to this day, a major problem in service supply chain is that the different parties are simply not aware of each other (Lember, 2019).

2. Bringing resources to the service: Both customers and suppliers bring individual resources into the process. Both will at least offer time and their particular expertise. For example, teachers know best how to educate children generally, parents know their own children best (Honingh, Bondarouk, and Brandsen, 2018). With the help of digital platforms in service supply chain, it is easier for customers and suppliers to interact and integrate their resources for the achievement of the better service. This is the element that past research has demonstrated most successfully, for example, how different parties contribute to the regeneration of their neighborhoods (Vanleene, Voets, and Verschuere 2017) or how patients bring expertise to their treatment (McMullin and Needham 2018).

3. Sharing decision-making: Co-creation presumably shifts decision-making power from service providers to customers. Studies have shown that the role of the customer can range from providers of services with full responsibilities to active co-producers, to consumers, to passive beneficiaries (Pestoff 2018).

2.3.5 Challenges in Healthcare service delivery

Healthcare systems currently face significant changes and challenges worldwide, both in developing and developed countries, due to the contradiction of the shortage of healthcare professionals and increasing demand for high-quality healthcare services. The current situation is basically caused by demographic and economic changes. The changes are mainly based on the increasing number of elderly population(WHO, 2016) and growing healthcare spending (Papanicolas et al., 2018) around the world.

Many countries' healthcare systems struggle to improve care quality as their populations age (Granström et al.,2020; Öberg et al.,2018).WHO (2016) noted that shifting global demographics are straining healthcare systems. According to the European Commission (2018), the growing elderly population is a major concern. Meanwhile, Kharas (2017) estimates that by 2030, 65% of the global population will be middle class. As societal demographics undergo a shift, healthcare needs are evolving alongside an increase in chronic illnesses, mental health conditions, and obesity, among other concerns (Deloitte, 2019). Moreover, heightened migration and the presence of diverse ethnic groups in certain areas can pose challenges for healthcare providers who may not have experience in addressing such diversity (Ahmed and Foster, 2010).

Meanwhile, According to Papanicolas et al. (2018), healthcare expenditure is predicted to increase in the future, not on account of greater utilization, but because of escalating administrative and professional costs. The healthcare costs are rising due to increased spending on drugs and higher salaries for medical professionals (Papanicolas et al., 2018). Administrative issues include

inadequate knowledge of covered costs for various structures, and inability to relate care costs to outcome efficiency (Kaplan and Porter, 2011). The current circumstances have resulted in a push for healthcare systems to adopt a "value agenda" that prioritizes the cost-effectiveness of healthcare services in a transparent manner (Porter and Lee, 2013). Implementing such a system requires a significant mindset shift among healthcare personnel to facilitate policy and procedural changes.

Based on U.S. data, healthcare expenses accounted for more than 17% of the country's gross domestic product in 2012. Over the past five years, healthcare spending has increased by approximately 3.7% annually, and in previous decades, the increase was typically even higher, as reported by Kaplan and Porter in 2011. It is crucial to control healthcare expenses and improve healthcare outcomes for the well-being of both our economy and citizens. These healthcare concerns are not exclusive to the United States, as other countries also face similar issues (Sampon et al., 2015).

Although the demands for medical services is constantly increasing, the service quality required by the patients does not decline but rise. The concept of people-centered healthcare service was initially brought out by the World Health Organization in 2009 to create a framework putting people at the centre of healthcare. Since then, many healthcare system from variable countries tried to achieve the PCC to fulfill this new requirement for medical service. however, there are still problems to achieve it. There are several main barriers that hinder effective communication in healthcare. These include the absence of necessary information and proper methods to gather it, lack of trust, respect, and reliable exchange of information, organizational culture, as well as clinicians' demographics, beliefs, and training. Additionally, external factors such as incentive

alignment play a significant role. The contemporary healthcare systems need a redesign to facilitate closer collaboration between healthcare beneficiaries and professionals (Sinaiko et al., 2019).

According to Patrício et al. (2020), healthcare providers have fragmented into different specialties, external labs, insurance providers, and competing practices. A major problem in the United States is the complex network of insurance plans and varying costs for medical care and procedures. Although advancements in medicine have improved the ability to perform intricate procedures, they have also resulted in larger medical teams and more complex workflows(Barjis, 2011). Therefore, effective collaboration and information sharing among healthcare units is crucial for successful treatment outcomes. Failure to do so can result in serious consequences, including medical errors, delays, and increased costs. Healthcare organizations must prioritize the development of robust communication strategies to ensure high-quality patient care.

One challenge is the distribution of healthcare facilities, such as clinics, rehab centers, and specialized surgery centers. The rationale for this dispersal is grounded in demographic trends. Healthcare network administrators are actively implementing strategies to streamline the process of delivering health services to individuals in the comfort of their own homes (Garagiola et al., 2020).

Besides, the PCC still brought great challenges to SSCM. Isolated examples of people-centered care/ family-centered care can be found in many hospitals. However, not every hospitals are able to provide PCC service to every patients. When everyone need the higher quality care like PCC, only a few of them can genuinely receive that service (Johnson & Abraham, 2012). however, in a long time, the high-quality services PCC provided are expensive which means a large part of people

cannot afford such service because it requires patient consultation and scrupulous care from medical staff. Physician-centered healthcare service as a traditionally way is a way to save medical expenses and improve medical efficiency under limited medical staff resources(IPFCH,2004). Therefore, when the healthcare professionals provide the PCC to solve medical problems and increase healthcare service quality, It is particularly important to establish a healthcare delivery solution so that every patients are able to obtain PCC service.

Digital solution

The field of healthcare has seen the emergence of new services in the information sector, which have helped streamline record keeping and integrate patient data across various providers. This has led to a more personalized and patient-centered approach to healthcare, resulting in improved effectiveness (Pinho et al., 2014; Bolton et al., 2018). New technologies are expected to expand the use of artificial intelligence and machine learning in diagnosing medical conditions, as well as introduce robotic medical assistants, virtual reality medical visualization systems, online healthcare, and related products. These advancements will likely enhance the medical field even further (Deloitte, 2019). In an ideal scenario, these advancements could ease the burden on healthcare workers and enhance service delivery.

Furthermore, certain modern digital platforms aid in improving co-creation within PCC. Zhou et al. (2019) presented a novel mobile Personal Health Record (PHR) application called PittPHR that simplifies managing diverse personal health information to bridge the knowledge void. The PittPHR app consists of six main modules: health records, history, trackers, contacts, appointments,

and resources. Users can personalize their trackers based on their preferences. The app's personal health record (PHR) system empowers patients to take charge of their own healthcare by enabling them to manage and monitor their health data (Roehrs et al.,2017).

The implementation of new technology can bring about certain risks and challenges. There are still some ethical problems around the digitalization in healthcare. Automating medical procedures can make patients feel disconnected and raise concerns about safety, control, transparency, and privacy. The healthcare industry has yet to fully capitalize on the vast potential offered by emerging technologies and data. Despite their significant benefits, these resources remain largely untapped (Kellermann and Jones, 2013).

Solution from service management and digitalization

Although the concept of PCC and telehealth have been brought out to improve service quality and reduce the burden on medical staff to a certain extent simultaneously. The progression towards a patient-centered and cohesive model of care has faced obstacles due to conventional practices that regard patients as passive beneficiaries of healthcare, as well as a fragmented and increasingly intricate system (Lee, 2010). The potential for significant healthcare advancements through emerging technologies and data is vast, yet largely unrealized (Kellermann and Jones, 2013). It is important to integrate co-creation and digital technologies into current healthcare practice to transform it into a system suitable for PCC.

Under this circumstance, with the popularity of people-centered care(PCC) in healthcare industry recent years, scholars (Patrício et al.,2020; Borja, 2017; Huetten et al., 2019) in service management areas were also starting to study the people-centered care service system to support the PCC practice and explore the management issue around people-centered service.

In 2019, Huetten et al. conducted a study on the effects of occupational stereotypes in human-centered service systems. Their research aimed to contribute to the current service research priorities by exploring the concept of value co-creation in collaborative settings such as healthcare, and to investigate the evolving role of healthcare customers in this context. However, when they mentioned the relation between occupational stereotypes hold by patients and patient participation in PCC service system, they failed to specifically introduce the human-centered service system and analyze the operational transformation of co-creation in that system. By contrast, Borja (2017) briefly defined that the outstanding feature of human-centered system in the area of service in artificial intelligence is that the system will collaborate with humans, not seek to replace them. Sociotechnical systems consist of both human components and physical objects that possess a form of intelligence. These systems also have interfaces that enable interaction and exchange of information between humans and machines in innovative ways. Consequently, they broaden the notion of service systems.

With the concept of human-centered service, these papers above still could not specifically describe the PCC system practice until Patrício and his colleagues (2020) tried to associate PCC to service design and give solutions for PCC practice by leveraging service design. They concluded three approaches of service innovation to achieve PCC which are the human-centered participation

approach, digitalization approach and service system approach. It is the first to propose a way to assist PCC in the field of service management.

2.4Patient and co-production in healthcare and digitalization

2.4.1 House of care

In the healthcare industry and healthcare research, there are also two significant conceptual models to illustrate healthcare service co-production, which are the “house of care” (Coulter et al.,2013)and the “chronic care model”(Wagner, 1998). Of these two models, the "Chronic care model" emphasizes the importance of changing the healthcare system for individuals with long-term illnesses. Instead of being reactive and only responding when someone is sick, the model promotes a proactive approach that supports patients in managing their own health (Wagner, 1998). The “House of Care” (coulter et al., 2013) was brought out after the “Chronic Care Model” and based on the “Chronic Care Model” to specifically explore and explain the co-production phenomenon.

In order to transform healthcare service, many scholars put forward their theories and plans, most of which have very similar structures in which they try to build a new service delivery system that leads to better outcomes for specific groups of patients (Roland et al 2012; Newbould et al 2012). However, under these circumstances, the “house of care” was raised to transform the relationship between patients and clinicians rather than illustrating a whole new healthcare service delivery system. In “House of Care”, The management and care of long-term conditions were recognized as a collaborative process with active patient involvement and effective self-management support.

Besides, coulter and his colleagues(2013) put forward the model to manifest that the co-production of healthcare service relies on engaged, informed patients and healthcare professionals committed to partnership working. In addition, it still needs the organizational support and external support of surroundings to complete integrated service co-production.

The “house of care” model is illustrated as follow (figure 2.8):

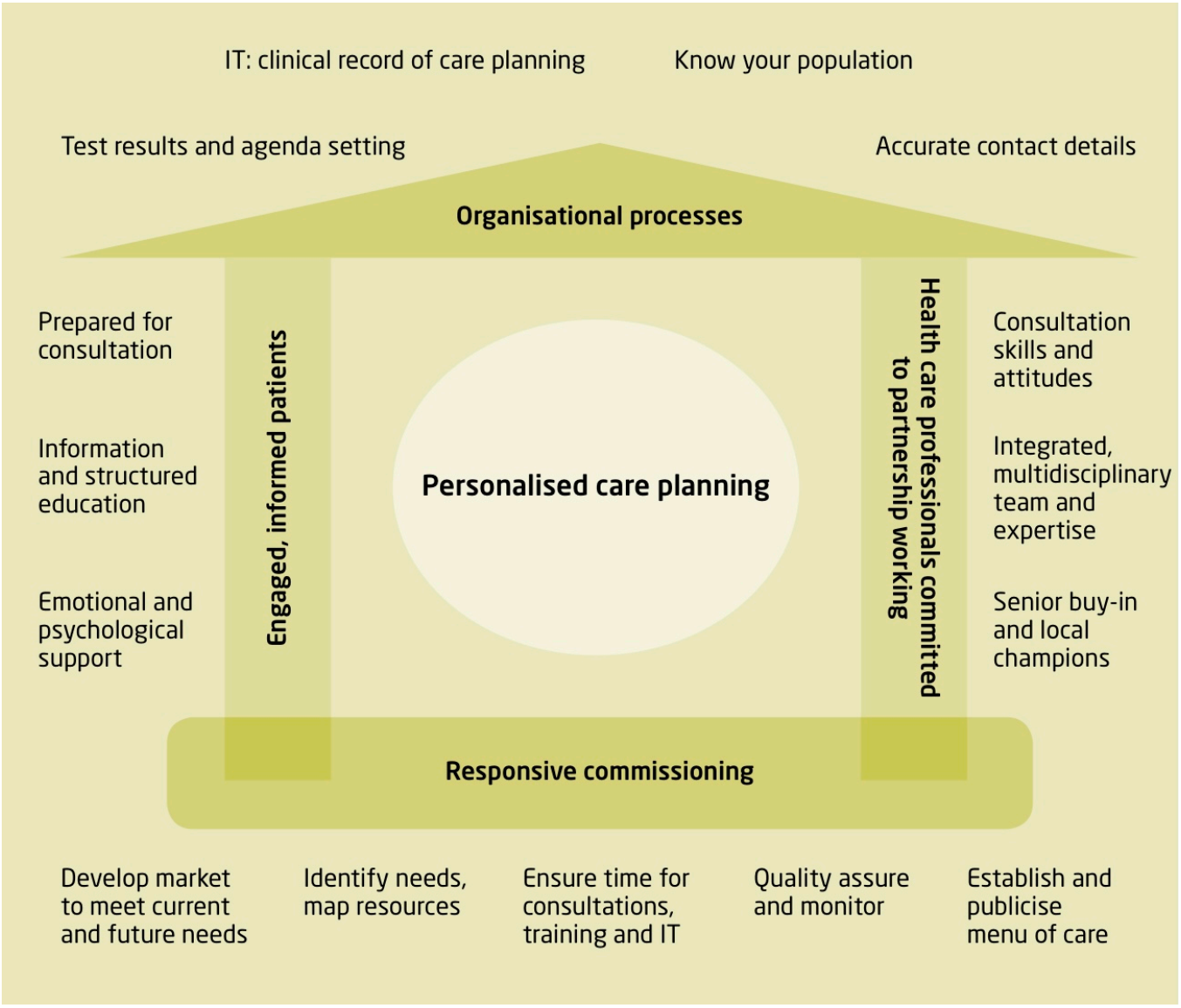

Figure 2.8 House of care (coulter et al., 2013)

The “house of care” model was structured to describe the requirements needed for personalized care planning. The personalized care plan is located at the centre of the map, which means the “house of care” aims to create higher-quality and tailored healthcare service by service co-production. The two walls of the house are engaged, informed patients and healthcare professionals committed to working together in partnership. It emphasizes the role of patient and professional engagement in collaborative service creation. Patient need more encouragement to actively engage in the co-production process while professionals should grasp the way of working and help patient to develop abilities to support self-management.

The roof “organizational processes” means methods like organizational management systems to ensure the collaborative process proceed properly. For instance, various procedures can be classified under the umbrella of "organizational processes," including a dependable patient management system for hospitals that enables the identification, communication, and management of patients, adaptable appointment systems that facilitate linked contacts and permit lengthier consultations when required, and record systems that can be utilized to document and exchange care plans. Similarly, the bottom of the house “responsive commissioning” means external conditions required for this plan like local approval and support of patients and staff training.

According to Batalden et al. (2015), the house of care model is distinct from other models in two significant aspects. Firstly, it includes all individuals with long-term health conditions, not just those with a single illness or those in high-risk categories. Secondly, it emphasizes an active role for patients by prioritizing collaborative, personalized care planning. To implement the model,

healthcare professionals must adopt a partnership approach where patients take an active role in determining their own care and support needs. This requires a shift away from traditional thinking and behavior where healthcare professionals see themselves as the sole decision-makers.

Besides, Britten et al.(2020) also stressed the importance of circumstances of patient engagement. He asserted from the research in Gothenburg Centre that the successful practice of patient-centered care relies deeply on cooperation from different sides and the circumstances of treatment.The Gothenburg patient-centered care model necessitates customization to different settings, specialities, demographics, and structures. Rather than relying on standardized protocols, ethical principles ensure adherence to the model (Britten et al., 2020).

2.4.2 People-centered healthcare and self-management

The World Health Organization introduced the concept of people-centered healthcare in 2009, with the aim of creating a framework that prioritizes people in healthcare (World Health Organization, 2016). It described the people centered healthcare service as “an approach to care that consciously adopts the perspectives of individuals, families and communities, and sees them as participants as well as beneficiaries of trusted health systems that respond to their needs and preferences in humane and holistic ways. People-centred care requires that people have the education and support they need to make decisions and participate in their own care. It is organised around the health needs and expectations of people rather than diseases.” The nurse discussed options with Malcolm, sought his input, and agreed to meet his needs on a daily basis (Burton,2018).

Healthcare is moving towards prioritizing patient-centered care, which tailors treatment to each individual's needs and values. This approach improves the quality of care and patient outcomes. Scholars have expanded the concept of person-centered care beyond just fulfilling wants or providing information. When devising solutions, it is pertinent to take into account the individual's personal preferences, values, familial situation, social circumstances, and chosen lifestyle. This approach is supported by Sepucha et al. (2008) and Gill (2013). It is important to respect that individuals have their own opinions on what is best for them, as well as their own values and priorities.

To conclude, the PPC is the way to increase the self-care and self-management of patients and enhance the collaboration between service users and providers based on partnership by sharing panning of treatment and care together (Stewart,2001; Santana et al.,2018).

Healthcare providers operating within England are required to adhere to the 13 fundamental standards of care established by the Care Quality Commission. One of these vital standards is centered around the provision of person-focused care. Burton(2018) also stressed the importance and necessity of people-centered care service that “The ever-increasing demand on healthcare often causes caregivers to lose sight of the person behind the condition they’re treating. This is why person-centred care is so important. It helps care providers refocus on a crucial aspect of care: fulfilling a patient’s needs beyond their disability or ailment”. In contemporary times, the healthcare industry is increasingly embracing a person-centred care approach. This approach has numerous benefits, such as enhancing the quality of care provided to patients and improving the overall healthcare environment.

In doing this, active and compassionate cooperations between professionals and healthcare users and other relevant individuals are essential (Ward et al., 2018; Phelan et al., 2020). It means that people-centered care prioritizes supporting individuals' involvement in the care they receive and their ability to take care of themselves. In the past, people were expected to conform to the routines and practices that health and social services deemed most suitable. Services need to be more flexible to meet people's individual needs in a person-centered manner. The process involves collaborating with individuals and their families to determine the most effective method of providing their care. This collaborative approach may be done on a personal level, where individuals participate in decisions regarding their health and care, or on a group level, where the community or patient groups are involved in determining the design and delivery of services. The philosophy is to collaborate with people, not control them (Healthcare Innovation Network, 2016).

The current literature emphasizes the importance of shifting towards a more person-centered approach in healthcare, with increased involvement of patients and the public. However, there seems to be a lack of information on the practical implementation of this approach and its impact.

The work conducted by the Gothenburg Centre offers a robust, evidence-based framework for the provision of person-centered care across a range of clinical domains (Britten, et al., 2020). Co-creation of care and person-centeredness is crucial within the team, at the bedside, and within organizations. The successful practice of patient centered care deeply relies on the cooperation from different sides and circumstances of treatment. The patient centered care model from Gothenburg may need to be adapted to fit various contexts, clinical specialties, patient populations, and

organizational structures. The model's fidelity is based on ethical principles rather than standardized guidelines. This means patients can expect consistent care and support from multiple professionals in order to achieve their goals. (Britten et al., 2020)

For the specific requirement of the people-centered healthcare delivery, According to Burton (2018), healthcare providers should familiarize themselves with the advantages of person-centered care and its practical applications. This can enhance their ability to perform their duties efficiently and improve the quality of life for their patients.

DT in PCC and self-management

With the development of the digital technologies (like big data/IoT and digital platform), people-centered healthcare have been used in a larger scale with E-health and had great improvement and transformation by applying digitalization. The use of digital tools has the potential to facilitate communication between patients and healthcare professionals.

The World Health Organization (WHO) defines eHealth as the use of information and communication technologies (ICT) for health purposes (WHO,2005). The concept encompasses various areas, including patient treatment, self-management support, research, student education, disease tracking, and cost-effective and secure public health monitoring (WHO, 2005; Grajales et al., 2014).

Öberg et al (2018) provided an example of a digital application for person-centered care and patient self-management in Sweden. This highlights the significant changes primary healthcare is undergoing worldwide due to limited resources, rising hospital transfers, and an aging population with chronic conditions like heart disease, diabetes, stroke, cancer, and arthritis. The healthcare industry is facing a challenge as its workforce is aging and finding replacements is difficult. The demand for specialist doctors and both specialized and nonspecialized nurses is higher than the availability. However, the solution to this problem is not as simple as just producing more healthcare professionals. Bowles and Baugh (2007) emphasized the need for increased and improved use of internet and web technology in healthcare. This shift towards home-based care due to digitalization will greatly affect interactions between health professionals and patients, as opposed to just intra-institutional care. (Bowles and Baugh, 2007; Townsend et al.,2013).

Through the use of mHealth, diabetes patients can monitor and manage their self-care activities, leading to better control of their health behaviors (Holmen et al., 2014). Technology can support patient empowerment and interaction between patients and healthcare professionals, like diabetes specialist nurses (Wrong and Lam, 2016). Utilizing eHealth can enhance access to care, communication with healthcare professionals, and self-management.

Besides, the appearance of personal health record(PHR) system is also an application of digitalization on PCC and self-management. A PHR system empowers patients to manage and track their health data (Roehrs et al., 2017). This is different from the traditional electric health record(EHC) system usually created by hospitals. An important limitation of EHC systems developed by hospitals is that patients are restricted to accessing only specific health data extracted

from their medical records. Patients are not given the opportunity to incorporate crucial personal health data they collect in their daily lives into their PHR. This issue was highlighted by Bates and Wells (2012). In 2019, Zhou et al. created an innovative mobile application known as PittPHR, designed to assist in the management of personal health information and eliminate information gaps. The app comprises six primary modules, including health records, history, trackers, contacts, appointments, and resources. Users also have the flexibility to tailor their trackers to suit their unique requirements.

In recent years, the patient takes part in health record management has become increasingly popular. One app named “Intelligent new resident health record management system” was put into use in 2020 in China which is created to help different organizations and individuals to manage the health record together. It takes the individual as the center, the family as the unit, and the community healthcare institution as the scope to share their health record and co-manage them. From the introduction of this app, it is designed to help resident health record management, health education, vaccination, 0-6 years old child health management, maternal health management, elderly health management, health management of hypertension patients, health management of type 2 diabetes patients, management of patients with severe mental illness, infection Reporting and handling of diseases and public health emergencies, as well as health supervision and coordination service specifications.

In this practice, it is found that citizens and patients have started to engage in the health record management. They stand at the center of their health service as pivots and facilitate the health record flow of service delivery from separate healthcare organizations.

Beside, the patient-centered service delivery have another case in recent years which is self-health management. Self-health management is a new way for healthcare delivery transformed from triggered by healthcare staff to triggered by self health. The emergence of this concept is because hospitals and medical institutions often only provide treatment, prevention and inspection for certain diseases, and they lack the supervision and improvement of people's daily physical conditions. Many chronic diseases and hidden physical sub-health conditions are still experienced by many patients now. Therefore, this part remain patient/customer to handle by themselves.

There are also some digital platforms which can reflect the concept of self-health management. The Whoop app which focus on collecting real-time health data and used it to analyze customer's healthy conditional and give promotion advice was lunched in recent years. Through the utilization of a wrist strap, the Whoop application can furnish clients with continuous updates encompassing their sleep quality, recuperation level, everyday activity proposals, and general health status based on an extensive range of data points. In this example, Whoop needs to complete data collection and back-end data analysis, while customers will need to understand these analyzes and make positive responses to these analyzes combining with their own realistic situation. As a result, this process is a co-delivery process between healthcare organization, digital platform and customers for self-health management.

Besides Whoop, there are still some similar app in China created for the purpose of customer's self-health management. For instance, "Meal counter" is an app that focuses on self-diet health management. It is dedicated to the basic needs of users who don't know what to eat and how to eat

to be healthy. At the same time, it further caters to people with higher needs, such as pregnant women, obesity, sub-health, and chronic diseases. “small sleep” app is created to measuring people’s sleeping time and quality. It also can provide analysis of sleeping quality and promotional solution.

2.5 Summary of Chapter 2

In the tide of world, with the development of service economy, “service" which is not physical product gradually attracted interests to researchers. Due to the nature of the virtuality, intangibility, and heterogeneity of service which manufacturing products do not have, the existing theories for management based on manufacturing products need to be further updated and upgraded. For example, in the past, most of the research on healthcare supply chain focused on the supply and distribution of equipment and medical materials in hospitals. But in the current environment, with the popularity of service supply chain and service delivery research, intangible healthcare service has become an important subject of research. Especially in the service only supply chain (which is distinguished from product service supply chain), the investigations of customer service for service supply management and supply chain channel coordination is important and needed (Wang et al., 2015). This research is based on the above studies of “service” in service innovation in the field of healthcare services and healthcare delivery.

CHAPTER 3 : CONCEPTUAL FRAMEWORK

3.1Conceptual framework

The conceptual framework of this research is based on Toulmin's model of argument. The Toulmin model is a framework to structure the argument of a research. according to the Toulmin's model of argument (figure 3.1), Figure 3.1 illustrates the connections between the six elements (Toulmin et al., 1958; Toulmin et al., 1979). The logic linking the six elements is: Given grounds, assert a qualified claim to the audience with proper backing. The Toulmin model categorizes an argument into distinct parts, allowing for individual evaluation to ensure logical soundness. Additionally, the Toulmin model offers several advantages. It allows for the assessment of how different elements of an argument contribute to the overall structure. It also guides the construction of a logical argument in a systematic manner. Furthermore, it facilitates the analysis of arguments that follow a linear structure, where one idea leads to the next. Lastly, it helps to identify and address specific weaknesses within an argument, thus strengthening its overall effectiveness (Toulmin et al., 1958; Toulmin et al., 1979).

FIGURE 1:

Toulmin's Model of Argument

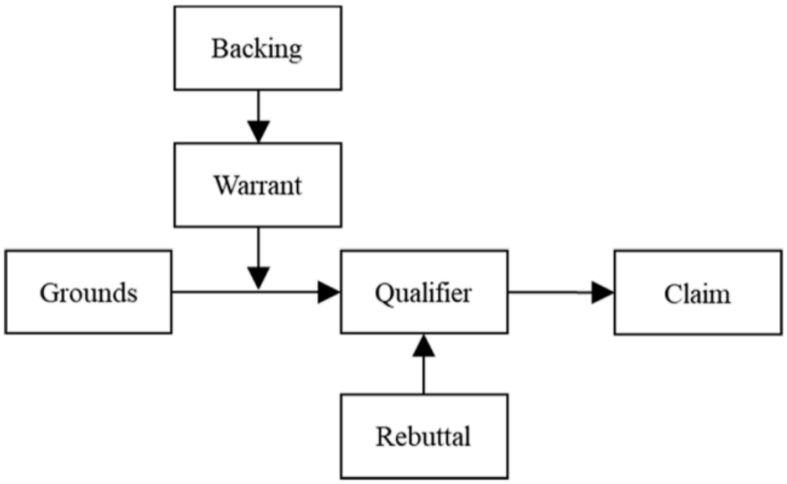

Figure 3.1 Toulmin's Model of Argument

According to the above Toulmin's model of argument, combined with the actual situation of this study, the conceptual framework of this study is shown in the figure below.

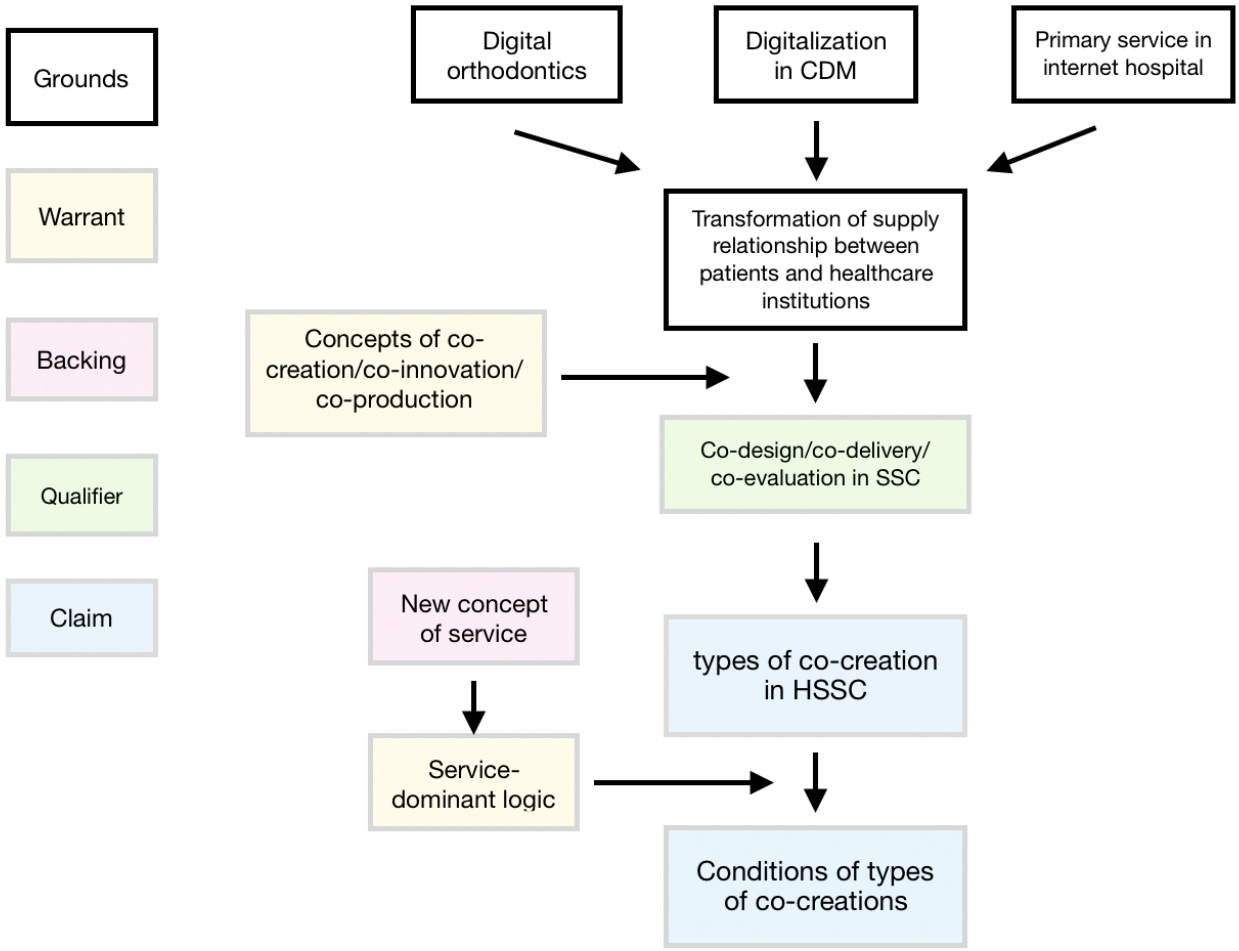

Figure 3.2 : Conceptual framework

This conceptual framework needs to be read from top to bottom. According to the Toulmin model (Toulmin et al., 1958; Toulmin et al., 1979), grounds are the data, facts, and evidence "on which the merits of the assertion (the claim) are to depend". In this study, the top "ground" part refers to the current situation of digital development in the field of HSSC, which is the basis, background and main part of this study. As the figure shows, the ground of this article is based on the digitalization found in this article in the fields of three cases, namely digital orthodontics, digitalization in CDM,

and primary service in internet hospitals. In these three fields, this study found some transformation of supply relationships based on digitalization between patients and healthcare institutions.

Looking down from the figure, the yellow box is the warrant for this conceptual framework based on digitalization grounds. The warrant and the qualifier are the assumptions on which the claim and the evidence depend (Toulmin et al., 1958; Toulmin et al., 1979). Another way to say this is that the warrant explains why the data supports the claim. In this figure, the phenomena related to co-creation in digitalization are extracted based on the warrant of “concepts of co-creation/co-innovation/co-production”. While the digital transformation happened in the area of digital orthodontics, CDM and primary services and new technologies like digital platform/big data/IoT et al. have greatly transformed in the area of person-centred care (PCC) and telehealth, the supply relationship between patients and healthcare institutions has to be changed accordingly. In this situation, customer/patient co-creation, co-production, and co-innovation are essential components in the healthcare service supply chain, and they have also been given abundant and innovative roles in the supply chain. Therefore, this study proposes the hypothesis that the above digital transformation will have a positive impact on co-creation. This study assumes that there is richer co-creation in SSC according to digital transformation in HSSC, which also links the qualifier in the green box below.

"Co-design/co-delivery/co-evaluation in SSC" is the qualifier in this conceptual framework, as this research can organise and summarize the co-creation phenomenon extracted above according to it. The literature research on "co-design/co-delivery/co-evaluation" in SSC helps this research find out whether the co-creation found in this study has chances in line with co-design/co-delivery, etc.

Therefore, first of all, this study made the first claim about the types of co-creation: co-design, co-delivery, and co-delivery in SSC from the customer's perspective.

After obtaining the types of co-creation, this paper explores the conditions of types of co-creation in combination with the service-dominant logic (warrant about the definition of services and resources involved in the service). This is another warrant for this study. This logic is structured to put forward the final claim, which is the conditions for co-creation in HSSC based on the digital transformation in the healthcare area. The terms of “service” and “innovation” must be clear by integrating the warrants. Therefore, the warrants here have the function of determining the concept of “service” and “innovation” from the research in the area of service innovation. In this research, with the understanding of S-D logic in health care industry, the patients in service delivery is not only the party who accepts the product, but also the coordinator for its own requirement of healthcare service.

With the logical support of the second warrant —— S-D logic model, this paper draws the second claim--- a model of conditions of types of co-creation which integrated conditions from various aspects. Detailed aspects of conditions are introduced below in this chapter.

The above conceptual framework connects the knowledge in the literature review. Related literatures from digitalization in healthcare to collaboration in SSC to service innovation work together on the research topic to clarify the areas of this research and to help answer these research questions.

3.1.1 Forms of co-design and co-delivery in co-creation in SSC

In the research on co-creation of services, Scholars have mentioned the form of co-creation which are co-design, co-delivery and co-evaluation. From the time line, Bovaird (2007) first proposed the phenomenon of co-design between customer and service provider in service process. Later, Moreau and Herd (2010) pointed out in their study on value co-creation that co-creation has a richer meaning than customer collaboration and is the embodiment of the essence of service, which includes the phenomenon of co-design and co-delivery. In addition, with the development of co-creation research, other scholars have also analyzed and studied co-design and co-delivery in co-creation (as shown in the figure below). Fugini and Teimourikia (2016) and Rodriguez Muller et al. (2021) also explained the phenomenon of co-evaluation in co-creation. They defined co-evaluation as the evaluation of comprehensive public services made by public citizens when they are service receivers in cooperation with government departments. However, the service evaluation here is not a study on specific service processes, while this study mainly discusses the operational level in SSC. Therefore, the issue of co-evaluation is not discussed in this study.

Author	Forms of co-creation
(Rodriguez Müller et al., 2021)	Co-design, Co-delivery, Co-evaluation
(Fugini and Teimourikia, 2016)	Co-design, co-evaluation
Bovaird, (2007)	co-design
(Huang and Yu 2019)	co-design
(Trischler and Scott 2015)	co-design
(Linders, 2012)	Co-delivery, co-evaluation
(Moreau and Herd, 2010)	co-design, co-delivery

Figure 3.2.1: Forms of co-creation

It can be seen from the above table that in the research on forms of co-creation, the most research is on co-design, followed by co-evaluation, and the least research on co-delivery. For the research on co-delivery, Rodriguez Müller et al., (2021) and Alzaydi et al.,(2018) both stated that in co-creation, the research on co-delivery is still close to a blank state, which needs to be studied further in the future.

3.1.2 Digitalization in healthcare and co-creation in healthcare service supply chain.

With the fast development of digital technologies, dramatic changes have also taken place in digital healthcare. Most of the changes caused by digital transformation are based on upgrading information processing technologies such as digital platforms (DT), the Internet of Things (LOT), cloud computing(CC), and big data (Lember, 2019). The rapid development of technology has led to 1) patients' demand for high-quality and interactive services has increased. 2) The interaction capabilities of stakeholders in the service supply chain are rapidly increasing. Therefore, in the service supply chain, the relationship between patients and healthcare organizations has gradually changed from traditional service providers and service receivers to interactive functional co-creators.This technological development also calls for a redesign of contemporary healthcare systems to allow for closer collaborations between healthcare beneficiaries and healthcare professionals (Sinaiko et al., 2019). This shift is reflected from the inside of the hospital to the outside of the hospital. Markarian (2019) explored digitalization by simultaneously embracing all links in the supply chain. Rubbio et al. (2019) explored the transformation of the movement of patients in the hospital. Outside the hospital, a wealth of digital platforms and digital wearables provide comprehensive complementary functions for medical services in the hospital, from out-of-

hospital care to health consultation to daily health monitoring and management. according to the "White Paper on the Development of China's Digital Economy (2022), building digital healthcare outside the hospital and promoting the patient co-creation in healthcare has become an important goal for the future development of China in the medical field.

3.1.3 Customers, service providers and other stakeholders in the co-creation of SSC

The requirement and condition for exploring co-creation proposed in this article are based on the new understanding (S-D logic) of the word "service" in SSC. The condition of co-creation, as the name implies, refers to the actions and resources provided by various organizations, suppliers, and stakeholders in order to complete the co-creation between customers and service providers during the service supply process. Regarding the new understanding of service, Vargo and Lusch (2004, 2008a, 2008b) and Miles et al. (2017) in-service innovation stated that service could not only be regarded as a “product”; it should be given more significance and understanding in research. Vargo and Lusch (2004, 2008a, 2008b) proposed an S-D logic model to redefine “service", which suggested that service (singular) should be regarded as a process of using one's resources (e.g., knowledge) for someone's (self or other) benefit which means the service is the output of the collection of variable resources and conditions and requirements.

Existing articles have done part of the study on the conditions of co-creation as shown in the following table

Reference	Co-creation Factors
To customer	
(Fawcett et al., 2014)	Sharing experiences
(Kao et al., 2016)	emotional engagement, knowledge sharing and
(Prahalad and Ramaswamy, 2004)	Dialogue, access, risk assessment
(Payne et al., 2008)	Emotion, Cognition, Behavior
(Le et al., 2022)	customers' knowledge
To supplier	
(Payne et al., 2008)	Providing co-creation opportunity, planning, implementation and metrics
(Kao et al., 2016)	Positive surprise

Table 3.2.2: Co-creation factors

3.1.4 Conditions from four aspects of co-creation of SSC

It can be concluded from all the studies and ideas presented that value co-creation is only effective when the goal is to improve the experiences of all parties involved. This was noted by Sandhu et al. in 2019. In the above table, this study can find that in the conditions to customer, sharing experiences, emotion, and knowledge are the most mentioned factors. The conditions to suppliers mainly emphasizes the importance of communication channels provided by service providers. However, most of the factors in the table revolve around the customer.

In addition, as shown in the table below, in the field of medical service management, some researchers have provided ideas for conditions of co-creation in the field of healthcare service.

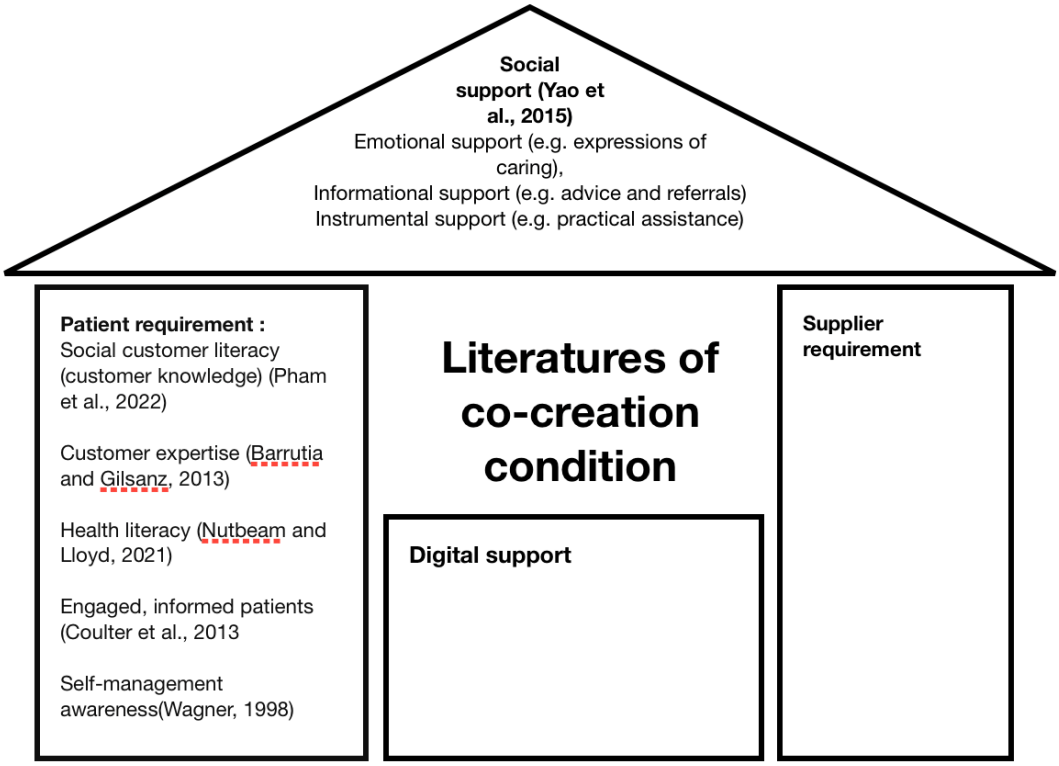

Figure 3.2.3: literature of co-creation conditions model

in the existing study of co-creation in SSC, researchers only pay attention to the relationship between supplier and customer, but failing to pay attention to the conditions that supplier needs to provide in order to achieve co-creation.

3.1.5 Co-creation in SSC with digitalization and the provision of patient-centered care.

Although the concept of PCC and telehealth have been brought out to improve service quality and reduce the burden on medical staff to a certain extent simultaneously. The advancement towards healthcare that is patient-centered and integrated has encountered obstacles due to conventional

practices that perceive patients as passive recipients of care within a fragmented and complex system (Lee, 2010). Emerging technologies and data present vast healthcare opportunities, but their potential remains unfulfilled (Kellermann and Jones, 2013). It is crucial to integrate co-creation and digital technologies into current healthcare practice to create a system suitable for PCC.

Under this circumstance, with the popularity of people-centered care(PCC) in healthcare industry recent years, scholars (Patrício et al.,2020; Borja, 2017; Huetten et al., 2019) in service management areas were also starting to study the people-centered care service system to support the PCC practice and explore the management issue around people-centered service. Patrício and his colleagues (2020) tried to associate PCC to service design and give solutions for PCC practice by leveraging service design. They concluded three approaches of service innovation to achieve PCC which are human-centered participation approach, digitalization approach and service system approach. It is the first to propose a way to assist PCC in the field of service management and mentioned the collaboration of patients help to facilitate the PCC.

CHAPTER 4: METHODOLOGY

The aim of this study is to investigate how co-creation between service providers and customers impacts the digital transformation of service supply chain. Based on the conceptual framework, this study present two research questions and justify the suitability of the case study research design. The methodology chapter is structured into five distinct sections. The first section presents an overview of the research paradigm employed in the study. The second section provides a synopsis of the fieldwork methodology, which encompasses the case study design as well as the tools and procedures used from a service supply chain perspective. The third section elucidates the unit of analysis and expounds upon the data collection process. The fourth section scrutinizes the data analysis techniques employed and provides a comprehensive discussion. Lastly, the fifth section evaluates the validity of this research methodology.

4.1 Research Paradigm

In the establishment and development and exploration in the research process, in order to improve the credibility of the research, the researchers first need to clearly prove and establish their philosophical positions and meanings. The establishment of meaning in philosophical positions includes basic beliefs or world view and choices related to ontological, epistemological, and methodological questions (Healy and Perry, 2000).

4.1.1 Ontological and Epistemological Assumptions

Research philosophy is significant in research and should be established first in research. First of all, the Research philosophy provides the most basic world view for the whole research, which helps researchers to better improve their cognition and understanding of research design and research questions. In addition, Research philosophy and research design are closely linked. A clear confirmation of the Research philosophy can help the research to better choose the appropriate research design and achieve better research outcomes (Guba and Lincoln, 1994). It is essential to clearly state the philosophical assumptions of each study since different disciplines, entities, and individuals may have varying views on how the world works (Creswell, 2013). Therefore, in this study, this study should first establish the research philosophy.

Ontological arguments are arguments about the nature of the world and how it works. The ontological argument was first presented as an argument for the conclusion that God exists. At present, there are two views on ontological research. The first is Ontological realism, which, in simple terms, holds that something is real which holds that objective truth exists. The other view is Ontological relativism. This view is contrary to Ontological realism, which believes that objective truth cannot be discovered and people get conclusions with subjective biases. In other words, research background, researchers, research methods, etc., will have a great impact on research questions and results (Blaikie, 2007).

Epistemological arguments are arguments about the generation of knowledge. specifically, it includes the correct methodology of the knowledge creation. Epistemological arguments contain two aspects: objectivism and subjectivism. Objectivism posits that reality is independent of the

researcher, while Subjectivism holds that knowledge of reality is subject to interpretation and exists only in the researcher's mind.(Johnson and Duberley, 2000).

The philosophical framework is shaped by assumptions concerning ontology and epistemology, as stated by Guba and Lincoln in 1994. The positivism paradigm combines realism and objectivism. It assumes the social world exists externally and social entities must be studied and measured separately from the researcher (Saunders et al., 2012).

4.1.2 Philosophical Position of the research

This paper aims to understand the service supply chain and digital transformation in the service field through its research objective and questions. Based on the understanding of service research, this study find that the traditional positivist view is common in service studies. Especially with the deepening understanding of service research and the study of service supply chain and supply process, Tronvoll et al. (2011) proposed three research paradigms – hermeneutic, dialogic, and monologic – that researchers can use to advance theory in this area.

In the research related to service research, service research paradigms are roughly divided into two categories in terms of philosophical position. This classification is done according to different aspects in epistemology.The two types of research are: studying the nature of relationships and examining researchers' perceptions of the relationships between research participants (Deetz, 1996). These two philosophical positions can be used to explain the presentation and proposal of concepts and questions in service research.

Deetz (1996) divides the research paradigm into two types: emergent approach and priori approach, based on the origin of concepts and problems. The emergent epistemology happened in the situation when the situation in the real world is difficult to describe and conceptualize through a fixed law, model, etc. (O'Connor & Wong, 2002)。Within the philosophy of science, emergentism is analyzed both as it contrasts with and parallels reductionism. Emergent research is qualitative and involves dialogue between researcher and individuals. Popular methods include focus groups and case studies, providing deep understanding and valuable insights. It's crucial to approach these methods thoughtfully for significant results in businesses and academics. Tronvoll et al. (2011) argue that under emergent epistemology, one obtains phenomenological insight, revelation, and an open language system. The priori epistemology pertains to the positivistic and monologic research paradigm. Typically, the priori approach involves quantitative research designs (Rust et al., 2004). However, conceptual articles (Vargo and Lusch, 2004) may also fall under this quadrant as they are often developed without direct engagement with research participants.

Besides the line of the origin of concepts and problems, Tronvoll et al. (2011) also build the model for philosophical positions for service research by adding the horizontal line according to the nature of relationships which are static and dynamic. When conducting research, the dimension of relationships refers to the researcher's perception of the type of relationship between actors, such as customers and service companies. This perception determines whether the study is dynamic or static. A dynamic study takes a process-oriented approach and examines behavior patterns over time, while a static study focuses on a model of the relationship. (Benitez et al., 2007). The dynamic approach to service research considers research objectives as active partners and co-creators in a

value-creating relationship. On the other hand, the static approach views research objectives as passive receivers in the transaction (Huy, 2002).

About the categories mentioned above, Tronvoll et al. (2011) built the model “philosophical position for service research” (figure 4.1) below.

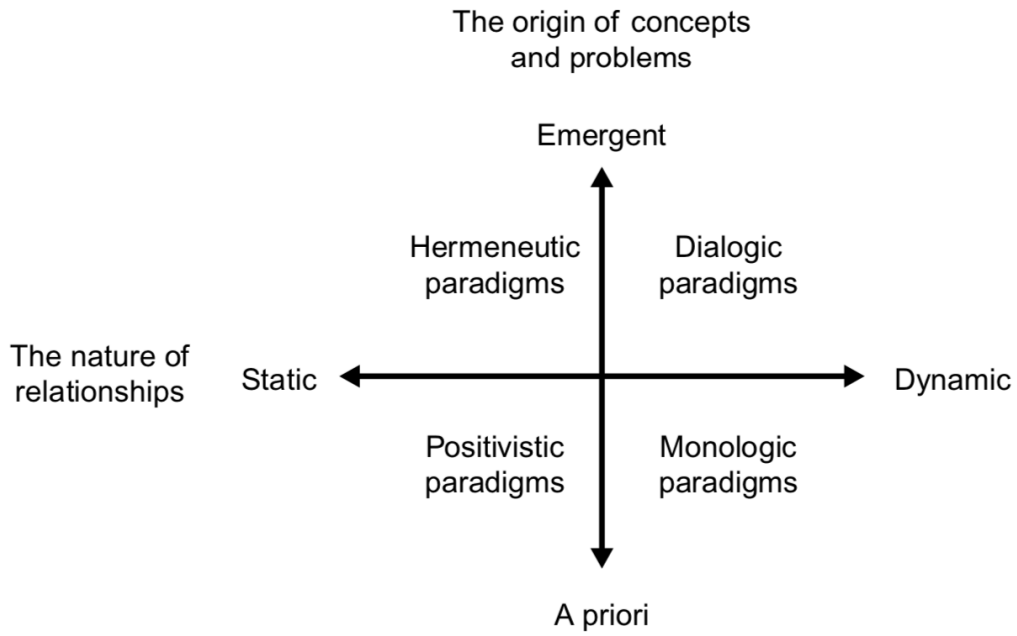

Figure 4.1 : Philosophical position for service research (Tronvoll et al. ,2011)

Looking at this study from the above classification, first of all, from the perspective of the nature of relationships, this study is static. this is because the research objective is the phenomenon of current digitalization, and the research objective of this paper is fixed and pure which does not participate in the research. In addition, this study is priori from the perspective of the origin of concepts. this is because this paper is a qualitative research based on dialogue between the researcher and

informants. Under the priori epistemology, By collecting and analyzing digitalization phenomena in the current HSSC, this research is supposed to contribute to the knowledge in the service supply chain and digital transformation field. Due to the literature review and current digitalization trends in healthcare, this research paradigm is priori rather than emergent (Deetz, 1996). That is to say, the philosophical position of this paper is based on the positivist position in ontology. On a more precise philosophical position, This paper uses the model from Tronvoll et al. (2011), who built the model to illustrate and explain the philosophical position of research in the field of services. According to the model, the research paradigms are based on the positivistic paradigms, as the research is priori from the perspective of the origin of concepts and problems and static from the perspective of the nature of relationships.

4.2 Research design

Research design refers to the framework of methods and techniques chosen to conduct a research study. It allows researchers to refine their methods and establish their studies for success. It usually includes data collection, measurement, and data analysis (Bhat, 2023). At the outset of this chapter, it was emphasized that comprehending a researcher's ontology and epistemology is essential for determining an appropriate research design (Easterby-Smith et al., 2002). Research design pertains to the structured framework that connects research inquiries, data collection, data analysis, and research findings (Yin, 2016). In social science research, there are four common types of research designs, which are experiments, case studies, cross-sectional surveys and longitudinal research designs (Bulmer, 2021). In the research about the service and service supply chain, these four types of research designs are all popular and common.

4.2.1 Empirical research in service supply chain management

Empirical research involves the systematic collection and analysis of data through direct or indirect observation. The empirical research draw conclusion from concretely empirical evidence. Empirical evidence is information obtained through observation or experimentation to support or negate a hypothesis (Bulmer, 2021).

The process of empirical research entails the creation, investigation, and verification of theories that align with the researcher's field of inquiry. For managers, especially for the supply chain managers, Boyer and Swink, (2008) reckoned that researchers should understand the current digital business background when conducting research in the field of service operation and supply chain management. In order to develop more valuable and realistic theories, researchers must be based on the real and exact business environment.

As this research is going to find the digitalization in co-creation in service supply chain, this research builds the conceptual framework to explore, develop and types of co-creation in HSSC and test the model of conditions required from stakeholders to facilitate the co-creation in HSSC. Therefore, this research is empirical research which try to explore and draw conclusion from real world phenomenons and empirical evidence.

Empirical research includes various types of research designs, such as experiments, case studies, and surveys. The data used in empirical research is also abroad, including the primary data and secondary data (Bulmer, 2021). In 2002, Forza categorized survey research into three distinct types:

exploratory, explanatory, and descriptive, each with its own unique objectives. However, Forza also indicated that the survey typologies presented in his study were better suited for theoretical contributions than practical ones. Therefore, it would be prudent for scholars to explore additional empirical research approaches and paradigms to enhance our comprehension of supply chain management.

4.2.2 Case study research design

To find out the best methodology for this research, this study first analyze the research questions of this study. According to the content of the previous chapters, the research topic is to figure out the digital transformation of co-creation in HSSC. The research questions of this paper are: Q1: What types of co-creation occurred with the application of digital technologies in the service supply chain? Q2: What are the conditions for various types of co-creation under digitalization? Q3: How does the co-creation in SSC in the healthcare industry under digitalization influence the achievement of patient-centered care?

Firstly, these three questions are “what types” and “what conditions” and “how” questions, which are open questions that need a comprehensive understanding of the current phenomenon in HSSC and its digital transformation. According to Yin (2018), The “how” nature of the current research question calls for an in-depth investigation. Besides, the question also requires a specific environment from organizations/companies that accept customer co-creation in their service provision so that theoretical knowledge can be interpreted and practised in this environment. Therefore, in-depth data and analysis should be used in the research. The digital transformation is a contemporary phenomenon and a hot topic not only in an academic area but also in wide practice by

companies and hospitals, so the research methodology must be suitable for contemporary phenomenon investigation.

Based on the analysis of research questions, the most appropriate approach to explore the topic is the case study design. The main reasons for choosing case study design are as follows:

(1)According to Yin (2018), case studies analyze specific issues within a particular context, such as an environment, situation, or organization.

(2)Case study methodology is used to investigate in-depth the "how", "why", and "what kind" questions related to a particular phenomenon or topic (Farquhar, 2012).

(3)Case studies are ideal for examining modern phenomena in-depth with real-life examples.

(4) The phenomenon is examined in a natural setting (Yin, 2018).

(5)Case studies offer valuable insights and practical solutions to real-world problems. By analyzing scenarios systematically, they can yield rich data and contribute to knowledge advancement in various fields. An open mind and attention to detail are crucial for conducting successful case studies (Benbasat et al., 1987).

To conclude, based on the above five reasons, in this study, the co-creation phenomenon in the digital transformation of SSC is explored and analyzed, which is typical for studying specific issues in a particular context. This is most consistent with the research scenario applicable to the case study methodology. Furthermore, the case study methodology is highly appropriate for answering the research questions of this study, which need in-depth investigation. Digital transformation in SSC is a phenomenon that occurs in the real world. Case studies could give real-life examples to this study and also can provide insights and practical solutions to real-world problems, which is

exactly the goal of this research. Therefore, the case study methodology approach is deemed appropriate in this work. The research is an exploratory study based on a literature review, conceptual analysis and case studies.

4.2.3 Case selection strategy

In the study of research questions, it is difficult for us to cover all the populations involved in the research questions. Therefore, this research must select representative cases in the current healthcare service industry for analysis and understanding (Marshall, 1996). From the perspective of statistics, researchers should select samples randomly. However， Voss et al. (2002) hold the opposite view that in qualitative research, it is more effective and acceptable to select cases according to their strength in supporting the stated research objectives. When developing theories, the criteria for selection is referred to as replication logic, which may take the form of either literal or theoretical replication (Voss et al., 2002). Therefore, in order to more effectively achieve the research objectives of this paper which is figuring out the digitalization of co-creation in HSSC, cases are selected based on the following three case selection strategies: (1)Service upgrade by digitalization in recent years (2) services that need much engagement and co-creation of patient (3) services that In line with current digitalization trends

When designing a case study, decisions must be made about the number of cases, the selection of firms, and the sampling method (Voss et al., 2002). Prior to collecting any samples, it is imperative to ascertain the ideal quantity of cases required, ranging from a single case to multiple cases. About involving a single case or multiple cases, Yin (2018) believes that multiple cases from multiple sources help the study to reach stronger conclusions. Of course, a single case is also valid in some

specific cases. For example, (1) It is difficult to find another case that meets the conditions, and this single case is extreme and appropriate. (2) This single case is perfectly representative of other cases. (3) Longitudinal studies of individual cases are needed. However, in this study, in order to achieve a more stable and credible conclusion, this article decided to use multiple cases for case study research.

According to the above cases selection strategies, the specific case selection criteria in this study are as follows:

1. This study chooses the cases which have experienced significant digitalization in recent years, compared to traditional healthcare services when the patients have to go to the hospital
2. This study chooses cases that need patient collaboration when the service is provided.
3. This study chooses cases which are consistent with the digital development trend in recent years and could represent the digital trend in healthcare service.

Through the above case selection strategy, this research selects three cases which are digital orthodontics practice, integrated primary care in internet hospital and chronic disease management. These three cases are selected because digitalization has developed rapidly and remarkably in the field of healthcare service in recent years. The cases selected in this study are three phenomena of digitalization in the field rather than specific companies (Bulmer, 2021).

Since the research on HSSC is very dependent on the medical systems of different countries, this study needs to put the research questions into a unified medical system (unified country). This study

found that in the past ten years, China has developed rapidly in the development of medical digitalization and the development of medical digital platforms (“White Paper on the Development of China's Digital Economy,” 2022). Therefore, the three cases of this study are mainly carried out in the Chinese background.

in addition, considering that the research object of this research is co-creation in HSSC, These three fields all require patients to participate in the service delivery process due to their nature (such as chronic disease management) and the development of technology in recent years (like primary care in internet hospital and digital orthodontics practice). Therefore, the selection of these three cases is also conducive to achieving the research purpose of this research.

4.3 Unit of analysis and data collection

4.3.1 Unit of analysis

The unit of analysis is the people or things whose qualities will be measured. The unit of analysis is an essential part of a research project. It’s the main thing that a researcher looks at in his research (Yin, 2018). Determining the unit of analysis is crucial as it makes the research process more explicit and clear. This decision can impact the research questions, findings, and conclusions (Yin, 2016). Additionally, it can simplify the task of identifying previous research and defining the current study's boundaries in relation to the applicability of emerging theories (Tronvoll et al., 2011).

Regarding the unit of analysis of this study, although this study aims to explore the phenomenon of co-creation, this study always analyzes from the level of service supply chain. In other words, this study is only focused on the digital transformation of the service supply chain in digital healthcare at the operational level rather than the whole service. The service supply chain is responsible for providing services on products. It involves supplying parts, materials, personnel, and services required to offer efficient and timely product service, including repair and maintenance (Maull et al., 2012). Thus, since this study focuses on service co-creation at the "operation" level, it employs an embedded multiple-case study design (Yin, 2018).

In addition, the object of co-creation is also the focus of this research. In literature, scholars generally call the object of co-creation "value", that is, value co-creation. However, the concept and definition of value are not unified, and they represent rich meaning in different fields and literature (Gallarza et al., 2011). In the field of service research, value refers to the things beneficial to customers, including service cost reduction, efficiency increase, consumer sentiment and other factors (Porter, 2010). In the service supply chain, this paper studies value co-creation from the perspective of the supply chain. The value here refers to the factors that benefit the management of the service supply chain in the service supply chain, such as supply chain efficiency, coordination and design. Therefore, this service supply chain and process is the focus of this study and, thus, the unit of analysis.

To conclude, the unit of analysis of this study is the service supply chain in various medical services (digital orthodontic, digital chronic disease management and digital primary care in Internet hospitals mentioned above). Within the realm of these service supply chains, the current study

accords greater emphasis to the facets pertaining to co-creation, encompassing scenarios of collaborative creation, personnel involved, digital technologies deployed, their positioning within the service supply chain, and other contributing variables. To enhance the precision and clarity of the unit of analysis, this investigation employs the service blueprint mapping approach to delineate the intricate dynamics of the service supply chain. A comprehensive explanation of the service blueprint methodology is furnished in the subsequent "data visualization" section.

4.3.2 Data collection

In order to build a case study theory, it is important to collect extensive empirical evidence. Yin (2018) introduced four types of data collection methodologies which are interviewing, observing, collecting(archiving) and feeling. The interview is based on language, which gets data from people's explanations, body language and reactions. Observation is usually described as a way to record the manifestation or gesture in a specific environment. The collection method means collecting data from existing documents, including online documents, personal documents and other archives. The feeling method is to record sensations for research. This study will use multiple data collection methods to provide a comprehensive full picture of the research question. Therefore, this study will use interviewing and observing methods to collect primary data and collecting/archiving methods to collect secondary data.

To enhance the credibility of data source and analysis, the triangulation principle is applied to make assurance. The principle of triangulation originates from navigation, using three reference points to determine the exact location of an object (Yardley, 2009). In case study research, the triangulation principle means using three different sources of data in the data collection process. By analyzing

three different data sources, the common points pointed out by these three results can ensure the stability and credibility of the results. In this research, the triangulation of research validity will be ensured by case study design, including case selection and data collection. First of all, this study selects three different cases in the digital medical field for research, which makes the data analysis and conclusion drawing reliable. Secondly, interviewees are selected from at least three functions (such as doctors, general managers, and operation managers), which enable the study to obtain comprehensive information and avoid bias.

In order to collect in-depth data on how healthcare institutions apply the new digital technologies to help healthcare delivery, the study will organize semi-structured interviews with necessary discussion and open-ended questions in the qualitative research(Seidman, 1998). Data from observations will also be utilized to structure a service supply chain network draft and customer co-creation extent in order to facilitate the study process and save resources for data collection (Lillrank ,2011). Interviews with the key persons in healthcare institutions who are able to provide key information about the service supply chain in the research will help to explain the main questions and effectively explore the possible opportunities and barriers on the aspect of the orientation of future development.

4.3.3 Interviews

When conducting research, unstructured interviews offer a lot of flexibility to the researcher. However, this flexibility can make it difficult to replicate the study and may affect reliability. On the other hand, structured interviews do not allow for follow-up questions or probing of the informant, so they are not recommended for theory building. To address these limitations and allow for all

issues to be included in the research protocol, semi-structured interviews offer a moderate level of flexibility to both the researcher and the respondent. Detailed instruments of the interview are as follows:

Population: current employees in the hospital and company who take charge of the service provision. That would include the whole individuals who get in touch with patients and customers and some people in the service management department.

Sample method: Judgement sampling: this study chooses the person based on the experiences from our current research, including doctors and operation managers, general managers, IT developers for healthcare digitalization and researchers. The interviewees from both operation managers and doctors also provide their suggestions on the selection of later interviewees. It helps us target the interviewees during the whole data collection process.

The specific selection criteria for the collected sample are: 1. The person who works in the healthcare industry, including hospitals, Internet hospitals, dental clinics, and companies providing healthcare services. 2. The person who works close to digital healthcare and who has experience in digital healthcare service provision in digital orthodontics, digital chronic disease, and primary care in internet hospitals. 3. The person who are managers and operation managers in companies providing digital support for healthcare service.

Convenience sampling: Convenience sampling is a sampling method according to researchers' convenience, which means researchers try to contact interviewees who are available and convenient

to provide their data. This study also uses convenience sampling to contact interviewees to collect enough data to support this research.

Interview questions design: open-ended questions on the current technologies the company/hospital has taken to help make the healthcare provision process smooth and make the process structure effective for patients. how the technologies will cost both the patients and the company/hospitals. The transformation of the service supply process based on those innovations and further potential development in this area should also be considered. In the end, the information about the feedback of the transformation from the patient and hospital should be collected.

In China, a total of 46 interviewees were interviewed for this article, among which three doctors are interviewees who overlap in the fields of IPC in Internet hospitals and digital CDM. A total of 46 interviews were conducted over the course of one year, with each interview lasting between 40 to 70 minutes. This allowed for the complete capture of all events during service delivery. The interviews were consistently conducted following the case study protocol. The list of informants can be found in Table 4.2.

Digital orthodontics		IPC in internet hospitals		Digital CDM	
Position	Number (10) (Name)	Position	Number (23)	Position	Number (16)
Orthodontists	8	Doctors	14	Doctors	12
Digital orthodontics manager	1	CEO	1	CEO	1
		Product manager	2	Product managers	2
Nurse	1	Operation manager	3	IT developer	1
		IT developer	2		
		Researcher	1		

Table 4.2 list of informants

4.4 data analysis

Data analysis requires the interpretation of data and is inseparable from data collection (Yin, 2018). The techniques used are discussed in this section. The qualitative data collected are analyzed at two levels: (1) within-case analysis and (2) cross-case analysis. In the analysis process, this paper will adopt the method of abductive reasoning.

4.4.1 Within case analysis

The initial focus of this analysis is to examine each case on an individual basis, with a thorough and comprehensive approach. According to Miles et al. (2014), data analysis in case study research generally includes three steps which are data condensation, data display and drawing and

verification of conclusions. Data condensation is the first step of processing the translated and transcribed data, which mainly includes filtering unnecessary information, emphasising key information, and data compression. Data display is to let readers see and understand the connection of the data to this research through data processing. drawing and verification of conclusions refers to noting of patterns and providing explanations. This research will analyze the cases from the above aspects

4.4.2 Data condensation

Data condensation begins when the author immerses himself in the data. The researcher needs to read the transcript multiple times, read it, and go back to the audio recording and re-listen. The Data condensation process includes data coding, which assigns meaning to blocks of data using tags. Data coding should be carried out at two levels: (1) the first coding process needs to reduce the number of paragraphs transcribed from text to code, and (2) the coding process needs to move from multiple codes to several topics/categories as research moves towards theorization (Saldana, 2012).

Therefore, in this study, this research first transcribed the interviews records obtained into text, and then coded the transcribed text. codes are created and chosen on two grounds：(1) in accordance with the research theme of this article, and (2) in accordance with the common themes stated in informants (because a lot of informants will express some similar descriptions and views in interviews).Firstly, based on the different content about co-creation provided by informants, co-creation is classified into co-design and co-delivery in service supply chain in this research. Then it is divided into a description related to service process and an evaluation of different co-creation and digitalization based on the transcripts. Finally, as for the content described in informants, we add

risk, advantage, application, suggestion, future direction, developing trend and other codes to each category. Through the above Data condensation, this research gradually transforms raw data (including records, notes, and news) into verbatim transcripts, continues to transform into Interview Notes, and finally transforms into useful information for research findings and matrix presenting in research.

This study also uses the “double translation protocol” methodology to identify possible discrepancies in the interview tests and enhance the robustness of findings. The interviews in this study are conducted in Chinese, which needs attention due to translation accuracy problems. The “double translation protocol” methodology requires translating the source version of the test (generally English language) into the national languages, then translating them back to English and comparing them with the source version to identify possible discrepancies. In this study, as the original interview texts are Chinese, this study first translates the texts into English and then translates them back to English and compares them with the original texts to identify possible discrepancies.

4.4.3 Data display

Data displays are based on information collected and processed that leads investigators to conclusions and actions (Yin, 2018). In this study, the text interpretation, chart interpretation and Blueprint methodology will be adopted to display data in the service supply chain.

The SSC analysis tool—service blueprint is the picture that experts design to check the effectiveness of their services to their customers. A service blueprint is a diagram elaborating the

relationship between different components, service providers or service receivers (Kostopoulos et al.,2012). In this research, we choose service blueprint for the following reasons:

1. The service blueprint method provides a comprehensive overview of how the service and its related experience are delivered, from start to finish, across all channels. The research aims to comprehensively explore the phenomenon of co-creation in SSC, including the necessary conditions. This powerful tool enables a holistic view of the user experience while providing a detailed insight into underlying processes (Kostopoulos et al., 2012).

2. Prior to implementing any enhancements to our services, it is recommended to utilize this tool in order to obtain a comprehensive overview.

3. This process aids in facilitating a clear comprehension of the tasks necessary to provide the service to all parties involved effectively.

In the display of data, this article uses the service blueprint tool for analysis in chapter cases introduction and finding chapters. Figure 4.3 is a service blueprint example which illustrates the traditional orthodontics process. The following figure is constructed according to the customer journey, including time, evidence, the front stage sector, and the backstage sector.

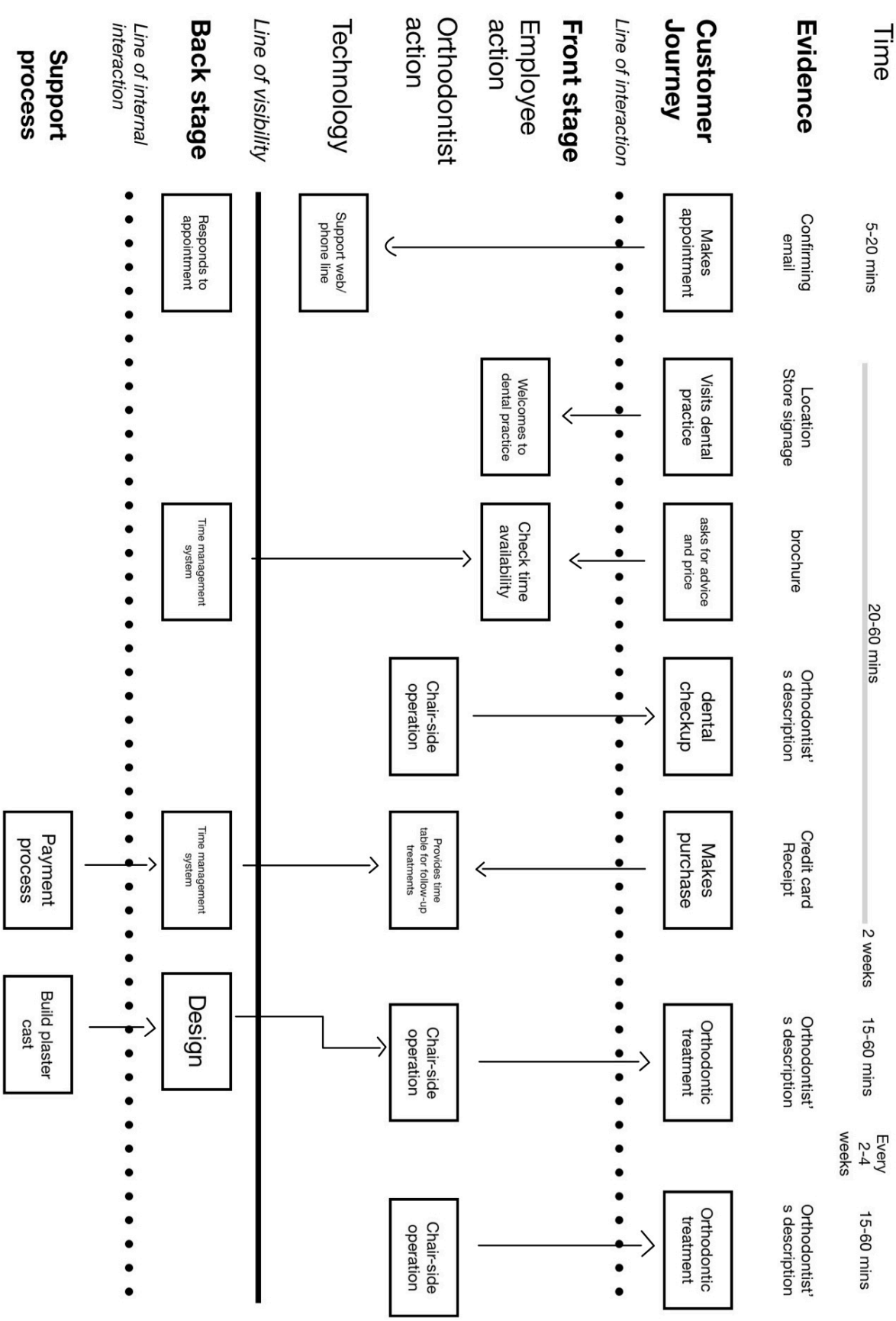

Figure 4.3 Service blueprint example—traditional orthodontics (Kostopoulos et al.,2012)

4.4.4 Cross-case analysis

Cross-case analysis is a method of data analysis. It achieves the objective of analysis and draws conclusions by comparing multiple cases. Cross-case analysis also includes different analysis methods (Khan and VanWynsberghe, 2008).

According to Miles et al. (2014) , there are three kinds of specific cross-case analysis methods which are (1) case-oriented strategy, and (2) variable-oriented strategy and (3) mixed strategy. In the case-oriented strategy, researchers can find similar or dissimilar according to a stable theoretical framework each case. In the variable-oriented strategy, researchers must identify common themes among all cases. The mixed strategy combines both cross-case analysis methods. On the one hand, this research aim to analyze the concept based on the conceptual framework established before, and on the other hand, analyze the data according to the type of co-creation and sub-themes. Therefore, this article will adopt a mixed strategy which combine case-oriented strategy and variable-oriented strategy to do the cross-case analysis.

4.5 Research validity

In the case study design and analysis process, credibility/validity and authenticity should be the main factors considered in this research to ensure a conclusion with great level of dependability. A study is considered credible if it ensures that researchers have collected and interpreted data properly. This guarantees that the findings and conclusions accurately represent the world that was

studied (Yin, 2016). According to Yin (2016), authenticity pertains to the dependability of data sources.

Internal validity – When conducting a study, it's important to consider the internal validity. This refers to the degree of support a study provides for one explanation of a relationship over another. The stronger the support, the better the study is at making inferences and explaining causal relationships. It’s crucial to ensure that our research is as accurate and thorough as possible to ensure we draw the right conclusions. The testing process involves several techniques such as pattern matching, explanation building, evaluating rival explanations, and using logic frameworks. For this study, a concise iterative approach was used to assess existing theoretical premises while analyzing data.

External validity –It is crucial to consider the broader applications of a study's results beyond the specific context in which it was conducted. The ability to apply the results to different contexts, such as different entities and times, is crucial in determining the overall impact of the study. By understanding the limitations of generalizability, we can better evaluate the relevance and applicability of the research. This study used theory and replication logic to test and develop a conceptual framework for cross-case theory replication.

CHAPTER 5: INTRODUCTION OF THREE CASES

5.1 Case 1: Orthodontics practice

the common digitalization of orthodontic on the market is divided into two levels in recent years. The digitalization of first level is utilized by most dental practices which use the 3D scanning, online design and orthodontics treatment system to facilitate the process of treatment design and backstage operation. Another digitalization is to add the application of digital platform to integrate resources to allow patients to manage and monitor their own condition on the basis of the first level. This operation mainly takes smile direct club as an example in this article.

This part will introduce the operations and service supply chains of the digitalization in first level and the second level in turn. In order to better demonstrate the transformations in the service provisioning process, this study will also add the traditional dental procedure in this thesis, and draw the maps of service supply chains with the tool of service blue print.

5.1.1 Service supply chain maps based on blueprint mappings

The following supply chain maps illustrate the service supply process before and after the digitalization in orthodontics. The applied mapping method is according to the service blueprint mapping methodology (Felberg, 2019).

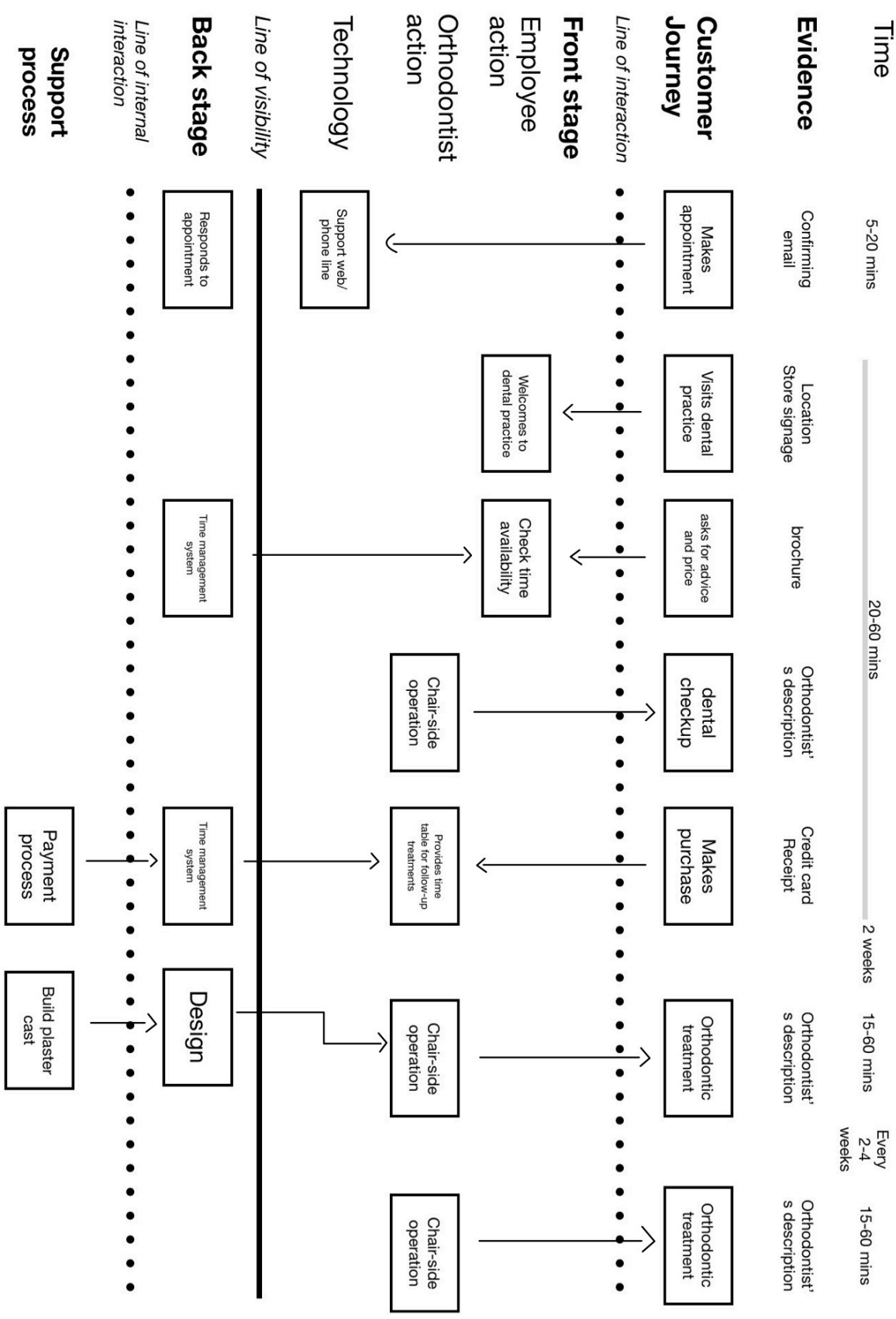

Figure 5.1.1—service supply chain of traditional orthodontics

As illustrated in this service supply process (figure 5.1.1—service supply chain of traditional orthodontics) above, the traditional model of service supplement in teeth correction have lasted for decades. In the traditional process of orthodontics, patients are supposed to make appointment to meet the orthodontists and discuss about the price and treatment. After the dental check-up, the orthodontists will take 1-2 weeks to make a plaster teeth model based on the patient's tooth print for later design. After that, orthodontists need to wear steel wire braces for the patient, and then adjust the tension of the wire every 2-4 weeks to achieve the goal of orthodontic treatment.

The whole process circle only between two individuals which are one patient and his/her orthodontist. Similarly, the 2-3 years' entire process of teeth correction service only happened in the dental practice. Every contacts between patients and orthodontists are physical process which means both the patients and orthodontists need to show up every 2-4 weeks during the whole 2-3 years.

Interviewees also pointed out several drawbacks when introducing the traditional orthodontic service supplement. The "inconvenience" is the most mentioned word to describe the traditional service. This "inconvenience" refer to both the doctors and the patients. For doctors, they left comments in the interviews that they have to repeat the treatment of teeth adjustment every time when patients return to them which takes up a lot of their working time. The same problem haunted patients. To patients, they must insist on returning to the clinic every two-four weeks with appointment, and endure pain caused from the treatment of teeth adjustment. It is stressful not only in terms of time but also in terms of mental health.

This traditional service supplement also has many disadvantages besides inconvenience of service delivery. From the perspective of medicine, the conventional orthodontic cycle depends vigorously on the experience and capability of the specialist. To some extent, the end-product of orthodontics is totally constrained by the dental specialist. The whole process and result of teeth correction is invisible to patients which makes the satisfaction of patients after 2 to 3 years of orthodontic treatment is lower than expected in some cases.

In order to mitigate the impact of these disadvantages, orthodontics industry has ushered in a huge digitization in recent years. The digital service process illustrated as follow (figure 5.1.2—service supply chain of digital orthodontics)

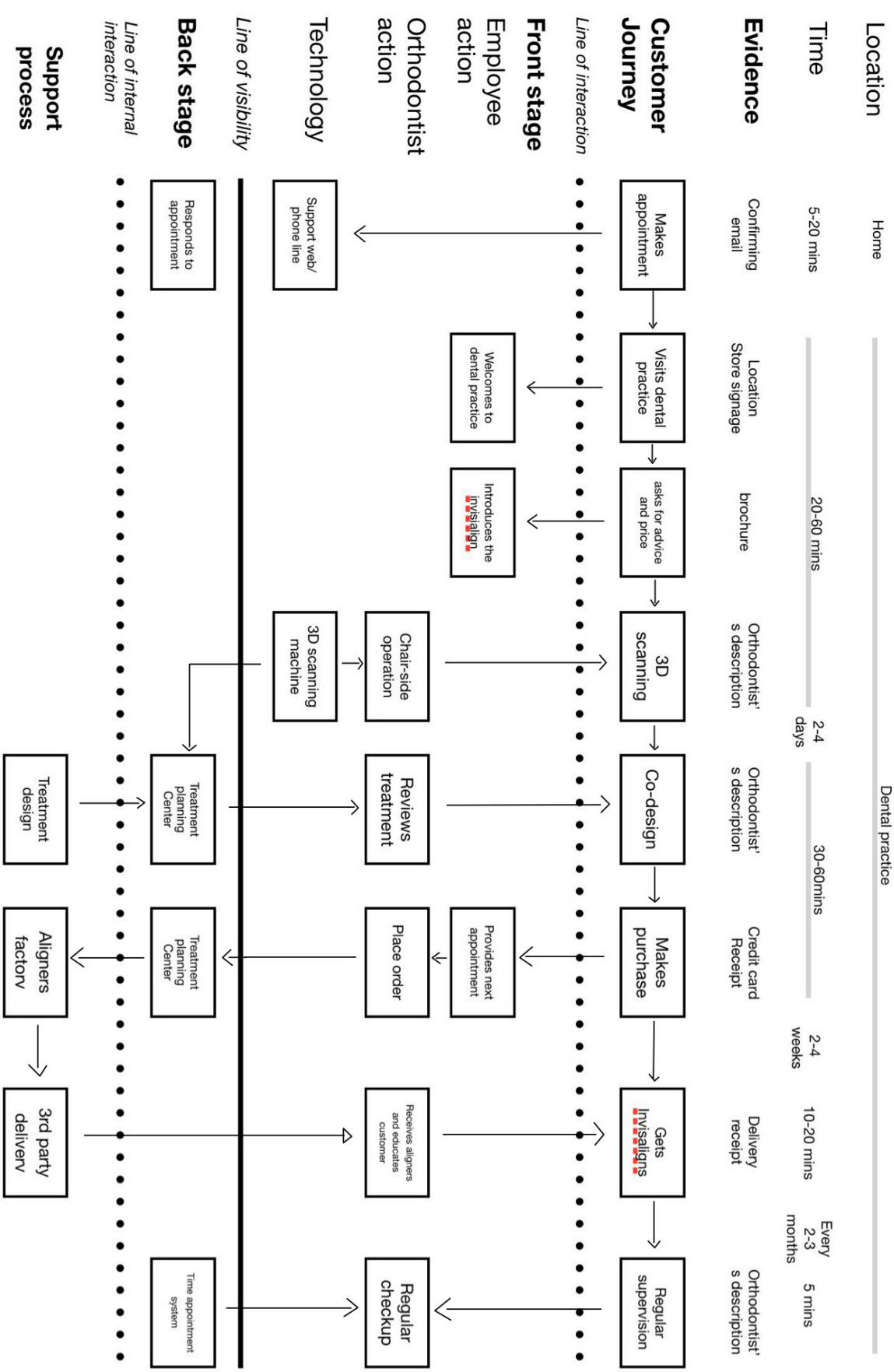

Figure 5.1.2—service supply chain of digital orthodontics

The service supply chain above shows the process of teeth correction after applying digital platforms, 3D modelling, artificial intelligence and an orthodontic treatment system. The flow chart starts at the upper left corner and ends at the lower left corner, which shows the whole process from the patient's decision and order to the dental practice to the dentist's contact with digital suppliers (invisalign and angel align) to the production of align(braces) to the final period of periodic review.

Compared with traditional orthodontics, digital orthodontics has been upgraded in many ways. Patients also need to make an appointment to see a doctor and make a decision on teeth correction after sufficient communication, just like in traditional orthodontics. The difference is that they no longer need to bite teeth print, wait for plaster cast and wear wire braces. The patient will undergo another 3D scanning of the teeth after the dental checkup at the clinic. After a short wait, patients can see the full appearance of their teeth from the computer. At this time, the orthodontists will guide the patients to jointly design the scheme of teeth correction on the computer with orthodontists. At this point, the patient will make many suggestions and requests regarding the appearance of the teeth.

For orthodontists, with the help of the global orthodontic treatment system, they no longer need to make a plaster cast of the patient's teeth but only need to show the patient the 3D model on the computer after 3D scanning and guide the patient to understand the process of teeth correction, accept the patient's demands for the final result. For the design of the teeth correction process, orthodontists only need to upload the 3D scanning and the expected results to the global orthodontics treatment system, and GOTS can help them design the whole process of the teeth

correction. When the orthodontists confirm the plan that system designs, the align factory will directly produce all the invisible braces and send them to the orthodontists or patients. That is to say, orthodontists do not need to design the plan directly in this process, they only need to serve the patient, help the patient and review the treatment plan designed by GOTS.

As can be seen from this service supply map, compared with the traditional orthodontics, in the process of service provision after digitization, in addition to orthodontists and patients, different suppliers in the service supply network are likewise involved. Orthodontists abandoned the traditional steel braces and used removable transparent aligns instead. Similarly, orthodontists are no longer fully responsible for tooth design. The professional part of tooth design is jointly completed by treatment supplier and orthodontists, and the aesthetic part of tooth design is jointly designed by patients and orthodontists which means the patients' preference can also be adopted in treatment.

5.1.2 Invisalign and Angel align

"Invisalign" and "angel align" are two of the most influential technology suppliers in the UK and China respectively. They are widely regarded as manufacturers of invisible braces in the market. In fact, they are also the most efficient and knowledgeable assistants for orthodontists around the world. "Invisalign" and "angel align" currently provide services such as treatment programs, invisible braces production, and education of orthodontists to almost all orthodontic practices around the world.

Online process monitoring is an extension of the products offered by companies like Invisalign and Angelalign. Because invisalign can design the whole process of teeth correction at one time and can produce braces for several years at one time, it largely increases the possibilities of remote monitoring in the following years. In the interviews, most dentists said that they can get in touch with patients through social online platforms and achieve remote monitoring. This operation is used more frequently during the pandemic.

5.1.3 Orthodontics treatment system

The technologies of dental scanning and orthodontics system have been mentioned by interviewees both in UK and China. By applying these digital equipment and digital platform, the visibility inside the teeth is greatly enhanced.

The orthodontics treatment system is the treatment planning center run by invisalign/angelalign at the upper right corner of Figure 2. This is an auxiliary medical system. The data generated by scanning in the system can directly generate treatment plans through this system which not only greatly reduces the workload of orthodontists, but also improves the quality and standardization of services.

Compared with traditional orthodontics, the digital orthodontics treatment system has more advantages. Traditional orthodontics rely solely on the experience and senses of the dentist. In order to correct as soon as possible without combining the patient's oral data analysis, it often leads to the behavior of random tooth extraction and multiple tooth extraction. At the same time, due to the unsupported situation of technical equipment, there are risks like abstract communication, oral

presentation by doctors, and no postoperative effect can be seen, which poses a risk of correction to customers. In contrast, the digital orthodontics treatment system is able to help orthodontists analyze the patient's maxillofacial and dental conditions through 3D scanning and combine the orthodontist's experience and technology to accurately formulate the best correction plan. The whole process achieves a more accurate, more intuitive and more professional results.

5.1.4 fDirect connection mode

The "direct connection" mode of the second type of digitalization in the orthodontic field is based on the first basic digitalization we have described above. This model has applications in both of the UK and China, mainly referring to services provided by companies led by the "smile direct club" that allow patients to skip the orthodontist and directly connect with the global orthodontic treatment system.

The model of the “direct connection” is the most complex application of the digital platforms and technologies in orthodontics industry today, and also the most controversial operation among dentists. In addition to the application of invisalign's assistant system for orthodontists and online monitoring, it has also established a digital platform to directly allow patients to connect with invisalign's backstage assistant orthodontist system. The establishment of this platform has replaced the work of most orthodontists and reduced patient expenditure by 40%-50%, but the safety of this platform has also been questioned.

The service supply chain of the “smile direct club” model are illustrated as follow in figure3—service supply chain of direct connection mode.

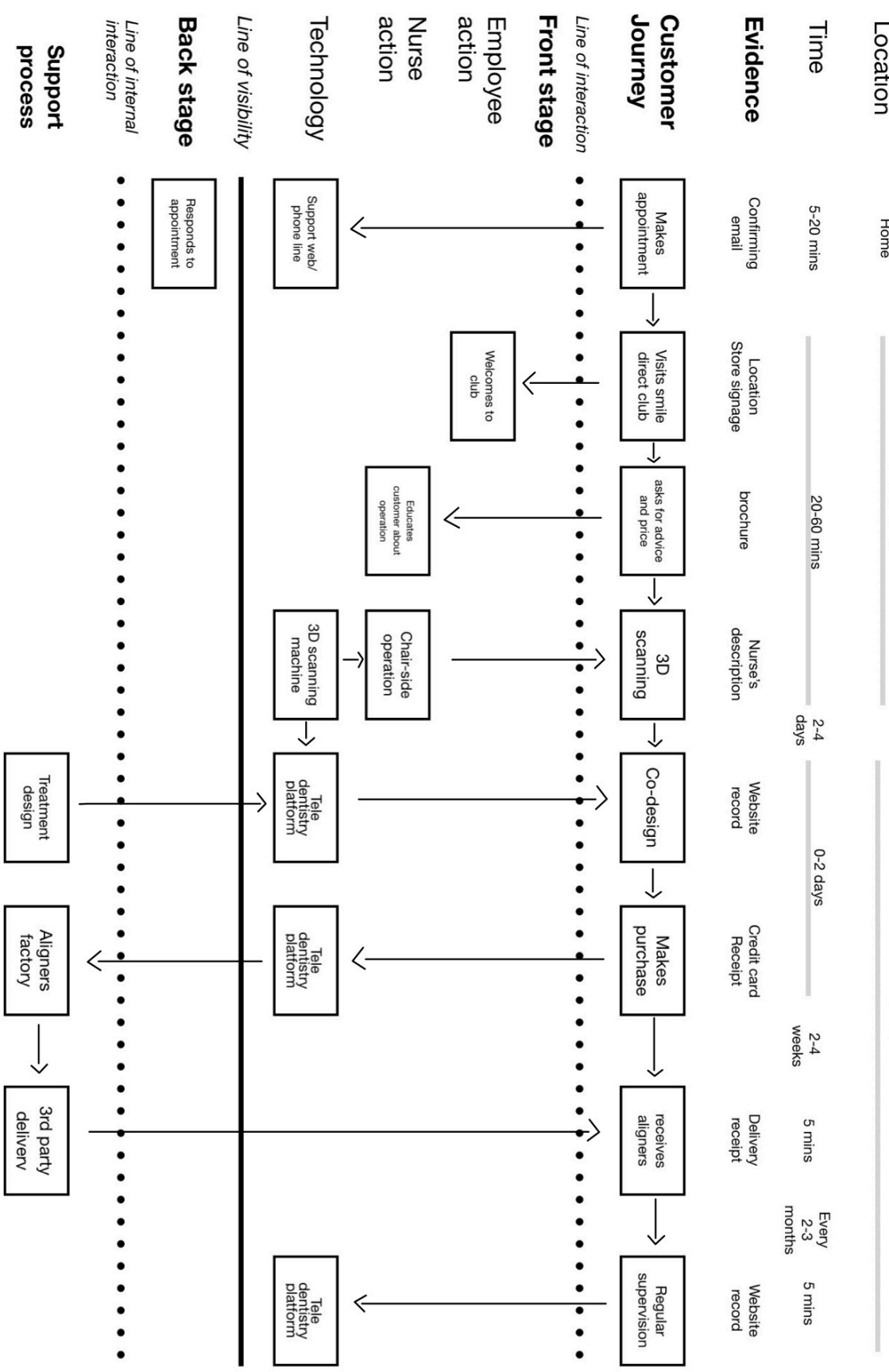

Figure 5.1.3—service supply chain of direct connection mode

The map of the service supply chain for “smile direct club” model based on blue print shows that since the patient designed it together with his orthodontist, it has almost replaced the orthodontist to obtain treatment directly through the treatment system. As can be seen from the transformation of these two figures, smile direct club has adopted a new model, so that suppliers who provide treatments for orthodontists can communicate directly with patients.

5.2 Case 2: integrated primary care in internet hospital

The concept of Internet hospital which has been brought out in China in recent years is a kind of digital platform which gather variable medical resources from hospital and clinics to patient. From an overall perspective, Internet hospitals, as a digital platform, have experienced rapid development in recent years. From some medical assistance platforms with only a single function (such as online appointment and healthcare knowledge), it has gradually become an "online hospital" that integrates multiple medical functions and has a large number of doctors. As a result, Internet hospital is designed to provide integrated healthcare service and medical resources to patients.

The difference between the Internet hospital platform and the offline hospital is that the Internet hospital is not a disease-oriented hospital, but is classified according to the type of service that patients require including medical consultation, health planning, electronic medical records

management, daily monitoring, outpatient appointment, vaccine appointment, tele diagnosis, tele treatment, follow-up treatment, disease risk assessment, medicine provision.

5.2.1 Types of Internet Hospital

There are three main models of Internet hospitals in China, which are perspectively led by the key offline hospitals (HLH: hospital-led hospital), IT companies (ELH: enterprise-led hospital) and medical departments of government(GLH: government-led hospital). For now, every kind of Internet hospital is under development. Each kind of platforms has its own strengths and weaknesses

The former is mainly represented by the key offline hospitals which mainly use the doctors of the hospital to carry out Internet diagnosis and treatment activities. For the key offline hospitals, the internet hospitals allow them to bring many medical services that can be performed remotely to this platform, enabling patient to receive medical services faster and more conveniently. The advantage of HLH is that it has direct connection between the hospital and digital platform which means the HLH usually includes all of their doctor resources and the background systems of offline hospital. Therefore, online platform can be connected and unified. however, there are still some drawbacks. Firstly, it would be hard to unify different diseases if the patients had treatments in more than one hospitals. If patients receive treatment in different hospitals, they will have to download multiple apps that is very inconvenient for the patient and also hinders the patient's willingness to use this platform. And, usually, when a patient discharges from the hospital, they will rarely use the app again. As a result, it is difficult to HLH developers to build a continuous health management platform for patients.

the other type is enterprise-led Internet hospitals (EIH) usually created by IT company like Baidu, Alibaba, Tencent etc. the EIH is represented by Internet medical enterprises, relying on offline physical medical institutions, and using doctors registered in this institution and other medical institutions to carry out Internet diagnosis and treatment activities. of the 497 Internet hospitals, 415 are dominated by hospital-led Internet hospital, accounting for 83.5% (China Net News, 2020). Although the number of hospital-led Internet hospitals is relatively large, the enterprise-led Internet hospitals are more dominant in terms of market size and investment amount.

Compared with HLH, the advantage of ELH is that it is not limited to cooperate with a certain hospital, but cooperates with large hospitals all over the country. Just like a delivery person on “deliveroo”, any qualified doctor can register on this ELH platform to become a registered doctor of the platform. This also allows the amount of platform's doctors to expand rapidly until it covers the whole country. In addition to digital hospitals developed by large IT companies, insurance companies (such as Ping An Insurance) have also participated in the construction of this kind of digital platforms.

The third type is the Internet hospital led by the medical department of local government. The main purpose of this kind of Internet hospital is to help the residents to do their health management and other service. However, due to the limited operational capacity of the government's medical institutions, the utilization rate of GIH is not very high.

To conclude, the services provided by HLH are mainly disease-based since the services provided by HLH are mainly the supplementary and extension of in-hospital services that patients receive. It is a digital platform to play the role of tool of patient and doctors. EIL is mainly based on patient health management, providing patients with more functions and channels to contact doctors so that patients can better achieve self-health management. GIH also has some applications, but due to the lack of investment and professionals, it has not taken the mainstream of the market. This thesis mainly focuses on the digital platform of ELH.

The interviewee 25 who is a product manager commented on the different types of internet hospitals in china " For now, in fact, the development of Internet medical care in China is also very tangled. At present, it is actually a state of blooming flowers. All parties are trying new models, hoping to use the medical resources better to provide the public with more efficient and high-quality medical services. But back to the question: which mode is the most appropriate to the current medical environment? In fact, this question is still being explored and related to medical policy in China."

5.2.2 The main function of Internet hospital

As a new innovation in the medical and health industry, Internet hospitals have effectively promoted the flow of medical resources, empowered the level of primary medical care, improved the productiveness of graded diagnosis and treatment, and alleviated the problem of unbalanced distribution of medical resources.

1. Online communication with doctors

In an internet hospital, patients can communicate with doctors via text, phone or video through the channels provided by the internet hospital. Different from the need to wait for days or even weeks after making an appointment in ordinary outpatient clinics and hospitals, under normal circumstances, it only takes 1-2 hours after making an appointment with a doctor in an Internet hospital to directly talk to the doctor. Now, the top EIH Internet hospitals generally have nearly 200,000 doctors who can solve medical problems for patients online, covering various departments in the hospital and various regions in China.

In the process of proper medical service delivery, this online communication with doctors can be divided into several different types: after treatment connection, cross hospital connection, online diagnosis and healthcare consultation.

After-treatment connection refers to a condition in which a patient needs monitoring and hospital assistance after completing treatment or part of the treatment in a hospital or clinic. For example, when a patient goes home after surgery, they will need the doctor to further confirm the recovery situation, prescribe further medicine, and communicate with the doctor when encountering a problem. This situation generally occurs in the after treatment rehabilitation stage and the recovery stage of chronic diseases. In addition, the after treatment connection in the Internet hospital also occurs when the patient cannot obtain the report or report interpretation immediately after the physical examination. In this case, the patient will interpret the report in the Internet hospital after obtaining the report. After treatment connection is mainly a process of finding a specific doctor in internet hospital who has treated you in an offline hospital to communicate with.

Interviewee 24, who is the registered doctor of ELH Internet Hospital, pointed out that “ Many doctors ask their patients to scan their personal QR codes in Internet hospitals to be their followers, so that patients can communicate online if they have any questions. This is also related to the level of the doctor. Generally, well-known senior doctors will maintain communication with patients in this way.

Cross hospital communication refers to patients looking for help from other hospitals on the Internet rather than their local hospitals. This situation generally occurs in the pre-treatment consultation stage when the patient needs treatment and the report interpretation stage after the patient completes a physical examination.

Regarding this issue, Interviewee 44, who is the CEO of “Farsighted” healthcare insurance company, said: "Patients are much smarter than you imagine, and many patients will become experts in this field after being ill for a long time. Similarly, many patients will also try to get a full understanding and preparation before surgery or treatment of big diseases. For example, they usually compare the treatment plans of different doctors, strive to obtain better and more advanced doctor's advice, etc."

Internet hospitals provide these patients an online platform to connect with high-quality doctors nationwide. This has also helped solve the medical inequality problem in China to a certain extent. Almost every interviewee regarding the Internet hospital stressed the importance of Internet hospitals in helping patients in underserved regions obtain better healthcare services.

Online diagnosis and healthcare consultation is the process of a patient going online to seek help after having some uncomfortable symptoms. This usually occurs before patients go to clinics and hospitals. As online consultation is very fast and generally can help patients build communication with real doctors within one hour, many patients are willing to choose an Internet hospital for communication when they encounter uncomfortable symptoms. When the doctors in the Internet hospital can't diagnose, then patients will go to the offline medical institutions to treat further.

According to the opinions of the nine interviewees on the suitable condition of online diagnosis, we have concluded that, for the problems of departments of obstetrics and gynecology, dermatology, pediatrics, and psychiatry that can be easily diagnosed through video and communication, the efficiency of online diagnosis is still very high. In addition, 11 interviewees who are the registered doctors of internet hospitals said that the problems solved by online diagnosis are actually the problems of healthcare consultation. The main topics of this healthcare consultation include the early prevention of disease, relieve patients' anxiety, home nursing problems and a wide range of questions raised by patients.

2. Online prescription and drug purchase

Online prescription refers to the phenomenon that after the patient communicates with the doctor in the Internet hospital, the doctor prescribes the medicine for the patient when the doctor thinks the situation is appropriate. Since the right to prescribe medicine is a serious matter, the government and Internet hospitals also have many regulations and restrictions on online prescription.

In our investigation, we found that with the development of Internet hospitals, the regulations for online prescription and drug purchase are more and more detailed and perfect. Most online prescriptions occur when patients have uploaded their healthcare reports. Therefore, most patients with chronic diseases can obtain online prescriptions and purchase drugs through Internet hospitals, because patients with chronic diseases have enough healthcare reports to prove their physical conditions. In addition, Internet hospitals have very strict regulations on the granting of prescription rights. Only a few departments that the government believes that online prescription in their departments is relatively safe can obtain the prescription rights of Internet hospitals.

3. Online health education

Online health education refers to some health information and some popular science knowledge of diseases provided by Internet hospitals. Like Wikipedia, Internet Hospital provides professional, officially endorsed knowledge of disease and health management on the Internet. In addition to the knowledge on the web, Internet hospitals also provide online live broadcasts of famous doctors. Patients can listen to the doctor's lectures through live broadcasts and communicate with the doctor online.

4. Online private doctor

Online private doctor refers to the annual or monthly services provided to patients at Internet hospitals, which is similar to medical insurance provided by Internet hospitals. In this service, patients can designate a doctor as their personal doctor, and they can communicate with the doctor at any time during the validity period of the service. This service is generally applicable to some chronic diseases and long-term diseases. The function of an online private doctor has many

advantages, including increasing patient trust, understanding the continuity of the disease, reducing the cost of consultation and so on.

5.2.3 Internal service and external relations

Besides the above-mentioned key functions of allowing patient interacting with doctors, Internet hospitals also provide a set of services on primary care. According to the data from interviews and data from official website of internet hospitals, this study draw the following diagram (figure 4 — internal service of internet hospital) to illustrate the service cycle in internet hospitals.

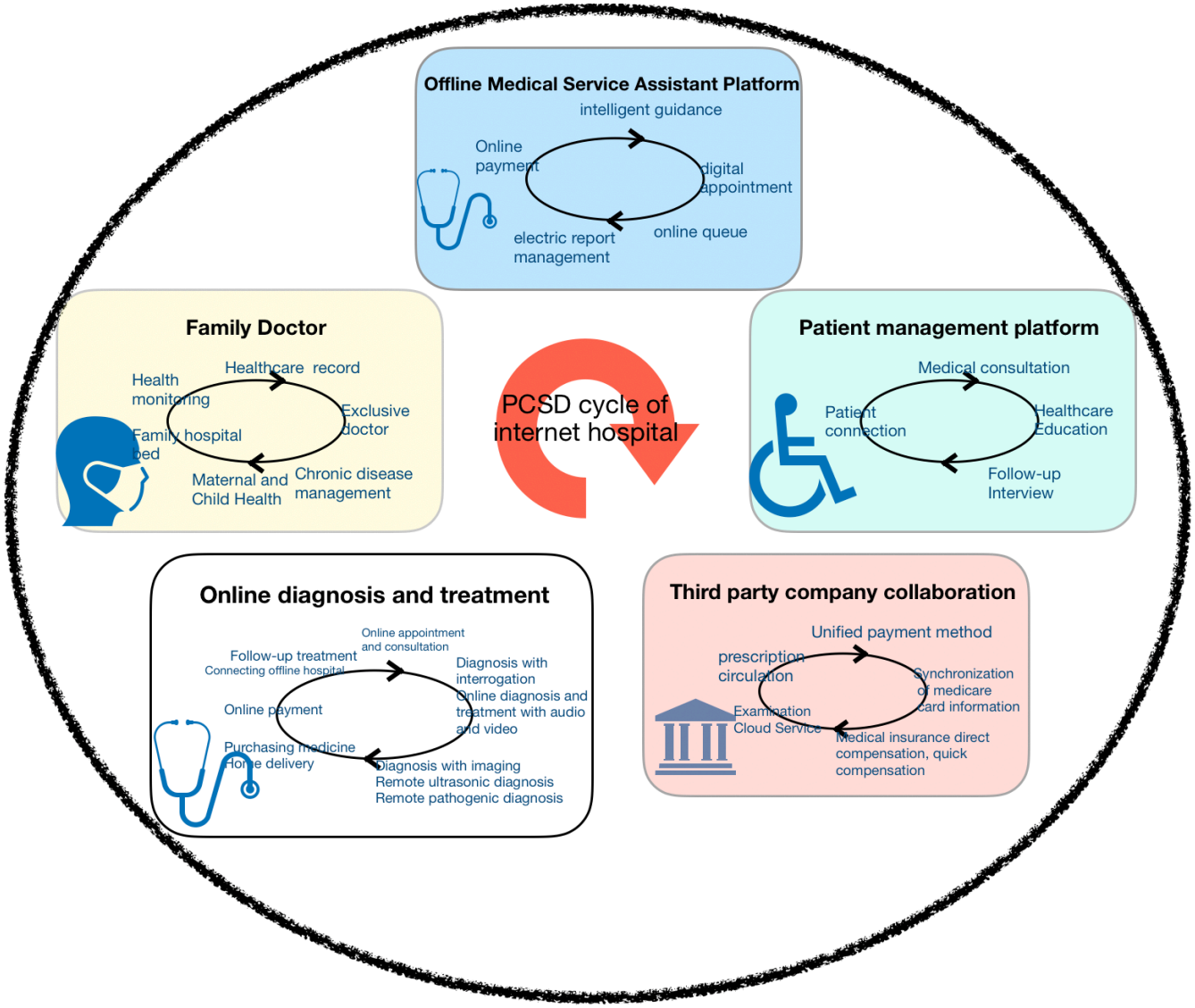

Figure 5.2.1 — internal service of internet hospital

According to the data from interviews and data from official website and APPs, this study draws the following diagram (figure 5.2.1 — external connection of internet hospital) to illustrate illustrates the service system with external agencies

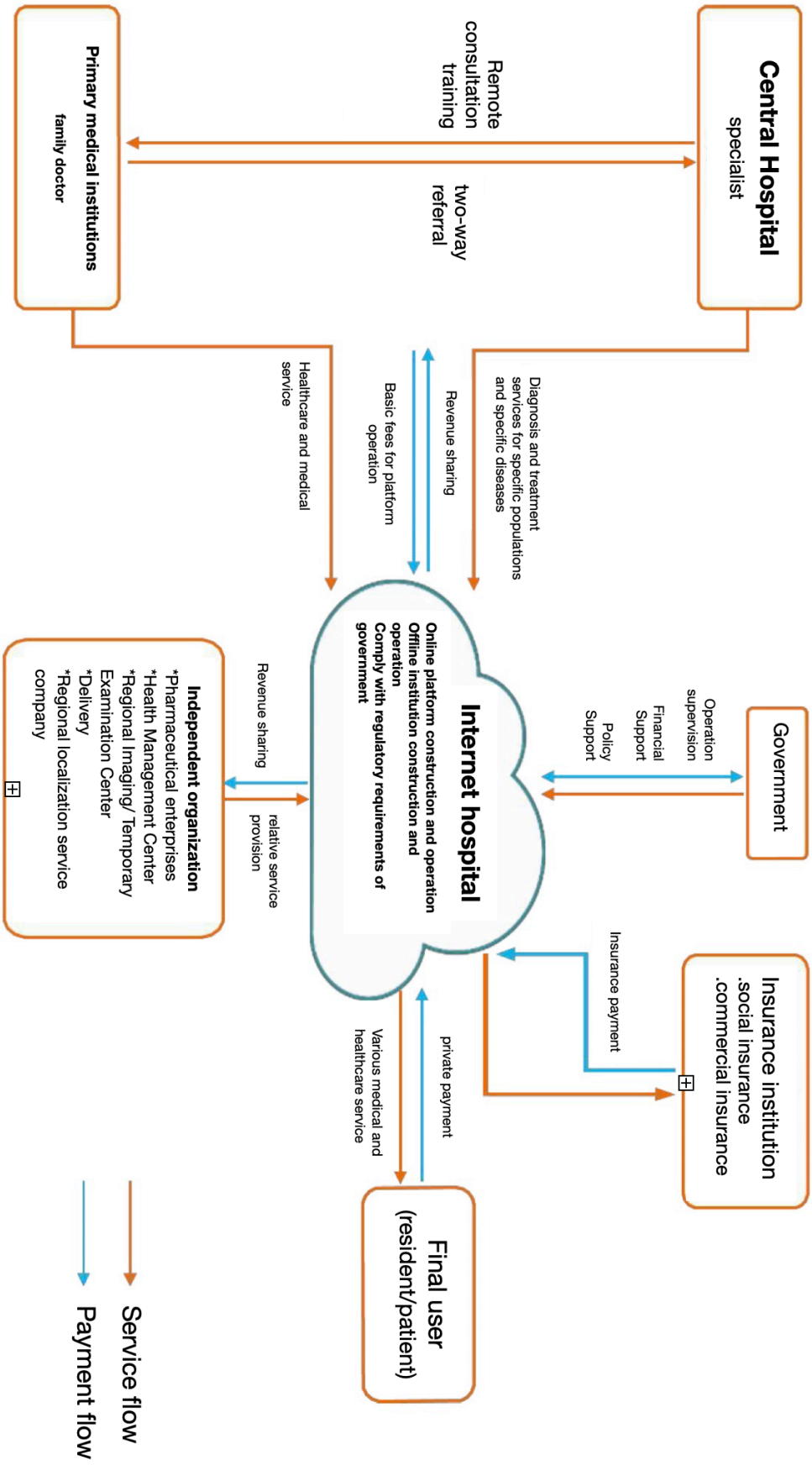

Figure 5.2.2— External connection of internet hospital

As can be seen from the figure, the red arrows represent the service flow while the blue arrows represent the payment flow. The Internet hospital locates In the middle of the figure which is surrounded by other organizations including government, insurance institution, offline hospital, clinic, independent organization and final user.

5.3 Case 3: chronic disease management

Chronic disease management refer to an integrated care approach to managing illness which includes screenings, check-ups, monitoring and coordinating treatment, and patient education. In recent years, the digitization of CDM has also been greatly developed.

Traditional chronic disease treatment only includes the operations finished within the hospital, including doctor operations and prescriptions etc. However, most interviewees regarding to CDM believe that chronic disease management still needs to be done mainly by the patient. There are not many things that hospitals and doctors can do to help patient manage their chronic disease in their daily life. The main thing is that patients need to have better health management awareness and cultivate a healthier lifestyle. Therefore, the digitalization of chronic disease management usually helps patients learn health knowledge, conduct better health management, daily data monitoring, etc.

According to the interview data, this study also summarizes the four existing digitalization of different degrees in chronic disease management based on the digitalization in this area (figure 5.3.1

— digitalization of CDM). Digital health technologies, such as digital therapeutics, wearables, remote patient monitoring, coaching, and education, can help manage condition-specific factors in CDM. Activity trackers, medication reminders, and vitals recording help keep important health information easily accessible for infrequent doctor visits.

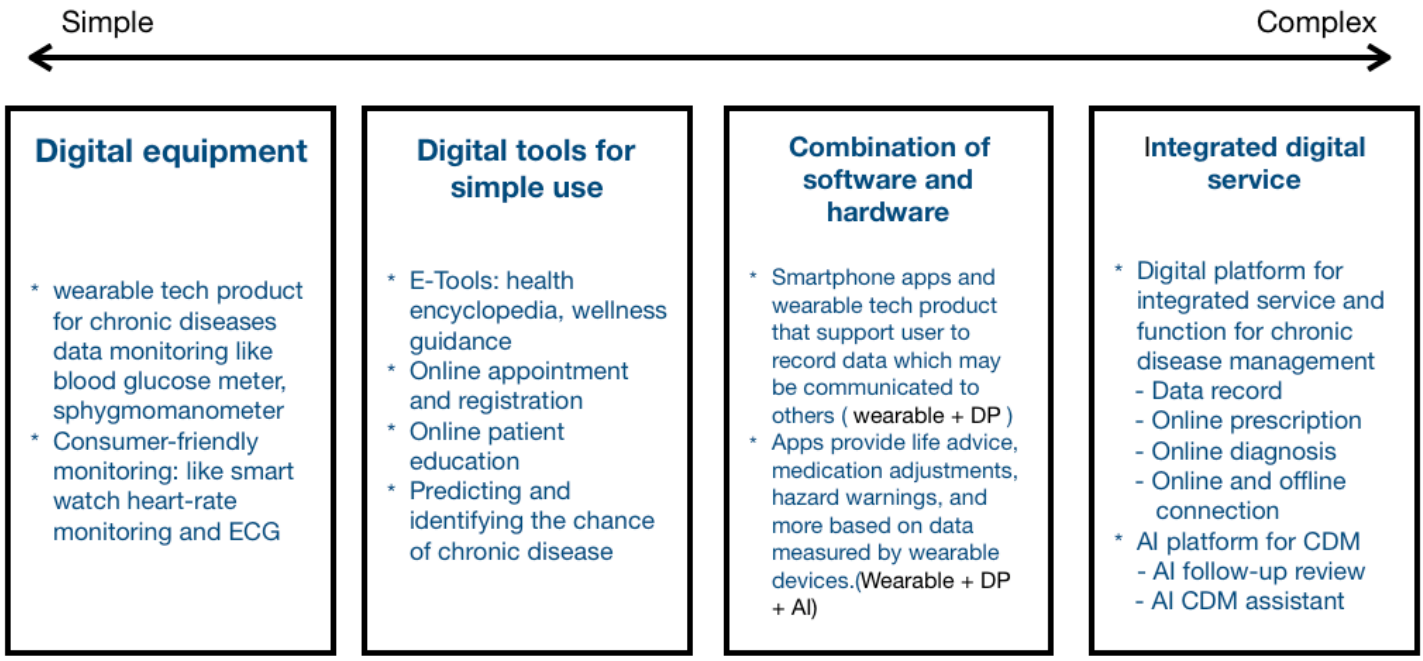

Figure 5.3.1 — digitalization of CDM

5.3.1 Single use of hardware and software

In this figure, the first two boxes are digital equipment (wearables) and digital tools for simple use. These two parts represent the digital application in hardware and software, respectively which have simple and single function to help the CDM. For the digital wearables, it usually help to collect and monitor medical data like blood glucose and heart rate. The digital tools are mainly online platforms

that provide basic medical services like online registration, patient education, wellness guidance et al.

For online health education, 8 interviewees emphasized its importance. Interviewee 42, a cardiologist, said: "Primary prevention should be done to prevent him from getting the disease. After the disease, secondary prevention should be done to prevent him from getting the disease again. The prevention of these diseases is the most important thing in the treatment of chronic diseases, and it is exactly what the patient needs to learn and be vigilant about."

Interviewee 45, the product manager of internet hospital, commented: "This is a matter of concept of healthcare. Medical care should not only be generalised to treat patients but also help patients prevent the disease. Because chronic disease is the result of a long-term unhealthy living habit many people don’t even know that there is a problem with their living habits.”

In addition, It is worth mentioning that the last item in digital tools for simple use is a tool that uses AI to predict and identify the chance of chronic disease. For example, “Avalon AI” can diagnose Alzheimer's disease with 75% accuracy. They use deep learning technology to develop computer medical imaging diagnostic tools. The development of this service product has greatly improved the service efficiency of early chronic disease prevention. It is the earliest diagnostic service available to patients.

The AI developers this study interviewed also commented on this aspect. They emphasized the importance of the amount and source of data. To gain the better data, the company majoring AI

image interpretation often requires resources in partnership with many hospitals and even governments. However, they mentioned that policy support is also important for the development of direct-to-patient AI interpretation tools, because people are still questioning the safety and accuracy of AI diagnosis.

5.3.2 Combination of software and hardware

The third type of chronic disease management is the combination of software and hardware like the third box in this figure. This type of application (Shark Health in China) involves a wider range of real time data and a wider range of applications to that data. Through the analysis of data, it can effectively and meticulously monitor, analyze and manage the physical condition of the patient.

For example, Interviewees described the operation that hospitals or patients themselves collect glycemic(blood sugar) and blood pressure index through unique implantable healthcare device and automatically send these data to APPs where the patients have their own accounts and check their data everyday. According to the flow of their data during a period of time, the AI engine in the backstage will automatically give suggestions on their diet and drug dosage.

5.3.3 Integrated digital service

The last box is mainly the services that chronic disease patients receive in Internet hospitals. It provides a one-stop service for patients, which greatly reduces the cost of time, energy and money in the service delivery process and avoids unnecessary waste of strained medical resources in the delivery of chronic disease services.

As depicted in the figure, some chronic disease patients can access chronic disease management assistance through a number of digital platforms. For example, this kind of digital platform are able to help the storage and analysis of daily data monitoring (such as heart rate) on the platform, online diagnosis, prescribing and adjustment of doses, and online AI assistants' suggestions for life, diet and exercise, etc.

CHAPTER 6: CO-DESIGN

Co-design is the cooperation process to accomplish a specific design goal; the customer and more design subjects (or experts) jointly complete the design goal with different design tasks through a certain information exchange and mutual coordination mechanism.

Co-design generally refers to the collaboration between the customer and designer during product design in product manufacturing. But in service, "design" and "co-design" represent richer meanings such as service planning, decision making, process designing, etc. Therefore, in service supply, Co-design refers to the customer through particular knowledge learning, through communication with some service providers and other information exchange methods, which can impact service designing, planning, operation and final results to achieve service goals better.

In the medical field, co-design means that in decision-making and planning, patients can communicate with professionals to affect the treatment plan and planning (Fugini and Teimourikia, 2016b). In our research on the three cases in Chapter 4, we found the co-design phenomenon in the cases of digital orthodontic and digital chronic disease management. The co-design phenomenon in these two fields will be introduced and expanded in detail below.

6.1 Co-design in the digital orthodontic industry

In these interviewees, we have 6 dentists who give us information on the co-design phenomenon in orthodontics therapy with the assistance of digital support by Invisalign.

In the co-design of customers and orthodontic professionals, customers mainly communicate with professionals about their treatment plan (such as teeth arrangement plan, desired treatment effect, treatment cycle, etc.) and then proceed to the next treatment step. During the communication of the treatment plan, customers can obtain 3D dynamic images of their teeth arrangement through 3D scanning and other auxiliary software and then co-design with orthodontists on the problem of teeth arrangement and the subsequent treatment.

From the beginning of orthodontics to the treatment of consumers wearing braces, there are three stages: checkup stage, treatment design, and treatment implementation. The checkup stage is the first process of therapy including the medical history investigation, medical image shooting, model making, photo taking, and health record establishment. This procedure requires professionals and service providers to determine the teeth alignment, teeth position, and teeth bone situation. The second stage is the treatment design. Treatment design is to find a program to conduct the treatment based on the patient's main complaint and profession as well as treatment time, aesthetics, and economy. Orthodontic patients need to be clear about their needs and understand the impact of some orthodontic arrangements on appearance. Orthodontic professionals generally recommend that

customers have a clear understanding of their teeth and the desired effect in the future before orthodontic treatment. After communicating with these two parties, professionals will design a final personalized plan based on X-ray images, dental measurement data, occlusion, facial shape and other data. The third stage is the treatment implementation, that is, the professionals or other service providers from clinics order braces to the Invisalign supply factory according to the treatment plan jointly designed with the patient and provide the patients with periodic dental checkups. The co-design we mentioned is when customers and orthodontic professionals together discuss and contribute to the final treatment plan in the second stage of "treatment design".

6.1.1 “Treatment plan co-design” and “Teeth arrangement (alignment) co-design.”

In the orthodontic process, many steps allow customer and orthodontic professionals to co-design. Four interviewees expressed that in the digital orthodontic process, co-design can be implemented in the following aspects: making the orthodontic plan, the design of the teeth arrangement, and selecting orthodontic materials. The most important of these are causing the orthodontic plan and the design of the orthodontic structure. Therefore, we define these two types of co-design as “treatment plan co-design” and “teeth arrangement co-design”.

Treatment plan co-design is making the orthodontic plan together, which refers to the communication between customers and professionals about the total duration, reviewing frequency, and reviewing forms of the orthodontic plan. As the whole orthodontic treatment is a long-term treatment of two to three years or even longer, such a long-term treatment involves a review every

2-4 weeks. Therefore, what is the total duration of the plan that the patient wants? What the frequency and forms of the reviewing? These questions can be adjusted flexibly and are jointly designed after communication between the customers and orthodontic professionals.

“This aspect differs greatly from traditional orthodontics, and the current solutions are personalized. ——Interviewee 7, Dentist.”

The orthodontic arrangement's design is the orthodontist's professional design and operation based on the relevant knowledge of biomechanics and orthodontics. Traditionally, orthodontists complete the overall design on the operating table over two to three years. Therefore, teeth arrangement design is traditionally a professional process of constant adjustment during surgery.

But now, the teeth arrangement co-design refers to the orthodontists’ design of the process and results of the orthodontics based on the relevant knowledge of biomechanics and orthodontics combined with the customer’s expertise and requirements for teeth arrangement and aesthetics. It concerns whether the customer is satisfied with the future effect achieved after orthodontic treatment. Many of the interviewees mentioned the co-design behaviour in the aspect of orthodontic arrangement design.

"After we (orthodontists) design the first draft, we must let them (customers) participate as the final plan combining their designs must be very different from the one we provided at the beginning. Sometimes, we can directly ask them whether the shape looks good and whether they are satisfied.

Sometimes, they will design with us about the effect and final result they want.——Interviewee 4, Dentist. “

"In terms of facial shape, the patient's opinion must be sought because everyone's aesthetics are different. The doctor will ask the patient if he has a protruding mouth and will also tell the approximate extent to which it can be improved——Interviewee 2, Dentist."

6.1.2 Frequency of co-design

Likewise, the degrees and forms of co-design achieved in these two situations (treatment plan co-design and teeth arrangement co-design) are also different. In digital orthodontics, Dentist Zhang 1 mentioned that most orthodontic professionals will invite customers to participate in the design stage.

Regarding the treatment plan co-design, almost every customer will participate in the design of the duration of the orthodontic treatment, the method and frequency of the following review, etc., as this issue is closely related to the customer. Due to the flexibility of digital orthodontics treatment, customers can choose and provide new follow-up review and supervision solutions as creatively as possible, such as uploading photos, FaceTime, daily communication, social media, etc.

However, treatment plan co-design is less common than teeth arrangement co-design. After recalling his customers, Interviewee 7 who is a dentist thought that *“the probability of teeth arrangement co-design is generally about 20%”*. Orthodontists think that teeth arrangement is a

more popular and fashionable practice now. In contrast, young people and those with higher education will prefer this co-design. The main reasons are as follows: 1. Young people will pay more attention to their appearance and the impact of teeth arrangement on their appearance and smile, motivating them to co-design with orthodontists. 2. Teeth arrangement co-design requires customers to master specific medical and aesthetic knowledge. Therefore, the willingness of participation is stronger among groups with higher levels of education.

In addition to the orthodontic industry, Interviewee 4, who is an orthodontist, said, *"This similar co-design phenomenon will also appear in some medical beauty treatment and plastic surgery treatment. This is because when customers value their appearance changes during treatment, They are more willing to study before the treatment to co-design with professionals."*

6.1.3 Co-design operation and SSC

From the point of view of the entire SSC, treatment plan co-design and teeth arrangement co-design are completed in the early stage of SSC in the period of orthodontic planning. According to the introduction above, we know that the total SSC of orthodontics consists of three stages: checkup stage, treatment design, and treatment implementation. The treatment plan co-design and teeth arrangement co-design take place in the treatment design process.

Figure 6.1 below shows digital orthodontics' specific service supply chain through blueprint analysis, including the co-design part. According to the table below, we can see and understand the position of the co-design process in the service supply chain, the process connection before and after co-design, and the front stage, backstage and support process of co-design.

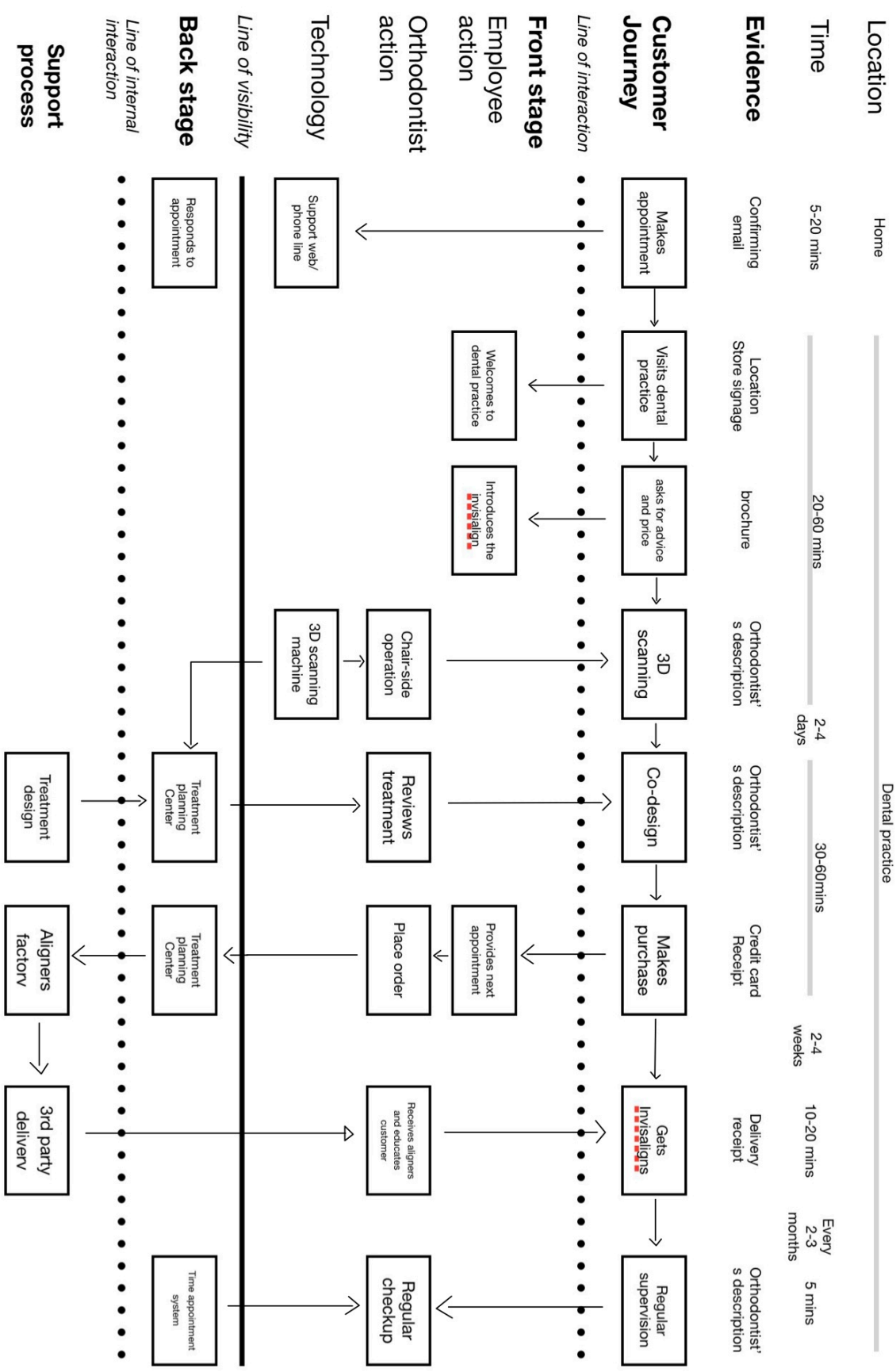

Figure 6.1: SSC of digital orthodontics

From the perspective of the whole service supply chain, co-design is at the position before customers purchase and after the action of customers coming to the orthodontic clinic for consultation and dental checkup. It can be found from the table that co-design has established a bridge for the processes of customers completing the dental checkup when they have yet to decide to purchase. At this stage, orthodontists and other professional staffs can communicate with customers about treatment and introduce the current digital orthodontic operation process and digital treatment plan to customers so that customers can become more familiar with the orthodontic process.

In the meantime, customers can also learn the whole process of upcoming orthodontics and specific knowledge required in treatment through co-design (such as how to align teeth in the next two to three years, the reason for healthcare review, review frequency and methods, etc.).

From the front stage and backstage perspective, the digital treatment design suppliers will provide orthodontists with a draft treatment plan from backstage. After receiving the draft treatment plan, orthodontists will review and modify the treatment with the customer based on professional and customer knowledge, requirements, and wishes and agree on the final treatment. Therefore, in this process, we found that co-design is a process of learning and creation that is actively guided by professionals and naturally integrated by customers.

6.1.4 Advantages of co-design

According to the above introduction and analysis of co-design, we found that the co-design of customers and orthodontists in digital orthodontic has the following advantages:

1. Co-design can better meet customers' needs and provide personalized services. In the co-design of the treatment plan and teeth arrangement, the designs provided by the customer side are all proposed according to their requirements. Since customers have different needs for services, it isn't easy to provide a treatment plan that best meets customers' wishes by relying on orthodontic professionals. But co-designing solves this problem and provides customers with more personalized and high quality service.

2. Co-design can increase user participation and improve user satisfaction. Customers can significantly increase. The interaction between customers and service providers is greatly increased when they co-design for common goals for customers which makes customers feel valued. For customers, the interaction in co-design is exciting and challenging, which encourages and enhances customers' willingness to learn orthodontic knowledge, and they can better understand the whole process of orthodontic and learn related knowledge, which improves the quality of service at the same time. However, for some users unwilling to co-design, orthodontists will provide them with a well-designed treatment plan.

3. Co-design can promote consumers' purchasing behaviour. According to the service supply chain of digital orthodontic service, co-design is the last process before the customer purchasing step, between the customer’s purchasing action and clinic consultation/dental check-up. In this situation, when customers are hesitant to pay for orthodontic treatment, the co-design behaviour with consumers can help customers better understand the process, knowledge, benefits and differences in

appearance after orthodontic treatment with a specific personalized treatment plan. Therefore, after co-designing with consumers, the purchasing behaviour of consumers is also promoted.

6.1.5 Digital technologies in co-design

The emergence of co-design is mainly due to digital auxiliary software (orthodontics treatment system) technologies, 3D scanning, and online modelling.

3D scanning and online modelling are based on the equipment of 3D scanners and technologies of online image software. With 3D scanners and image, customers no longer need to wait long for orthodontists to make a plaster model of their teeth but to obtain a 3D image through a 3D scanner during the dental checkup stage in one minute. Since the 3D image is simple and easy to understand, customers can see their teeth arrangement more intuitively, which provides a prerequisite for co-design. This technology makes the whole teeth correcting process more visual, which makes orthodontists and customers have an equal perspective in the treatment process. At the same time, the traditional orthodontic cycle can only be controlled by orthodontists alone.

"Because the cycle is very long when people generally do orthodontics. It usually takes one to two years or even two to three years. So, it is visualised so everyone can see the results from the beginning. If customers can see the final restorative effect, it will be more intuitive. —— Interviewee 4, Dentist."

Digital auxiliary software refers to the teeth alignment software developed by Bonsmile and Invisalign companies that are currently used by orthodontists. It is also called the orthodontics treatment system. It is a software that allows global orthodontists to gain teeth alignment design treatment and design the teeth arrangement online developed by Invisalign and Angel Align, which also helps to facilitate the co-design implementation.

From the service supply chain management perspective, the digital auxiliary software is the service provider of treatment design in the support process of the backstage co-design in Figure 5.1. This digital auxiliary software is developed to provide assistance for orthodontists from the lowest level to reduce the workload and human errors of orthodontists. At present, almost all orthodontists are using this digital auxiliary software to provide draft plans for customer's treatment design especially teeth alignment design.

In terms of technology, for example, the auxiliary alignment software provided by Bonsmile Company is supported by Professor Nanda, a founding member of Connecticut State University in the United States. It combines the principles of biomechanics and is independently developed by Taiwan's professional software, medical, and production technology teams to create the technological achievements—digital automatic teeth alignment software that simulates subtle changes in teeth in an all-around way. The development and application of the teeth alignment orthodontic software not only saves the time of teeth alignment, dramatically improves the efficiency of orthodontic scheme design, and accurately predicts the amount of teeth movement under computer-aided design.

The emergence of this digital auxiliary software enables orthodontists and customers to know the final appearance and effect of orthodontic treatment at the very beginning, which allows customers to put forward their own needs, plans and design ideas based on the final impact.

Therefore, with the assistance of the new generation of technologies, customers are able to have the chance to design their new teeth arrangement by themselves according to their wishes with the help of a dentist. In the process of digitization in orthodontics, patients are able to not only express their preference to orthodontists before treatment but also design the process and the result of their teeth correction and co-review the final treatment received from orthodontics treatment system run by Invisalign/ angel align.Thus, the requirements of patients are seen, adopted and integrated to a large extent, which significantly improves the communication efficiency and service quality of the orthodontic cycle.

6.1.6 Transformation from traditional orthodontic SSC to digital SSC

From the perspective of SSC, the behaviour of customer co-design is between the action of the customer buying the clinic consultation and the movement of dental examination. Traditional orthodontics, on the other hand, have no co-design behaviour. In other words, in the conventional orthodontic process, the customer needs to decide whether to purchase the services of the current orthodontic clinic after checking. The co-design process not only makes customers participate in the design of treatment and teeth arrangement but also makes customers better understand the whole orthodontic process. A bridge has been built between customer dental checkups and purchase.

In the treatment plan co-design, almost every customer will participate in the design of the length of the orthodontic treatment, the method and frequency of the review. In the past, there was no such opportunity because the customer had to go back to the clinic to find an orthodontist to adjust the teeth arrangement within the specified time. In digital orthodontics, after the orthodontist establishes the treatment plan at the beginning, it starts to supervise the whole process rather than operating in treatment. The form and time of supervision are flexible, which also allows online connection. The operation of remote supervision will be mentioned in the co-delivery chapter later.

In terms of the transformation of teeth alignment design, In the past, when a dentist wanted to change the arrangement of a patient's teeth, he had to use plaster to make a model. According to this model, the teeth arrangement will be adjusted on-site in the bi-weekly meeting. Therefore, both of the the dentist and the patient could not see the result of the end of the final orthodontics at the beginning of the correction. They could only wait for their bi-weekly meeting and see how the teeth move every times. This method not only wastes a lot of time and money of the dentist and the patient, but it is also difficult for the patient to have the teeth trimmed according to his own wish.

The use of combination of the tooth scanning equipment and online software and invisible braces solve these problems. The teeth scaring equipment just scan the teeth, and have the teeth model online, and with the online software, it can move and change every teeth, it usually help the dentist to design the teeth. This kind of software have made the teeth design process easier which could make the patient involve in.

Through these new technologies, the patient and dentist are able to see the final orthodontic result before they begin to teeth correction. Therefore, this technique gives patients the opportunity to design their own teeth and control the impact of orthodontics on facial structure.

Interviewees gave me a lot of examples on how patient co-design the teeth correction. They mentioned that patient education is essential in this case. Until now, most patients who are willing to co-design usually attach great importance to the impact of orthodontics on facial appearance and will do enough research and preparation in advance. Dentists generally do simple guidance, but do not ask patients to co-design.

6.2 Co-design in chronic disease management

Similarly, in addition to the digital orthodontic industry, there are also professionals and customers co-design phenomenon in chronic disease management. Different from the co-design in the digital orthodontic industry, in chronic disease management, the customer generally co-designs the treatment plan in a strategical level.

Chronic disease management is not only for the treatment of chronic diseases, but also for the early prediction, regular detection, continuous monitoring, evaluation and comprehensive intervention management of chronic non-communicable diseases and their risk factors. The main content of chronic disease management includes early screening of chronic diseases, risk prediction of chronic

diseases, early warning and comprehensive intervention, comprehensive management of chronic disease population, evaluation of chronic disease management effects, etc. (Aujoulat et al.,2008)

Interviewee 42, who is a cardiologist, said: *"Chronic disease management is the part that most requires patients to design the treatment plan with us. Because it involves the patient's living habits and requires the patient to live a new lifestyle, it also requires the patient to follow the medical order for a long time, and it requires the patient to upload self-test medical data (like blood pressure, blood sugar) in a time. If they don't want to do this, but we force them, the effect will be very limited. The co-design of treatment with the patient can allow the patient to monitor their own health and change their lifestyle according to their own habits. In this way, the management and prevention of chronic diseases are better."*

The ultimate goal of chronic disease management is not to cure diseases (as many chronic diseases are incurable), but to maintain the healthy status and healthy function of patients with chronic diseases in a satisfactory state, leading an independent life, and recovering and returning to society. At the same time, the emphasis on changing unhealthy lifestyles can effectively reduce disease risk factors, reduce drug dose, control medical care costs and save social medical resources.

In the co-design of CDM, we mainly discuss the co-design of the treatment plan. According to the specific content of chronic disease management and the content of co-design in CDM, treatment plan co-design in CDM can be divided into the following forms: therapy co-design, daily health co-design.

6.2.1 Therapy co-design

therapy co-design refers to the communication between patients and professionals about the specific content of medical treatment for chronic disease. The determination of chronic disease therapy generally includes the following steps: initial diagnosis, first determination of treatment plan, medical data monitoring, review, plan adjustment, medical data monitoring, review, plan adjustment..... In these steps, co-design actions are involved in the process of the first determination of treatment plan and later plan adjustment.

First, we need to understand the meaning and composition of chronic disease therapy. chronic disease therapy refers to a treatment combination of medication (dosage, frequency of medication), rehabilitation activities, data monitoring methods, dosage of other auxiliary health products and other factors. For example, patients with chronic conditions related to joint damage may need more than just prescription and "medication," but they may also need a combination treatment of rehabilitation, including physical exercise etc. co-design for chronic disease therapy refers to the communication, adjustment and design of patients and doctors for the treatment combination in the treatment process of chronic disease.

Co-design in the process of first determination of treatment plan means that patients and doctors should make decisions together about how to deal with current chronic diseases in the future. The content of the decision includes the type of medication, the determination of the therapy combination, and the transformation of lifestyle.

refers to the adjustment made by the doctor or other software (like AI platform) to the patient's therapy combination based on the data fed back from the patient's treatment for a period of time. The adjustment of the patient's medication dose is generally doctor-led, patients and doctors co-design. The adjustments to the patient's other health and lifestyles are made by the software, and the treatment plan is decided by the patients.

The co-design of treatment plan adjustment after re-examination and analyzing of medical data monitoring refers to the adjustment of the patient's therapy combination made by doctors or other software (like AI platform) and patients according to the data feedbacks from the patient's treatment over a period of time. The adjustment of patient dose is usually led by doctors and co-designed by patients. For the adjustment of other health lifestyle of patients, the online software proposes suggestions and the patients decides on the final treatment plan.

6.2.2 Daily health co-design

In addition to determining the treatment plan for chronic disease, CDM also includes other healthy lifestyle transformations suggested by patients or doctors, exercise patterns, dietary habits, daily medical data monitoring and so on.

Interviewee 34, who is a doctor, said that *"CDM is not only to treat a disease, but to treat an unhealthy lifestyle while treating an existing disease."* If co-design in a digital orthodontic treatment plan is simply about the design of current treatment and treatment duration, review frequency and forms, Then the co-design in CDM is more detailed and closely related to daily healthy lifestyle co-design.

Co-design with Doctors

In essence, the daily health co-design with doctors is similar to the treatment therapy co-design. They are all about the discussions, communication and treatment plan design between patients and doctors for better treatment and management of chronic diseases. The difference is that daily health co-design is not about the discussion of medical prescriptions but only about the design and discussion of lifestyle changes for patients. During this process, doctors will give advice to patients with chronic diseases on how to change their lifestyle, eating habits, exercise habits, etc. Patients will also co-design a more reasonable future life pattern with doctors according to their own needs.

Co-design with AI software

Interviewees working as AI developers manifest that there are a lot of applications of patients co-design supported by digital technology of artificial intelligence. Co-design with software simply means that the object of daily health treatment co-design with patients based on daily monitored medical data is no longer real doctors but AI software. The AI software is supposed to analyze the data returned by the patient and give an improved plan for the treatment of chronic diseases in the next step.

AI developer Lin from Baidu Healthcare gave an example that AI can recognize the daily intake of medicines and foods according to the image recognition function, so as to make recommendations for healthy diet and recovery from chronic diseases. Besides, they are developing the digital chronic disease management platform to help patient self-management get more education according to AI system.

There are also similar operations from Europe and UK. Deloitte (2020) introduced several APPs for self-management and self monitoring like “Luscii” and “e-patient”. Luscii was founded in 2018 and developed a mobile app that provides clinical support to vulnerable patients, reducing unnecessary hospital visits and improving their experience. Luscii is currently operating in seven countries and has established global partnerships with Apple and Omron. Over half of the hospitals in the Netherlands are utilizing Luscii's services and the company has expanded its offerings to other countries such as Ireland, Sweden, the UK, and certain African nations.

Therefore, regarding the future direction of co-design in CDM, more interviewees indicated that using AI software or other digital platforms to assist in the management and treatment of chronic disease is a promising and developing field. Many of the IT developers we interviewed mentioned that programs related to chronic disease management co-design are online or have already been online. For example, Miss Li the operation management manager of Ping An Health and Mr Liu the IT developer of Ping An Health both mentioned that there is a section in Ping An Health's digital platform about chronic diseases and food health. The function of this part is to help patients record daily medical data (such as blood sugar levels), diet and menu. After obtaining these data, the platform and AI engine will analyze first and then give suggestions for future dietary adjustments based on the patients' blood sugar performance and dietary patterns. After getting the advice, the patient can get future dietary adjustments that are more in line with the laws of CDM according to their own needs. This is also an example of co-design with AI software.

In regard to the treatment plan in which AI can be co-designed with patients, Interviewee 33 said, *"Nowadays, this part of the plan only focuses on some areas that do not need doctor's supervision, such as the planning of diet plan, lifestyle and exercise plan, etc."*. AI developer Interviewee 46 also stated that *"the current policy does not allow AI software to be delivered directly to patients for prescription-required medication adjustment."* However, some AI software is now entering the field of recommendations for drug dosage adjustment. AI software's advice in this regard must be supervised by professional doctors under current policy.

6.2.3 The source of the patient's knowledge

In CDM co-design, patients not only need to invest enthusiasm, time, and patience but also need to learn a lot of relevant medical knowledge before the treatment plan process to support themselves and professionals co-design. Patients can acquire this medical knowledge in many ways:

1. Communication between patients. Interviewee 22, who is a doctor, found that *"approximately 80% of patients shared their treatments and experience with other patients, although only a few of patients reported to their doctors and clinicians."*

2. Patients' self-learning, 4 interviewees mentioned that patients and their family members with chronic diseases will learn the relevant knowledge of chronic diseases independently. Especially for some chronic disease patients with many years of experience, they have a wealth of knowledge in this area. In these cases, the patient has a better understanding of all aspects of the disease and is more experienced in self-monitoring

3. Guidance from doctors and professionals. Most doctors will explain knowledge about chronic disease treatment and long-term coexistence with chronic disease to patients after the patient is diagnosed and during the long-term coexistence of chronic diseases. Doctors will also recommend patients to acquire knowledge in this field by reading books and looking through digital platforms.

4. Knowledge from the digital platforms. The knowledge acquired by patients from the digital platform is roughly divided into two parts. The first part is that patients actively search and browse on digital platforms. The second part is the knowledge that the platform specifically recommends to patients. Generally, a patient registers in the digital platform and uploads patient information and health record, and the platform will send the knowledge required by the patient at the current stage according to their analysis.

6.2.4 Challenge and benefit of co-design in CDM

Co-design in CDM also faces the problem of mismatch between service supply and demand capabilities, as co-design needs enough doctors and enough patience to provide very personalized services. Due to the current limited medical resources, doctors in public hospitals only provide medical advice and prescription after patients are diagnosed with chronic diseases. Most of the doctors in public hospitals do not monitor follow-up data and later lifestyles changes patients. Therefore, it is very difficult to provide such personalized service to each chronic disease patient. This is a huge challenge for hospitals and other CDM providers.

For this challenge, the digital platforms and softwares emerging in the market have responded. Many technologies such as AI software and digital platform for Internet hospital mentioned above

are helping doctors to complete this part of the work to co-design with patients about their chronic disease daily health plan. This digital transformation is able to reduce the workload of doctors and provide patients personalized medical services with higher quality at the same time. However, regarding the development of these digital technologies, both PM Li 1 and Doctor Wang 3 said that policy is the most critical part of promoting the development of this field. Most of the functional limitations of the AI software they are developing now come from policy restrictions. In addition, the application of AI software can also bring risks to the process of chronic diseases management. For example, if a patient changes the dosage of medication under the advice of AI software, it may cause some medical conditions that AI software cannot understand.Medical service is a service industry that involves human health and life. The use of its digital platform, especially the use of AI software, should be cautious and require close human supervision.

Although co-design in CDM has brought many challenges to hospitals and markets, it still brings many benefits to patients. Co-design in CDM provides patients with more refined services and greatly improves the service quality of CDM. In the past, the patient can only accept single, simple, programmed treatment plan (for example, doctors only prescribe drugs for a period of time to a patient with a chronic disease). Compared with the chronic disease management in the past, the implementation of co-design in CDM can take into account the needs of each patient according to the patient's different physical conditions and different living habits.

6.3 Cross cases analysis in co-design

The phenomenon of co-design occurs in both digital orthodontic industry and chronic disease management. About the form of co-design in digital orthodontic industry and chronic disease management, In the digital orthodontic industry, it mainly takes place in the form of treatment plan co-design and teeth arrangement co-design. In chronic disease management, the co-design between customers and professionals is mainly about treatment plan co-design.

In the research on the above co-design in digital orthodontic and CDM, we realized that in the medical industry, customer help co-design can bring many advantages, including enabling patients to obtain more refined services, helping service providers reduce costs, expanding business scope. However, co-design in the medical industry (including co-delivery below) occurs under certain circumstances. If we want to replicate or learn this co-creation model in other areas of the healthcare industry, we must understand what are the necessary conditions in the existing co-design, and study how to help create such Conditions for co-creation from the perspective of various stakeholders. In this thesis, we also investigate this issue.

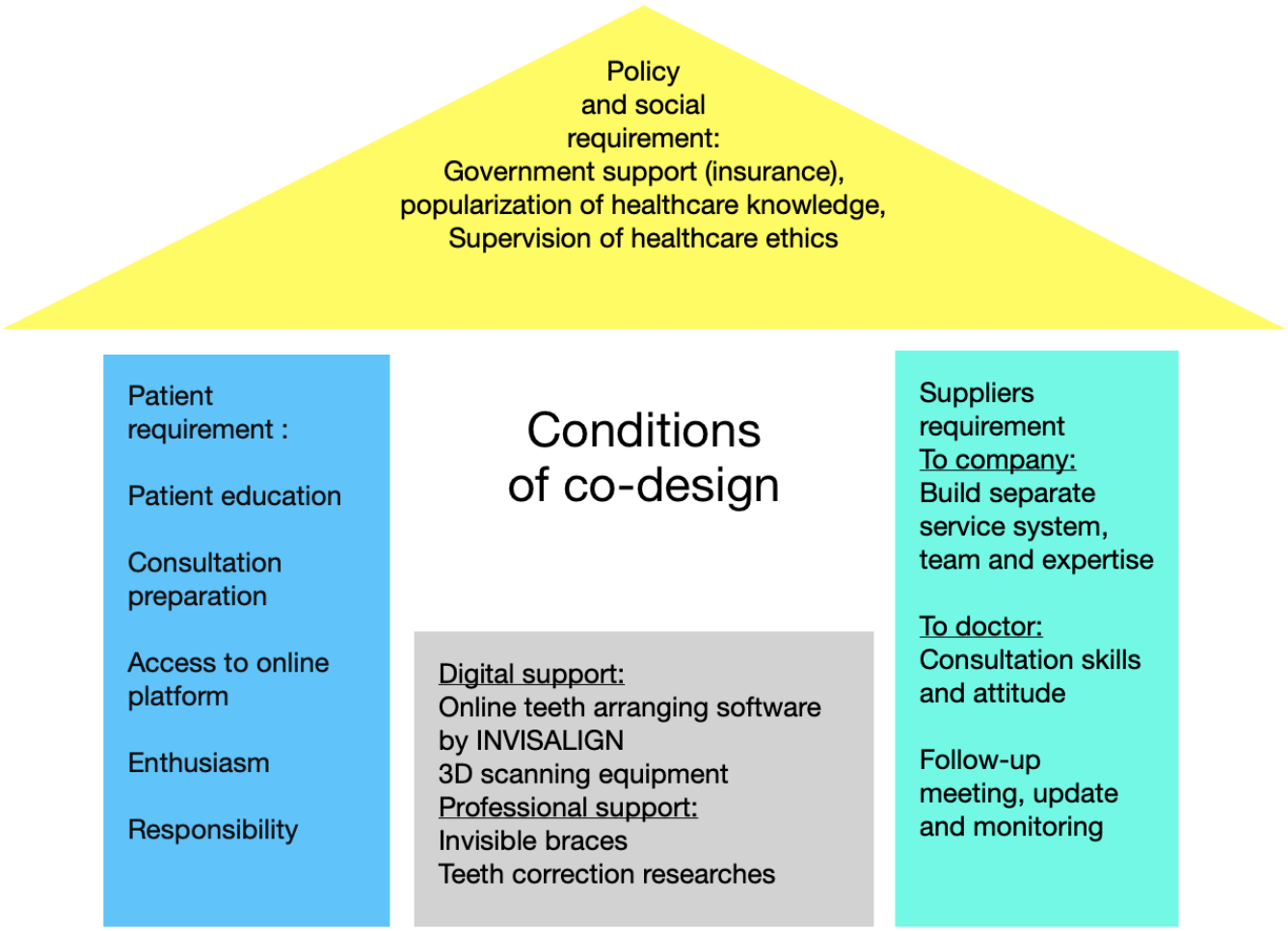

Figure 6.3.1 — Conditions of co-design

According to the interviews from the data collection process, we construct the conditions of "co-design". The "conditions of co-design" illustrate that the cooperation of customers in SSC is not a single operation involving customers. It is the combination of integrated resources, professions, digital applications, and operations. It comprehensively manifests the requirement, environment, and support from several aspects, which lead to a collective effect on the collaboration of "co-design".

As depicted in the figure 6.3.1 — conditions of co-design in digital orthodontics, a patient who needs orthodontics wants to co-design with orthodontists, it needs support from the service supplier,

the patient himself, digitalization, professionals and government and society. Patients need to have sufficient preparation and enthusiasm for co-design because the operation of co-design mainly comes from the patient's needs to pursue the effect of teeth correction that is more in line with their ideal final result. In addition, dentists, clinics and digitalization suppliers also need to provide appropriate assistance and support to patients to complete the co-design process. Finally, government departments need to supervise the process of this kind of digital application. The content of supervision includes the security of co-design(under the supervision of dentists), the qualification of dentists, and data safety protection.

Besides the situation in orthodontics, other parts of dental practice, like dental patches, can also engage patients with co-design operations. The co-design usually happens in the area relating the teeth' perfection to facial adjustment and medical beauty.

6.3.1 Policy and social requirements

Dentist Wu 1 and Dentist Zhang 2 both believe that co-design in orthodontics involves popularizing some medical knowledge. The popularization of this medical knowledge and the new co-creation operating model requires extensive help and cooperation from the government and society.

"As I said just now, the government needs to supervise because these things are just emerging, and many people who actually do not meet the regulations are also doing it, which is not good for the safety of orthodontics. But I think some Good innovation must be encouraged by government departments, and it should be generally controlled. —— Interviewee 3, Dentist."

Interviewee 30, who is an operation Manager, also mentioned China's current digital healthcare development policy - "healthy China in 2030". Under the policy, in China, with the support of the government and society, co-creation in digital healthcare is booming. *" In the case of health, it is not just treatment but also includes prevention in the early stage and then rehabilitation management in the later stage after consultation. It is a health management that forms a whole life cycle.—— Interviewee 30, Operation Manager."*

6.3.2 Patient requirement

Regarding patient requirements, Patient knowledge and Enthusiasm were the most mentioned aspects by the interviewees. They generally believe that The patient's Enthusiasm and self-learning are critical. In addition, Consultation preparation, Access to online platforms, Responsibility, and other aspects were also mentioned. These contents generally relate to the patient preparing relevant content before treatment and the patient's continuous status updates. Among them, Interviewee 35, who is a doctor, mentioned a fascinating example - an online mutual aid group voluntarily organized by patients. This group can help patients learn more medical knowledge quickly and in a targeted manner without assisting human resources from hospitals.

"I know that our hospital has a group of chronic diseases. Those groups are basically patients with chronic diseases and chronic diseases of the respiratory system. Sometimes, they will consult with the group if they have any questions. In other words, we think there are some related knowledge points, especially the knowledge points that patients can easily understand and accept, and some things that are easy to learn are closely related to patients, such as what to pay attention to in life,

what to stay away from, and the medicine What should I do? Sometimes, these popular scientific things will be released into the group. —— Interviewee 35, Doctor."

6.3.3 Supplier requirement

Regarding supplier requirements, there are two main requirements: one for doctors and the other for companies/hospitals. For suppliers, it is necessary to provide appropriate co-creation processes and instrumentation. For example, when a customer comes into contact with the co-design operating model for the first time, the company/hospital has the responsibility to set up staff or promotional brochures to let customers understand the co-design model that will take place. At the same time, doctors also need to provide additional explanations for patients' doubts during the treatment process to achieve the operational goals of co-design. Seven interviewees mentioned the above supplier requirement.

In addition, Operation Manager Li also mentioned some requirements for the online platform. He pointed out that if some online platform operations managers want to implement a co-design model on their platforms, they first need to obtain cooperation permission from the relevant hospitals. *"For example, if it wants to sell some online management package to this diabetic patient, then it must first obtain cooperation with the relevant departments of the hospital.—— Interviewee 30, Operation Manager."* Cooperation with hospitals can make the online platform's operations outside the hospital more secure and effective and can also build trust in the co-design model with patients faster and better.

6.3.4 Technology support

Technology support mainly includes two aspects, namely digital support and professional support. Digital support refers to the digitalization needed in the co-design process, such as 3D scanning technology for digital orthodontics and software developed by braces suppliers. Professional support refers to basic research related to co-design, such as teeth correction and chronic disease research. These fundamental researches are the cornerstone of the co-design operating model's success and the continuous development of digital health.

The “conditions of co-design” are made according to the following figures (figure 6.3.2 and Figure 6.3.3)

Conditions I	**Conditions II**	**Main content**	**POSITION**
Conditions for co-design Ortho			
Patient requirement	Patient knowledge	In terms of facial shape, the patient's opinion must be sought, because everyone's aesthetics are different. The doctor will ask the patient if he has a protruding mouth, and will also tell the approximate extent to which it can be improved —— Interviewee 2	55%
Patient requirement	Patient knowledge	In fact, it is still up to the patient to see if this is in line with his wishes. Just put forward some needs about appearance and shape—— Interviewee 7	79%
Patient requirement	Patient knowledge	Yes, it’s okay, but you think patients actually want to make their teeth look better. Well, we all want to be neat and tidy, and there is a certain point, that is, everyone’s requirements are good-looking. —— Interviewee 5	29%

Patient requirement	Consultation preparation	Because medicine is relatively professional, he couldn't do much work before, or he just searched on Baidu first, or asked netizens first. —— Interviewee 3	92%
Patient requirement	Consultation preparation	Including going to treatment, when designing a follow-up plan for her, she will search the Internet by herself, and she even knows more about many things than your doctor. —— Interviewee 3	41%
Patient requirement	Consultation preparation	But if the patient can understand the process of orthodontics and even some designs about the beauty of their own teeth in advance, it will definitely be very beneficial to the whole process. —— Interviewee 4	16%
Patient requirement	Access to online platform	The most important thing is to have a mobile phone, the Internet and a computer. Now these devices are necessary for ordinary people. —— Interviewee 4	98%
Patient requirement	Enthusiasm	That's what I mentioned before, you have to be patient to learn the process, and you have to be enthusiastic about changing your appearance. Because if you don't have enthusiasm, it's hard to be willing to do this. - Interviewee 4	7%
Patient requirement	Responsibility	That's what I mentioned before, you have to be patient to learn the process, and you have to be enthusiastic about changing your appearance. Because if you don't have enthusiasm, it's hard to be willing to do this. - Interviewee 4	92%
Digital support	Digital support	Its biggest advantage is that the use of invisible dental braces can allow patients to see a final effect from the very beginning. But you can't explain to him what kind of effect you will have in the end. —— Interviewee 7	32%
Digital support	Digital support	Now it is a digital oral scan, which can directly scan your teeth into a 3D graphic and present it. These models can then be viewed on the computer. — Interviewee 7	39%
Digital support	Digital support	Because people generally do orthodontics, the cycle is very long. It usually takes one to two years or even two to three years. So it is visualized in this way, so that everyone can see the subsequent results from the very beginning. Yes, see the final fix and then it will be more intuitive. — Interviewee 4	15%

Digital support	Digital support	Yes, it has a program, I can take a picture and show it to you, it is an animation of how the teeth move, which can be viewed and designed intuitively on the computer. —— Interviewee 7	39%
Digital support	Dental treatment system	Then he will make a whole set, and he will automatically generate a treatment system and a treatment plan for you. So in theory, doctors don't need to do too much. So you come to orthodontics, and then what it can look like, basically the system can make it for you. —— Interviewee 5	10%
Digital support	Dental treatment system	It will have all the doctors in the world who use invisilign, and everyone will use this system to generate plans. —— Interviewee 6	65%
Supplier requirement	For hospital	Because hospitals buy equipment through bidding, unlike private clinics, you can buy whatever you want. The hospital has to pass that kind of argument, and then we also have to investigate the market, which feels like shopping around. Then we choose a cost-effective one. —— Interviewee 4	96%
Supplier requirement	For hospital	The hospital just accepts the current back-office system and purchases equipment. In addition, it needs to design and adjust some personnel and departments around the current service type. Overall, it should be a macro-control. —— Interviewee 2	8%
Supplier requirement	For doctor	The doctor must learn to use this instrument. Because you want to apply it to the clinic, many of these things are constantly being updated, so you have to keep learning. —— Interviewee 4	95%
Supplier requirement	For doctor	It is based on the indications of this instrument. For example, just like he does veneers, he can use this thing or make an inlay. But if he didn't have this disease, he wouldn't be able to use this thing. So he doesn't fit his indications. —— Interviewee 4	22%
Supplier requirement	For doctor	When he comes to the doctor for the first time, he will give him an overview. That is, you give him a concept and an impression in the early stage, and then when he uses it in the later stage, he won't find it awkward, just use it normally. —— Interviewee 4	49%
Supplier requirement	For doctor	For doctors, the main thing is to learn to use these devices and systems. Then it is very important to explain to patients and let them understand our process. —— Interviewee 2	71%

Policy and social requirement	Government	As I said just now, the government needs to supervise, because these things are just emerging, and many people who actually do not meet the regulations are also doing it, which is not good for the safety of orthodontics. But I think, for some Good innovation must be encouraged by government departments, and it should be generally controlled. —— Interviewee 3	20%
Policy and social requirement	Society	In terms of society, we need to spread more knowledge and provide services to those who need them more. —— Interviewee 3	16%
Policy and social requirement	Society	In terms of society, it is necessary to improve consumers' awareness of orthodontics. After all, digitalization has been done very well in the past few years. If consumers know this, they will come to buy. After all, orthodontics is much more convenient than before.— — Interviewee 6	80%

Figure 6.3.2 Codes of conditions for co-design Orthodontic

Conditions I	**Conditions II**	**Main content**	**POSITION**
conditions for co-delivery CM			
Patient requirement	Patient knowledge	It's still like them, that is, in a pre-education, his patients do better. So patients will be more involved in communicating with you.—— Interviewee 39	42%
Patient requirement	Patient knowledge & Enthusiasm	The patient's enthusiasm and self-learning are very important. I know that our hospital has a group of chronic diseases. Those groups are basically patients with chronic diseases and chronic diseases of the respiratory system. Sometimes they will consult in the group if they have any questions. In other words, we think there are some related knowledge points, especially the knowledge points that patients can easily understand and accept, and some things that are easy to learn are closely related to patients, such as what to pay attention to in life, what to stay away from, and the medicine What should I do? Sometimes these popular science things will be released in the group. —— Interviewee 35	25%

Patient requirement	Patient knowledge & Enthusiasm	This actually only happens to some patients and requires 1, the patient has enough knowledge to do this. 2. The patient is very concerned about his condition. That is, compliance is better. —— Interviewee 21	61%
Patient requirement	Patient knowledge & Enthusiasm	The patient is very willing to do this, but the premise is that he must understand something, he can't make random requests, and communicate with the doctor blindly —— Interviewee 31	59%
Supplier requirement	For digital platform	So I think a model of this kind of enterprise, if he wants to sell the product he developed, he must build such a platform. For example, if it wants to sell some online management package to this diabetic patient, then it must first obtain a cooperation with the relevant departments of the hospital. After it obtains this part of the cooperation information, because now everyone is practicing the establishment of digital files and then identifying case files. —— Interviewee 30	8%
Supplier requirement	For doctor	Yes, definitely yes, even some early education for patients will be told to him. What should be the normal range? If the blood pressure is high, or if there is any discomfort, under what circumstances should you need to see a doctor in time, under what circumstances you can consider going to the hospital for a look, and under what circumstances you can adjust yourself, you can, and you will tell him. —— Interviewee 42	95%
Digital support	Digital support	In terms of digitalization, wearable medical devices and some digital platforms are generally required to provide patients with such participation opportunities. —— Interviewee 18	70%
Policy and social requirement	Government	Because doing these directions is also related to the current national policies. Well, the national policy is now to focus on the concept of a healthy China in 2030. Therefore, the direction of medical improvement now is mostly from the original treatment of diseases that have occurred to the current prevention and treatment of diseases. It is such a transformation to treat diseases that did not occur. Therefore, there is also an excess from disease treatment to health maintenance. Just one such shift to focus more on my personal health. In the case of health, it is not just treatment, but also includes prevention in the early stage, and then rehabilitation management in the later stage after consultation. It is a health management that forms such a whole life cycle. —— Interviewee 30	22%

Figure 6.3.3: Codes of conditions for co-delivery CM

6.4 Summary of chapter co-design

This chapter mainly introduces the current operating model of co-design in the medical field, divided into co-design in digital orthodontics and co-design in chronic disease management. In co-design in digital orthodontics, this chapter mainly introduces the "Treatment plan co-design" and "Teeth alignment co-design." It explains co-design in digital orthodontics from the perspectives of visiting frequency, operation, and SSC, advantages involving digital technologies, the transformation from traditional orthodontic SSC to digital SSC, etc. In Co-design in chronic disease management, this article discusses two modes of co-design: therapy co-design and daily health co-design.

Prior to this, numerous scholars have suggested the idea of co-design.Bovaird (2007) first proposed and studied co-design in service. He believes co-design is a crucial symbol of transformation from traditional services to new-generation services. In the co-design study, Bovaird (2007) believes that People’s different degrees of co-design for public services have transformed public services from traditional service to a self-organized service provision process.

Fugini and Teimourikia (2016b) introduced the phenomenon of co-design and co-planning of treatment plans between patients and doctors before treatment. As a patient, having a voice in one's treatment is crucial. Co-design and co-planning allow them to communicate with professionals and have a role in decision-making. It can lead to a more personalized and effective treatment plan. The research conducted by Fugini and Teimourikia (2016b) is a crucial advancement in service co-

design. It disassembles customers' co-design behavior in traditional medical services and conducts research and analysis, effectively promoting co-design—the development of creation and co-design research. This chapter on co-design explores the concept of treatment co-design and provides analysis and explanation. This article explains treatment co-design before treatment and discusses the co-design phenomenon in the entire service acceptance process. Moreover, based on this, this chapter involves more digitalization and emphasizes the promotion and trend of digital technology for current treatment co-design activities. As Fugini and Teimourikia (2016b) studied the co-design that occurred in the before-treatment stage, Huang and Yu (2019) studied the co-design phenomenon in the after-service stage. Their research mainly focuses on citizens' suggestions and influence on public service policy.

Regarding which part of service delivery co-design occurs, Rodriguez Müller et al. (2021) first realized this problem and discussed this research issue. He believes that co-design does not just happen before a service occurs which customers and service providers co-design future services. Co-design is a great way to ensure that users' needs and preferences are considered. By involving users in the design process, designers can create products and services more tailored to their needs. It can lead to better user experiences and higher levels of satisfaction. Therefore, Rodriguez Müller et al. (2021) believe that co-design is very common in the co-creation process, and co-creation is reflected in the entire service process. Based on the research on co-design in this article, this thesis also agrees with Rodriguez Müller et al. (2021) and studies the phenomenon of co-design in detail from the perspective of service operation throughout the service process.

Compared with other researches on co-design (Bovaird, 2007; Trischler & Scott, 2015; Fugini & Teimourikia, 2016c; Huang & Yu, 2019), this paper is the first to propose a co-design operation model in SSC in the field of digital health. Compared with other research on co-design, the contribution of this chapter in co-design is mainly divided into two parts. The first part is that this article continues the research on co-design in service and discovers and summarizes the phenomenon of co-design at the operational level in the field of the service supply chain. The second part of the contribution is that the co-design proposed in this chapter follows the current digitalization trend. With the emergence and popularization of digital platforms and Internet hospitals, medical resources are now more accessible to patients than ever before. The service supply chain in healthcare has gradually moved from a model led by hospital and doctors to a co-design model between doctors and patients. This marks the beginning of a new era and a crucial step towards developing future service operations.

CHAPTER 7 : CO-DELIVERY IN SSC FROM SERVICE PROVIDERS PERSPECTIVE

In our research and interviews, we also found the phenomenon of co-delivery between customers/ patients and service providers in the current service supply chain. Co-delivery in SSC is the situation that when customers receiving service, they can also help to transfer resources, knowledge, information, human resources and other materials in an existing service supply chain. The existing service supply chain refers to the service processes that companies or hospitals or other organizations building and designing for customers (this is different from SSC from customer perspective). Different from the manufacturing supply chain, service supply chain seldom involve the problems of transmission, storage, logistics of physical materials. Therefore, the objects of co-delivery in SSC is the constituent elements in the service: knowledge, information, resources, human resources and so on. co-delivery in SSC enables the customer to participate in the process of service delivery while receiving the service, and also reduces the working pressure of service providers, especially for the staff of some medical institutions.

In all the three cases discussed in this study, we found the phenomenon of patients participating in the process of service delivery. However, the methods and operations of co-delivery in these three cases are different. The following sections will introduce co-delivery in digital orthodontics, primary care in internet hospital, and chronic disease management respectively.

7.1 Co-delivery in digital orthodontics

In the case of digital orthodontics in chapter 4, we divided it into three parts to describe the three stages of digital orthodontics: traditional orthodontics, digital orthodontics and direct connection mode. The content of this part about co-delivery in digital orthodontics is based on the content of the third part above which is direct connection mode. The co-design in digital orthodontics mentioned in Chapter 5 is based on the second part of case one, which is digital orthodontics. Like the case in co-design, the first case of co-delivery is also based on the digital orthodontics industry in the company of Smile Direct Club. However, the difference is that in the process of co-delivery between the patient and the orthodontist, in addition to the co-design, patients are also largely responsible for the transmission of processes that were originally the responsibility of orthodontists.

In the third part of the first case, we have already mentioned that the operation model of Smile Direct is to help patients directly establish contact with the orthodontists' backstage system—the global orthodontic treatment system. Compared to "digital orthodontics", in which the orthodontist acts as a coordinator connecting the patient and the global orthodontic treatment system, the new "direct connection mode" allows patients to act as coordinators with the help of nurses and online doctors. Through GOTS(global orthodontic treatment system) and online orthodontists, a treatment plan is directly generated for the patient, and the patient is monitored online during the two-year treatment process without the need for an offline doctor conducting one-on-one review and guidance. At the same time, orthodontics companies like Smile direct club will provide online doctors to supervise the entire direct contact process.

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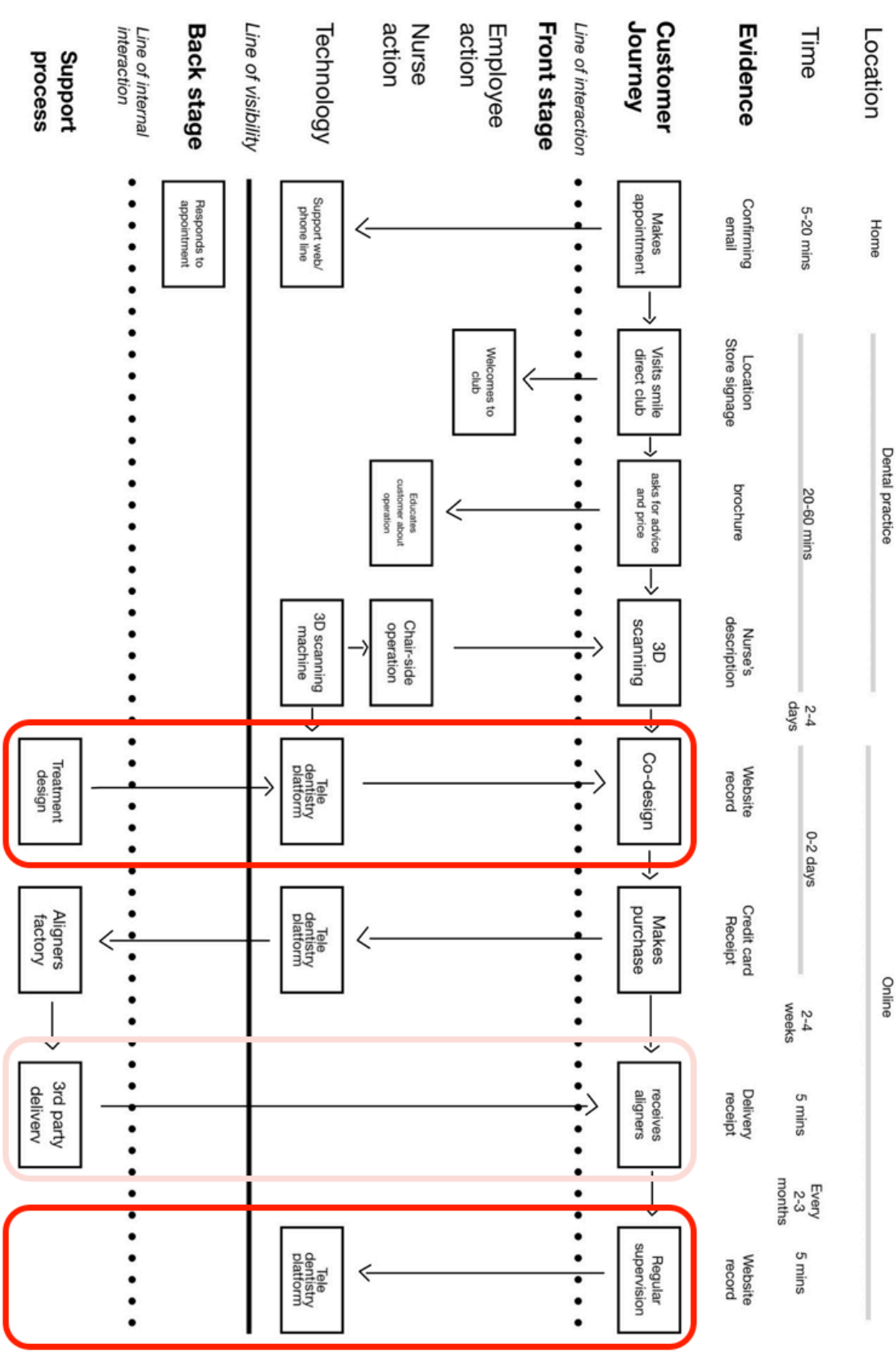

Figure 7.1.1: Orthodontics model comparison

Figure 7.1.1 is based on Figure 5.1.3 (SSC of direct connection mode) with a red box marked about co-delivery. According to Figure 7.1.1, there are three service steps in direct connection mode that involve customer co-delivery behaviour from the perspective of the customer journey. The two steps in the red box (co-design and regular supervision) are customer co-delivery for information. The "receives aligners" in the pink box are about the co-delivery of physical materials.

In the co-design process, the direct connection mode eliminates the need for orthodontists in the clinic to design a treatment plan. Instead, the patient is able to directly connect to the teledigital orthodontic treatment platform under the guidance of the nurses. In contrast to Figure 5.1.2, this connection with the treatment orthodontic platform is originally backstage, and the orthodontists in the clinic are in charge of this connection in digital orthodontics. However, in the direct connection mode, this teleorthodontic platform moves from the backstage to the front stage, allowing direct contact between customers and the backstage platform, as well as allowing patients to communicate directly with the orthodontists online on the platform.

"In fact, theoretically speaking, an orthodontist does not need to do too many things in this process. An orthodontist needs to do an assessment to determine whether the patient can undergo Invisilign, because not everyone can use Invisilign. The basic operation of an orthodontist is to conduct a digital scan and make an assessment. After the scan, we will upload it to the cloud, and then it (the treatment system) can give us a treatment plan. The SDC and such companies omit orthodontists and allow patients to connect to the treatment system directly. Of course, all of this must be under the supervision of a professional orthodontist. —— Interviewee 5, Dentist."

In the step of receiving aligners, patients no longer need to obtain aligners from offline orthodontists, but directly accept express delivery of aligners from the aligner factory. In this process, the patient's co-delivery behavior omits the processes of the aligner factory delivering produced aligners to the offline orthodontists and the orthodontists handing it over to patients.

In the steps of regular supervision, patients no longer passively return to the clinics every 2-4 weeks for examination, but conduct self-examination and take pictures according to the guidance on the digital platform, and then upload the data and situation of their own dental correction to the digital platform. In this step, the object of the patient's co-delivery is the situation of their own tooth correction and the medical data (take pictures, etc.) which means the patients are co-delivering the information in the regular supervision process of service.

In general, in the direct connection mode, the patient's co-delivery behavior in SSC is mainly the transfer of information, knowledge and braces materials by the patient himself instead of the offline orthodontists in the clinic. Patients can directly contact the orthodontic treatment system on the backstage and braces production factory on the digital platform according to the guidance by nurses and other staff in digital orthodontic company, and as well as complete all service processes. The patients are able to quickly master what they need to do in this service process through the education from the nurses before receiving the treatment, and complete it excellently under the guidance of the digital platform and nurses.

7.1.1 Digital transformation of co-delivery

From the perspective of the geographical location of the services required by the patients, the patient co-delivery in direct connection mode enables most of the patients' work in the whole orthodontic process to be completed online. The figure below shows the changes in the locations required for patients to obtain services before and after patients co-delivery

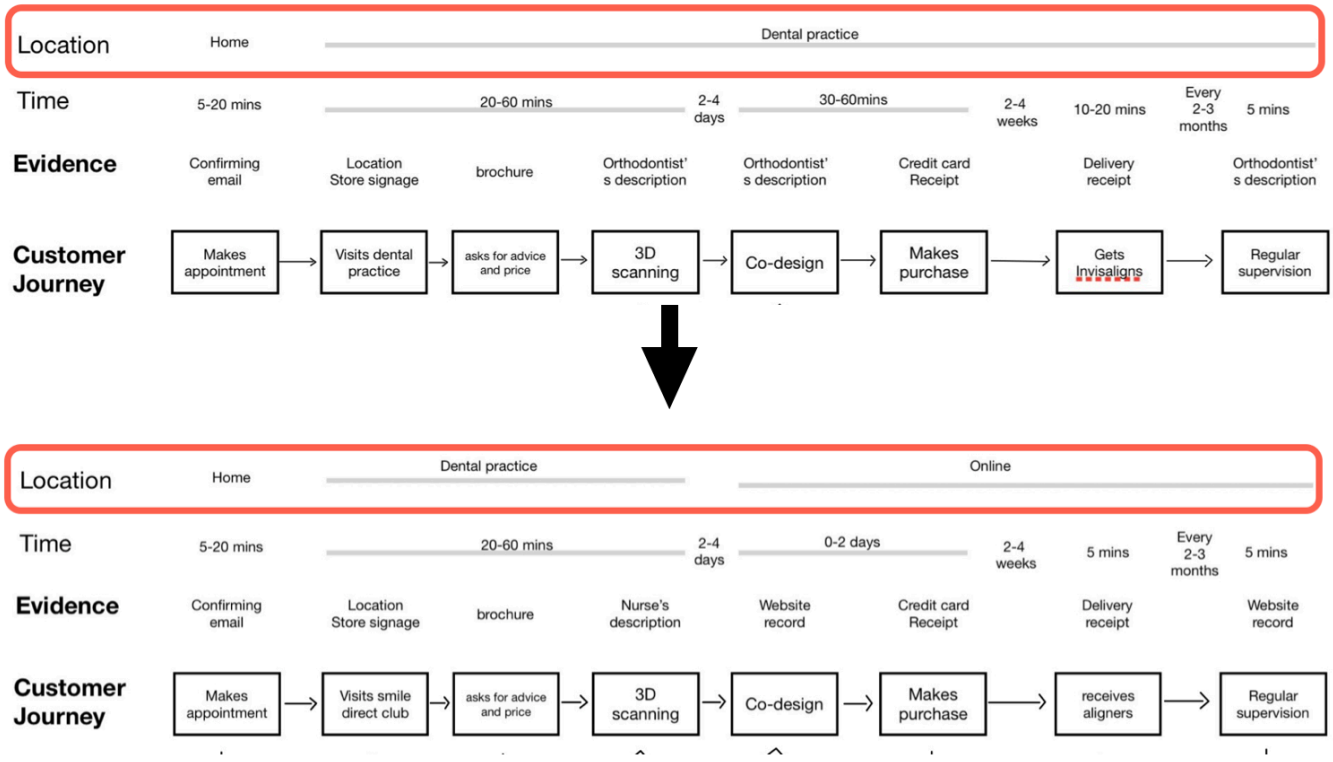

Figure 7.1.2: Orthodontics model comparison

As shown in figure 7.1.2, in the direct connection mode of patients co-delivery later, the patient does not need to go to the dental practice to complete the subsequent treatment plan, purchase, and

receipt of aligners and regular supervision. Patients only need to operate on the digital platform provided by the enterprise like smile direct club. On the digital platform, patients can learn some orthodontic knowledge online at any time, communicate with online orthodontists, and establish and access the medical data center about their own treatment.

Another transformation caused by co-delivery is the substantial reduction in the number of orthodontists required in the orthodontic process. the place for patient consultation and 3D scanning has changed from a dental practice to an orthodontics service center at the beginning. This transformation refer to The professionals who are in direct physical contact during orthodontics service change from dentist or orthodontist to trained nurse or officer. This transformation greatly reduces the need for intensive orthodontists in the orthodontics industry, and also reduces the money cost and time cost of the entire orthodontics cycle. However, many orthodontists and professionals have also expressed concern about such a shift.

7.1.2 Concerns on co-delivery in orthodontics

The most controversial part of the operation model of patient participation in co-coordinator is the lack of professionals. A lots of informants in the interviews think It is unreliable to control the process from treatment plan formation to finalization without the orthodontist. It is also an irresponsible behavior for a company to operate in this way. They argue in the interview that there are many complex orthodontic cases where the supervision of an orthodontist is absolutely required and the operation of Smile Direct Club cannot be used, although some simple cases can be done. Specific training is required for all practitioners who want to treat patients with the Invisalign

System. All orthodontic treatment is a complex process involving in-depth knowledge and is far more effective and safe when undertaken by qualified orthodontists.

the Smile Direct Club also made some efforts to increase the professionals' supervision in their service supply chain. As illustrated in figure 4, the Smile Direct Club builds their digital platform to make sure that the processes in the red squares proceed smoothly. This is also to say that the process of direct communication between patients and digital suppliers of orthodontics treatment systems is assisted and supervised by SDC. SDC also has its own orthodontists team to answer their patients' questions online in real time and help patients get better treatment.

7.1.3 Advantage of co-delivery

Co-delivery in orthodontics saves costs, making customers who were unwilling to have orthodontics began to have orthodontic ideas due to the cost. Since patients undertake part of the delivery of information and materials in orthodontics, orthodontic companies no longer need to hire a large number of orthodontists, which greatly saves the cost of orthodontics for customers. China News Weekly reported: "It is estimated that there are 200 million people in China who need orthodontic treatment, but there are only more than 6,000 orthodontists in China, and most of the people who need orthodontic have given up their plans for orthodontic treatment due to the high price." In orthodontics, The emergence of the co-delivery model has rekindled the hope of many consumers who do not have enough budget but need orthodontic treatment.

"Many consumers' concerns about oral health and aesthetics have shifted from basic oral medical needs to "beauty" needs such as tooth whitening, teeth alignment, and orthodontics, which has promoted the rapid expansion of our orthodontics market. —— Interviewee 1, Dentist."

in addition, co-delivery in direct connection mode also increases the efficiency of the service. In the past, an orthodontist could only serve a limited number of customers. Now due to the co-delivery behaviour of the patient with the background orthodontist of the company who provides online orthodontics service, and with the assistance of digitalization (like digital orthodontics treatment system and digital platforms), Enabling an orthodontist to take care of more customers.

7.2 Co-delivery in chronic disease management

In our study and interviews, we also found that patients co-delivery also exists in chronic disease management. It mainly appears in the following scenarios in chronic disease management:

1. Dissemination of knowledge about early screening and primary prevention and secondary prevention of chronic diseases. Interviewee 42 and Interviewee 16 said that the most important thing in treating chronic diseases is to do early screening and primary and secondary prevention before suffering from chronic diseases. The primary prevention of chronic diseases, also known as etiological prevention, refers to the measures taken against the pathogenic factors or risk factors of the disease before the disease occurs, which is the fundamental measure to prevent the disease actively. Secondary prevention, also known as three-early prevention or pre-clinical prevention, is a

measure to prevent or delay the development of the disease by doing a good job in early detection, early diagnosis, and early treatment in the pre-clinical stage of the disease.

Therefore, for hospitals and the public health sector, disseminating knowledge about early prevention and screening of chronic diseases is a very important part of chronic disease management. In this part, three interviewees, Doctor Wan and Doctor Zhou, all said that the screening of chronic diseases and the dissemination of other knowledge among patients were more effective than the activities organized by hospitals. Patients will naturally become co-deliver of knowledge about early screening for chronic diseases, primary prevention and secondary prevention, and have an impact on other patients around them.

2. The co-delivery of the patient's daily medical data monitoring and the patient's timely feedback of information about chronic diseases required by the hospital. In CDM, patients are required to provide medical data information at home on a regular basis during the treatment process. This information will be used by doctors to reflect the current treatment effect of chronic diseases. This also helps the doctors to provide advice on subsequent changing dosage to patients based on the information obtained.

3. The phenomenon of co-delivery of patients in the establishment of resident health records.In recent years, the patient takes part in health record management has become increasingly popular. Dr Li 2 introduced one app to us named “Intelligent New Resident Health Record Management System”, which was used in 2020 in China and created to help different organisations and individuals manage their health records together. It takes the individual as the center, the family as

the unit, and the community healthcare institution as the scope to share their health record and co-delivery them. This app is intended to aid in managing resident health records, providing health education, managing the health of children aged 0-6 years, managing the health of mothers and the elderly, managing hypertension and type 2 diabetes patients, managing patients with severe mental illness, reporting and handling disease and public health emergencies, and providing health supervision and coordination services according to established specifications.

Besides, the appearance of the personal health record(PHR) system is also an application of digitalization on PCC and co-delivery of medical data. A PHR system allows patients to manage their own health data, leading to more engagement and better outcomes. Studies show it's highly effective (Roehrs et al., 2017). This is different from the traditional electric health record(EHC) system that is usually created by hospitals. A significant limitation of hospital-generated EHC systems is their inability to incorporate vital personal health information that patients may collect outside of their medical records. This means that patients are only able to access specific health data extracted from their medical records without the ability to augment their PHRs with additional information gathered from their daily lives (Bates and Wells,2012). In 2019, Zhou and their team developed a mobile app called PittPHR for managing personal health data. This app offers six modules - health records, history, trackers, contacts, appointments, and resources - to help bridge the information gap. Users can also personalize the trackers to suit their requirements.

7.3 Co-delivery in internet hospital

With the application of digital platforms, real-time communication tools, AI-assisted treatment and auxiliary treatment tools, in addition to the dental industry, other healthcare sectors have gradually begun to change.

This “co-delivery” in Internet hospitals refers to patients’ help to deliver medical information like the health imaging record and daily monitoring data to assist their disease in different situations like after treatment rehabilitation, chronic disease, before treatment consultation and comorbidities. For example, with the popularity of Internet hospitals and the development of digital platforms (like Dingxiangyuan and Weiyi), the business of online diagnoses and prescriptions associating doctors and patients over a long distance has started to gain more attention around the world. With the assistance of digital platforms, patients are able to contact clinicians directly for early diagnosis. During this online process, patients can not only provide their basic information and subjective feelings, but they can also help to deliver some medical records and medical imaging as an information transportation center.

The phenomenon of patients helping “co-delivery” in internet hospitals was mentioned by almost every clinician who is working in internet hospitals in our interviews. It usually happens in some cases that a patient could only access some lower clinic and needed to get a diagnosis in some higher hospital. This behaviour is generated spontaneously by the patient when the patient wants to choose the most suitable hospital for treatment and multi-party consultation for some difficult problems.

in patients co-delivery in Internet hospitals, interviewees give a wealth of cases and views. After analyzing, we find that there is mainly co-delivery in the following two situations: prescription of chronic diseases and online consultation.

7.3.1 Co-delivery in chronic disease prescription

In prescriptions for chronic diseases, patients need to return to the hospital or clinic at regular intervals to get a prescription. After obtaining the prescription, the patient can take the prescription to the pharmacy to buy the medicine. In the case of co-delivery in the prescription of chronic diseases, patients with their own medical records (or other confirmation of illness) seek online doctors in Internet hospitals to prescribe drugs for them. After prescribing medicines in the Internet hospital, patients can directly place an order in the online pharmacy to purchase medicines. In this case, the patient does not need to go to a designated offline clinic or hospital with records to gain prescription and medicines. In this process, by co-delivering their medical records and online medical data, patients can change the scene of taking medicine from the designated clinic to the online platform, so that they can get faster and more convenient services on the online platform.

As for the safety issue that patients can prescribe and purchase chronic medicine in Internet hospitals, Interviewee 41, who is a doctor, said: *"The prescription of chronic disease medicines is generally regular and stylised. Doctors don't have to make a lot of changes to past prescriptions. We only need to adjust the dosage within our control for patients whose condition changes during chronic disease monitoring. If more problems arise that are beyond our control, such as*

deterioration, we will advise patients to go to the nearest clinic to get checked out and prescribed medication."

In the description of the co-delivery process of prescribing medicines for chronic diseases, seven interviewees proposed that doctors would adjust the dosage of drugs in the next period according to patients' conditions. The premise of prescription on Internet hospitals is that patients must provide sufficient description and medical data for the online doctor to refer, such as blood glucose data and blood pressure data of daily monitoring. Dr zeng also suggested that doctors at Internet hospitals could also help patients with chronic diseases change their treatment plans and medications after getting enough information.

In addition, in the interview with doctors who worked in Internet hospitals, we found that the groups who prefer to use Internet hospitals to obtain prescriptions and buy medicines generally have the following characteristics:

1. Patients live in remote areas and their home and work addresses are far from clinics and hospitals. Because prescribing and buying medicines for chronic diseases is something that needs to be done repeatedly every period of time, if the place of living is remote, which is far away from medical institutions, patients will be more willing to choose to prescribe and buy these drugs online.

2, The patient's work and life are busy. For residents working in large cities, many patients need to make an appointment long in advance to go to a clinic to prescribe and buy medicines, and it also

takes a long time for transportation costs. For these stressful patients, prescribing and buying medicines in the Internet hospital has greatly reduced the burden of chronic diseases on their lives.

Therefore, there are many advantages in the co-delivery process of prescribing drugs for chronic diseases:

1, First of all, patients co-delivery medical information enables patients to obtain services and treatment in the Internet hospital, which can reduce the number of times to go to the hospital. On the one hand, it is convenient for patients and saves time and money for patients. On the other hand, it also reduces the burden of high daily visits to hospitals and clinics, and eases the pressure on hospitals to provide medical care.

2, Interviewee 43, who is a doctor, said that *"because it is very convenient to see a doctor, prescribe medicine, and buy medicine on the Internet hospital, some patients are more willing to contact the doctor frequently to discuss their disease progress and treatment. "*This can effectively improve the health awareness of patients, unlike the situation in the past in which when going to the hospital for follow-up visits, many patients procrastinate and do not want to go. Interviewee 26 who is a product manager, pointed out that *"it is a phenomenon with very good social benefits, but the economic benefits of this are not obvious for the time being."* In China, whether it is treatment or prescription, the payers for chronic diseases are the state and the government. The improvement of patients' health awareness can effectively improve the average health level of society.

7.3.2 Co-delivery in online consultation

Co-delivery in online consultation is a kind of co-creation in Internet hospital most frequently mentioned by interviewees. online consultation refers to the act of patients establishing and communicating with various doctors through the digital platform provided by Internet hospital. These behaviors are generally spontaneous communication behaviors between patients and doctors in the early, middle and late stages of treatment, which do not involve primary care prescription. In this process, patients are required to upload their own health records and daily monitoring data, and doctors will provide answers to patients according to their requirements and questions.

Online consultation for treatment decision

Online consultation for treatment decision refers to the online consultation service that patients seek and conduct on Internet hospitals when they need to make a decision on treatment before receiving treatment. As for the situation in which such a service appears, Interviewee 43, who is a doctor, said, *"Most patients who use Internet hospitals want to find some higher-level and better doctors online."* Especially for some life-threatening diseases, many patients will take their health report to seek the opinions of some "famous doctors" (on the treatment plan) after the physical medical examination in the hospital, which can help patients get better and more comprehensive plans. Since Internet hospitals gather doctors from all over the country and even the world, Especially some well-known doctors are employed by Internet hospitals to help patients on the digital platform; many patients are able to consult with doctors on the platform while deciding their treatment plan.

As for the cause of co-delivery, Interviewee 43 and Interviewee 19 and Interviewee 17 believe that it is caused by the imbalance of medical resources in the whole country. For example, patients

living in remote areas can only go to low-level hospitals (hospitals for the countryside) when they are ill. However, for some patients with serious diseases or essential decisions to make, they will want to seek the diagnosis and advice of doctors in more advanced hospitals. co-delivery in online consultation for treatment decision is an inevitable situation for patients to seek for better medical resources and communicate with better doctors. All of our interviewees like Interviewee 43 and Interviewee 21 expressed strong agreement and positive attitude towards the co-delivery phenomenon in this situation. They believe that the emergence of Internet hospitals allows them to help more people in need. This is a great innovation for the whole healthcare system.

Therefore, on the one hand, the patient's co-delivery before treatment consultation helps the delivery of medical information and data in the healthcare service supply chain, which enables the patient to receive more experts' attention and enable the patient to obtain more comprehensive and advanced treatment plans. On the other hand, the patient's co-delivery of the treatment consultation also helps to deliver the resources (doctor resources) for the unbalanced medical system from the perspective of the medical system, which makes it possible for areas with poor medical care to contact well-known doctors and obtain treatment recommendations from these doctors. This is to say, co-delivery helps the medical system balance the unequal medical resources. As a result, the co-delivery consulted before the consultation is a co-delivery for information and medical resources (doctor resources).

Online consultation for health education

In the online consultation of the Internet hospital, doctors from our interviewees also introduced another way for patients co-delivery: online health education.

Online healthcare education refers to the health knowledge about various diseases and healthy lifestyles obtained by consumers on the Internet. Online healthcare education is generally uploaded and disseminated via video, audio, text, and pictures. The most common thing in healthcare education is to popularise knowledge content such as the symptoms, causes, and prevention methods of a certain disease in the form of text and video. This part of the function is usually available on the official website of the medical institution and also available on the digital platform of the Internet hospital. The difference is that the content of healthcare education on the Internet hospital is richer and more detailed, so rich that almost any medical question you want to ask can be searched. Part of the reason for this phenomenon comes from the fact that patients participated in the generation of healthcare knowledge. As patients, it plays the role of co-creation and co-delivery in online healthcare education.

First, online consultation services in Internet hospitals allow patients to contact hospital doctors online at any time before and after diagnosis and treatment. The way of contact can be video, voice, picture and text. When a patient asks some specific and detailed medical questions through pictures and text, the system will remind the patient whether they are willing to disclose the content of the consultation (privacy issues such as name, address, time, and pictures are not disclosed). If the patient selects the "agree to release button", the main content of the patient's consultation with the doctor will be saved and disclosed in the database of the Internet hospital. When other patients enter this website in the future, they can search for the communication content between the patient and the doctor and the medical knowledge answered by the doctor through the "search keyword" function.

In this way, the data of the healthcare information center in the Internet hospital expands rapidly. Every day, a large amount of data, patient inquiry information and doctor's medical science popularization and answers are poured into the healthcare information database. Since the amount and capacity of popular science content for healthcare education published and uploaded by a certain institution is limited, the collection of popular science materials answered by doctors on the platform through patients' questions is rapid and unlimited. Similarly, in this way, the data of the healthcare information center in the Internet hospital is becoming more and more specific and complete. Since popular science materials from medical institutions are not always necessarily suitable for patients to read, and secondly, it is difficult to meet the needs of all patients for many details and specific questions, and it is difficult to answer all patients' questions. In this way, a large number of patients in the Internet hospital will become co-editors in the document collection process of online healthcare education, and contribute questions to healthcare education.

To conclude, in the process of collecting healthcare education knowledge, the digital platform plays the role of information summarization and information presentation, doctors play the function of knowledge generation and knowledge introduction, and patients play the function of co-delivery and helping knowledge generation and promoting knowledge transfer.

7.4 Cross cases analysis in co-delivery

in terms of co-delivery in digital orthodontic of direct connection mode, chronic disease management and Internet hospitals, We find that co-delivery in HSSC is the process of patients transferring information, schemes, materials and resources in SSC through their own information, resources and knowledge in the process of service provision. The following is an analysis and a deeper understanding of co-delivery through cross cases analysis. The main content of co-delivery in SSC mentioned in Chapter 6 are shown in the table below:

Types of co-delivery	Co-delivery content	Content type
Digital orthodontic		
Co-delivery in “co-design”	Treatment plan	Knowledge
Co-delivery in “receiving aligner”	Aligners	Physical materials
Co-delivery in “regular supervision”	Medical data	Information
CDM		
knowledge dissemination of “Prevention and screening”	healthcare education	knowledge
CD data monitoring	Medical data	Information
Digital health records	medical data and healthcare report	Information
Internet hospital		
Online prescription for CD	Medical data	Information
Online consultation	Healthcare reports	Information
Online consultation	Doctor resources	Human resources

Figure 7.4.1 : content of co-delivery in SSC

The figure above shows that co-delivery content is knowledge, physical materials, information and human resources. Among them, co-delivery for information is the most common type of co-delivery

in digital orthodontics, CDM, and Internet hospitals. In addition, in digital orthodontics and CDM, patients can help deliver knowledge during the co-delivery process. While using Internet hospitals to get comprehensive service, patients have the opportunity to co-delivery doctor resources. Compared with co-delivery in other fields, patients in chronic disease management need to do more work, which plays a vital role in the early prevention of chronic diseases, early screening, data updating and uploading, screening of health records, etc.

7.4.1 Conditions of co-delivery

According to the data obtained from our interview (figure 6.4.2), the following figure shows the conditions from policy and social, patient, suppliers and digitalization required in the process of co-delivery mentioned above.

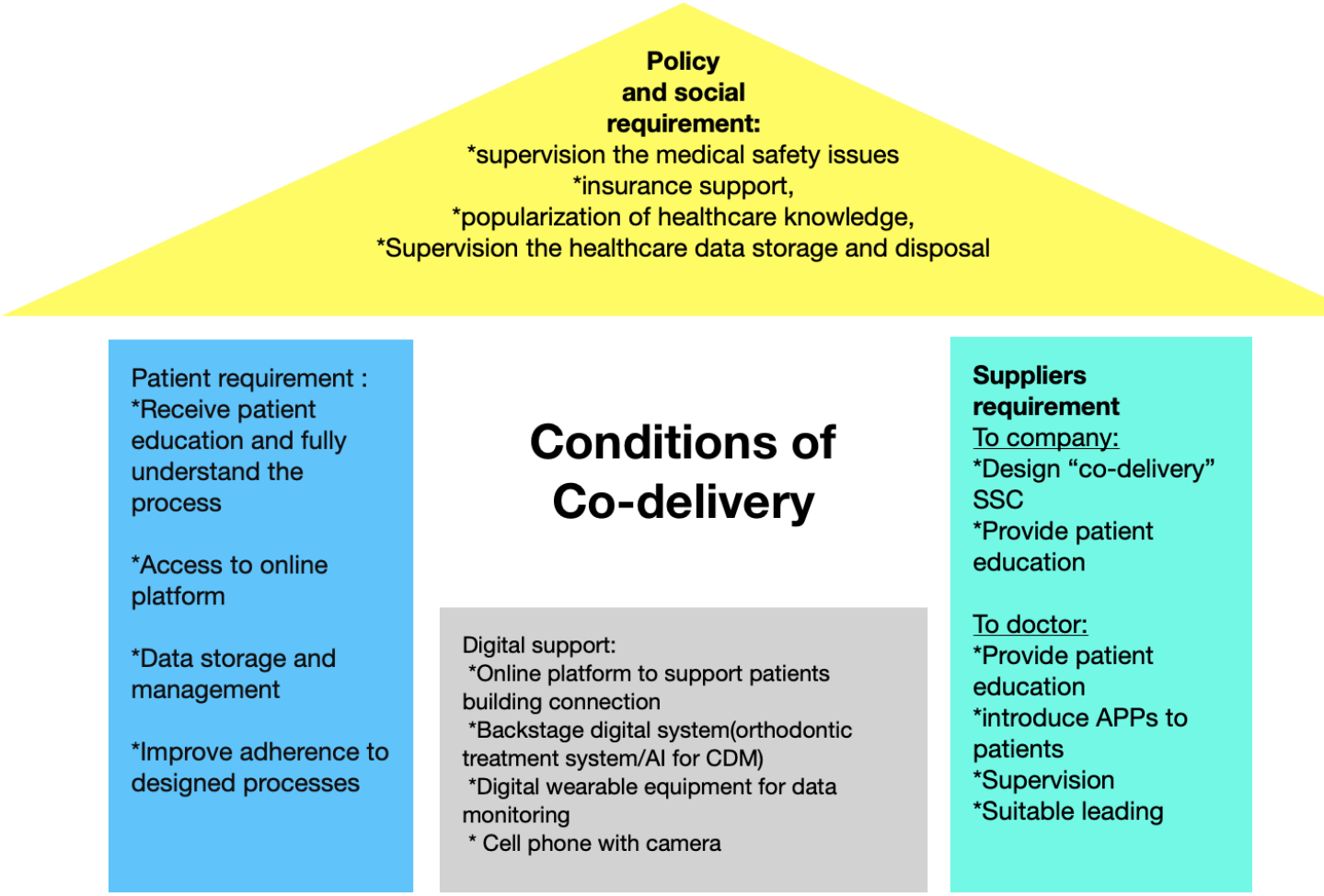

Figure 7.4.2 — Conditions of co-delivery

This article summarizes co-delivery conditions from four aspects based on the data obtained from interviews and data analysis: policy and social requirements, patient requirements, supplier requirements, and digital support.

Regarding policy and social requirements, Dentist Zhang 2 believes that with the development of remote dental healthcare, government departments need to invest more in supervising the operation models of this remote dental health. This is to ensure safety during medical procedures and co-delivery. These supervisions on medical safety include two aspects. One aspect is the supervision of the safety of the operating model. For example, in digital orthodontic co-delivery, patients must

continuously upload their status and communicate with orthodontists during follow-up visits. Orthodontists also have different views on this aspect, where patients must take the initiative and responsibility. The pessimists believe this is an excellent challenge to the patient's compliance and initiative, and most patients may need help to complete this task. Therefore, this co-delivery treatment plan will have a particular negative impact on the treatment results. However, some interviewees expressed a positive attitude towards this. They believe that the current co-delivery operating model is relatively mature and can bring substantial economic benefits to patients (the treatment cost is about the original half).

Therefore, the operational co-delivery model will be popularized to more patients and benefit a broader range of people. It is an unstoppable digital trend. In addition to supervising the security of the operating model, government departments also oversee medical data security during the co-delivery process. With the development of digital health, more and more online data will appear. Data storage, disposal, utilization, and authorization require strict supervision by government departments. In addition, regarding government support, Dentist Zhang 2 also discussed the issue of insurance support. With the development of digital health, these emerging operating models have brought convenience and economic benefits to traditional medical care. However, in China's current environment, the government has yet to include new products under the online healthcare and co-delivery model in the people's medical insurance. It will hinder the recent development of co-delivery in digital healthcare.

Regarding patient requirements, Interviewee 1 and Interviewee 2 believe that patient education is the most important. The co-delivery process requires patients to fully understand their role in co-

delivery and the necessary medical knowledge. In addition, it is also crucial for patients to master access to the digital platform and data storage methodology. Among them, patient adherence was the most mentioned word by the interviewees.

"We must insist on follow-up visits and follow the process we designed. Because, in fact, many consumers will disappear in the later stage of supervision, which is not good. —— Interviewee 1"

In terms of supplier requirements. Companies of online platforms need to provide professional service processes and service supply chain designs for co-delivery to give instruments to patients and doctors who are registered on this platform. They also need to provide patient education together with cooperating doctors on their platforms. Doctors, they provide professional services in the co-delivery process, including patient education, introducing APPs to patients, supervision, and suitable leading.

The interviewees emphasized the importance of the dental treatment system in digital support and the co-delivery of digital orthodontics. Dentists say that the dental treatment system can not only assist dentists in completing orthodontic treatment plan design. In addition, since using a dental treatment system dramatically reduces the need for dentists, a dental treatment system can replace many of the steps in designing an orthodontic treatment plan. It promotes the formation of a co-delivery operation model, an essential requirement for co-delivery. In addition, Doctor Yuan and OM Liu also said that developing digital platforms and apps for cellphones and digital wearables are also necessary requirements for co-delivery.

"Wearable devices should be considered. They can monitor the data of patients at any time. In this way, we have something to refer to when they want to ask us questions about their conditions

online. They (patients) don't have to bother to tell us a lot, nor It must be useful. —— Interviewee 36"

Conditions I	**Conditions II**	**Main content**	**Position**
conditions for co-delivery			
Digital support	Dental treatment system	Then he will make a whole set, and he will automatically generate a treatment system and a treatment plan for you. So in theory, doctors don't need to do too much. So you come to orthodontics, and then what it can look like, basically the system can make it for you. —— Interviewee 5	41%
Digital support	Dental treatment system	You do a digital scan, and after the scan, you upload it to the cloud, and then he can give you such a method. —— Interviewee 5	96%
Digital support	Dental treatment system	It will have all the doctors in the world who use invisilign, and everyone will use this system to generate plans. The doctor has to do the final review. After all, the doctor is responsible for the patient, so the doctor is mainly responsible. The professional aspect is actually handed over to the system. That's it. —— Interviewee 6	38%
Digital support	Digital support	Digitalization is the construction of platforms and APPs. After all, these services are now provided through APPs. —— Interviewee 28	44%
Digital support	Digital support	Wearable devices should be considered. They can monitor the data of patients at any time. In this way, we have something to refer to when they want to ask us some questions about their conditions online. They (patients) don't have to bother to tell us a lot, nor It must be useful. —— Interviewee 36	13%
Policy and social requirement	Government	This requires the government. For example, for this software, the government needs to promote it to everyone, that is, we adults, to promote it. —— Interviewee 42	59%

Policy and social requirement	Government	I think the main problem is the supervision from the government. Because of the current system, there are more and more examples of this kind of remote dental treatment. Many institutions will engage in this kind of remote treatment regardless of some security, because it can make money. But this is actually somewhat Irresponsible to patients. Government supervision is still needed. Of course, if it develops, if the government can include this in medical insurance, there will be better development. But there is no such situation at this stage. —— Interviewee 6	76%
Policy and social requirement	Government	This security issue must be supervised and managed by the government. —— Interviewee 4	46%
Supplier requirement	For doctor	We looked at the information they ever send into patient. It had to make it very simple. So so it was particularly patient education. —— Interviewee 12	15%
Supplier requirement	For doctor	Hospitals mainly push patients in. It is impossible for patients to enter this APP independently. The promotion of most APPs is the promotion of medical APPs. Doctors push their own patients in. Doctors manage from above. APP Just a provider of data. You can do whatever you suggest with your doctor. —— Interviewee 22	95%
Supplier requirement	For doctor	It is to teach him how to measure blood pressure correctly. After he learned how to measure blood pressure, if the platform is smart enough, it will upload automatically, which is the best. After automatic upload, we can see it here. —— Interviewee 42	12%
Supplier requirement	For company	In these institutions, there will be nurses teaching patients what to do in the subsequent procedures during the first meeting - Interviewee 4	24%
Supplier requirement	For company	The most important thing is to guide consumers. This is the responsibility of the company, which is to let consumers know what to do next. Because ordinary consumers do not understand and understand these by themselves, there must be a process of patient education. —— Interviewee 6	28%
Supplier requirement	For doctor	First of all, it must be that doctors need to teach patients how to cooperate, how to use portable devices, and how to upload data. So patient education is very important. —— Interviewee 43	84%

Policy and social requirement	Government	Because doing these directions is also related to the current national policies. Well, the national policy is now to focus on the concept of a healthy China in 2030. Therefore, the direction of medical improvement now is mostly from the original treatment of diseases that have occurred to the current prevention and treatment of diseases. It is such a transformation to treat diseases that did not occur. Therefore, there is also an excess from disease treatment to health maintenance. Just one such shift to focus more on my personal health. In the case of health, it is not just treatment, but also includes prevention in the early stage, and then rehabilitation management in the later stage after consultation. It is a health management that forms such a whole life cycle. —— Interviewee 30	22%
Policy and social requirement	Government	The government has also seen the needs of the public and accelerated the entire work process and work efficiency, so as to ensure the lack of some safeguards in the past as soon as possible, such as online medical insurance reimbursement, which has provided great convenience to the entire business format—— Interviewee 23	21%
Policy and social requirement	Government	These all require government approval. In contrast, as long as I have an electronic voucher for a prescription, I can go to a pharmacy outside the hospital or an Internet hospital to buy these medicines normally, and it will be cheaper than now. This promotes the prescribing of medicines for patients with chronic diseases in Internet hospitals—— Interviewee 44	67%
Policy and social requirement	Government	The government should also strengthen the popularization of science on these chronic diseases or disease prevention and treatment, so that everyone has some understanding of these knowledge. After all, most people will encounter such problems when they are old. —— Interviewee 41	27%
Patient requirement	Patient education	During this process, the patient must fully understand this matter and accept it from the very beginning. But generally, consumers who buy this kind of orthodontic service will know this in the early stage. Then some nurses will also guide the patients. Therefore, it is most important for patients in the early stage to understand what the process is. —— Interviewee 1	18%

Patient requirement	Adherence	In addition, we must insist on follow-up visits and follow the process we designed. Because in fact, many consumers will disappear in the later stage of supervision, which is actually not good. —— Interviewee 1	37%
Patient requirement	Data management	One very important thing is that in the monitoring stage, the patient needs to upload pictures to help the doctor check the effect of the correction. Therefore, it is best for the patient to keep these pictures, records, etc., so as to communicate with the doctor online. —— Interviewee 2	78%

Figure 7.4.3: Codes of conditions for co-delivery

7.5 Summary of chapter co-delivery

This chapter mainly introduces the current co-delivery operating model in the medical field, which is primarily divided into co-delivery in digital orthodontics, co-delivery in chronic disease management, and co-delivery in internet hospitals. In this chapter, co-delivery in digital orthodontics mainly introduces the operation model of co-delivery and the analysis of the service supply chain. In addition, this article also explains the digital transformation, advantages, and concerns from traditional orthodontics to the co-delivery of digital orthodontics. In Co-delivery in chronic disease management, this article describes three current situations in which co-delivery occurs and analyses each situation. In Co-delivery in Internet hospitals, this article mainly explains the operation model of Internet hospital co-delivery from the perspectives of online consultation and online prescription. Finally, this article analyzes the content of co-delivery in different situations.

Regarding the study of co-delivery in SSC, Etgar (2008) first proposed the importance of co-delivery in operational activities. Customers create valuable outcomes that all can enjoy by participating in various activities. Sampson & Spring (2012) later proposed that Consumers can play different roles in the service supply chain besides the service receiver, which is divided into the component supplier, labour, design engineer, production manager, product, quality assurance, inventory, and competitor currently.

However, the theory they proposed to investigate the collaboration in SSC only based on the understanding of service at that time, which regarded the service as a kind of "product" delivered by the service provider to customer. This understanding of the concept of service has fallen behind current research on service and service innovation. An increasing number of research indicated that service can not only be regarded as a "product"; it should be given more significance and understanding in research (Vargo and Lusch 2004, 2008a, 2008b; Barrett et al, 2015; Miles et al., 2017; Pham et al., 2022).

Scholars now have a new understanding of co-delivery with the emergence of a new version of service. Sichtmann et al. (2011) believed that co-delivery integrates resources between customers and service providers. Alzaydi et al. (2018) thought that the co-delivery of goods is a process in which customer-organization interactions transform the organization's resources (rather than customer resources) into the customer's product. At the same time, Park et al. (2020), also in the medical field, expressed similar views. This article agrees with the arguments put forward by Sichtmann et al. (2011), Alzaydi et al. (2018) and Park et al., (2020). Moreover, this article

innovatively proposes a "condition of co-delivery" model based on their views, which can more accurately understand and analyze the co-delivery phenomenon in SSC.

Regarding the impact of digitalization on co-delivery, Linders (2012) explained the promotion effect of digital platforms on co-delivery. He proposed that digital platforms and other technologies can enhance communication between the public and government agencies. Additionally, as a service provider, the government can invite average citizens to contribute their skills and expertise towards resolving government challenges about public services. This collaborative approach can help bring about positive changes for everyone.

Compared with other research on co-delivery, the contributions of this article mainly focus on the following two aspects. First, compared with the research on customer collaboration in SSC (Sampon, 2012; Zhang, 2015; Petri & Jacob, 2016; Gong et al., 2019), this paper innovatively proposes and studies co-delivery in SSC which regard the service as a process of gathering resources rather than pure product. This article innovatively studies and analyzes the conditions of co-delivery in SSC to better explain the resources, knowledge, and information required in the co-delivery process, which also provides a new perspective for customer collaboration research in SSCM. On the other hand, compared with further co-delivery research (Linders, 2012), the research of this article is comprehensively carried out from the current digital environment, which allows this article to better consider comprehensive digital technologies (including digital platforms). , digital wearable equipment, AI software, 3D printing) promote co-delivery rather than digital technology alone. The emergence of digital technologies affects multiple aspects of SSC. They interact with each other to form the co-delivery digital trend studied in this article.

CHAPTER 8: CO-DELIVERY IN SSC FROM THE CUSTOMER PERSPECTIVE

Co-delivery in SSC from customer perspective means that patients make contributions to co-delivery in SSC. The SSC mentioned here is not the SSC developed by enterprises or organizations but SSC from the customer perspective.

In the literature review chapter, we have mentioned the development and literature related to SSC from customer perspective and its model. This chapter will review some essential parts here. Maull (2012) first proposed the service supply chain model from the customer's perspective. He believes that SSC is not only a service provision process that connects suppliers and customers built from the perspective of the enterprise, but should also be viewed from the perspective of customers, about the SSC from service provider vs. customer perspective as shown in the figure below.

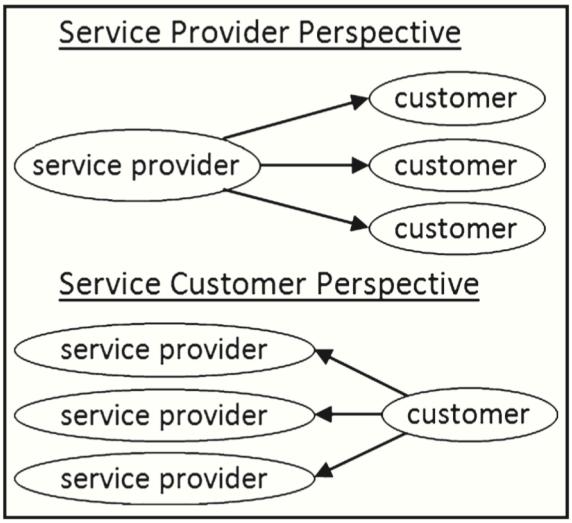

Figure 8.1.1: Service provider VS customer perspective (Maull, 2012)

As shown in Figure 8.1.1, The SSC from a customer perspective, is a service supply network including several service supply chains centered on the customer that needs to obtain resources and services from multiple service providers for a particular service goal. It emphasizes that customers naturally need services from multiple service providers under a common service goal.

Co-delivery in SSC from customer perspective refers to the SSC under the customer perspective also needs the customer to deliver the information, resources, materials, etc. in the SSCs. In this case, The customer's co-delivery behavior not only provides and deliver resources and information to different service providers, the customer also acts as an information center to promote the communication and delivery of information and knowledge between service providers. Through our research and interviews, we find that with the development of online platforms, APPs (like Internet hospital) and the increasing use of these platforms by patients, more and more co-delivery phenomena exist and appear in the process of patients' transferring resources and information between online platforms and offline hospitals. The content of this chapter below discusses this issue in detail.

In conclusion, co-delivery is an exploration process from common medical treatment to refined medical treatment. The growing demand for sophisticated medical treatment for patients and citizens has led medical institutions and companies providing medical services to form the operation model of co-delivery. Through the joint efforts of the company and patients, the PCC goal can be achieved and the progress of medical quality can be promoted.

8.1 Co-delivery in internet hospital

With the application of digital platform, real-time communication tool, AI-assisted treatment and auxiliary treatment tools, in addition to the dental industry, other healthcare sectors have gradually begun to change.

This “co-delivery” in internet hospital refers to patients transmit the health imaging records and other health information to assist their disease in different situation like after treatment rehabilitation, chronic disease, before treatment consultation and comorbidities.
For example, with the popularity of Internet hospitals and the development of digital platform (like Dingxiangyuan and Weiyi), the business of online diagnose and prescription associating doctors and patient in a long distance start to gain more attention around the world. With the assistance of digital platform, patients are able to directly contact clinicians for early diagnosis. During this online process, patients can not only provide their basic information and subjective feelings, they can also help to deliver medical records and medical imaging as an information delivery center.

Co-delivery in SSC from customer perspective in internet hospital refers to that patients in a different situation like after treatment rehabilitation, chronic disease, before treatment consultation and comorbidities do not only play the role of co-delivery with a party or a medical institution, they also play a role in the delivery of information, resources, etc. between these hospitals and medical institutions that provide different services.

The phenomenon of “co-delivery” in internet hospital was mentioned by almost every clinicians in the interviews. It appears in many different medical scenarios including diagnosis, medical consultation, rehabilitation training, long-term health monitoring, etc. It also usually happened in some cases that a patient could only access to some lower clinic and need to get diagnosis in some higher hospital. This behavior is generated spontaneously by the patient when the patient wants to choose the most suitable hospital for treatment and multi-party consultation for some difficult problems.

8.1.1 Comorbidities

First of all, one of the situations mentioned by interviewees about patients using Internet hospital in HSSC co-delivery is the contribution and help of patients for the treatment of comorbidities. Comorbidities consist of one disease associated with another or more diseases. There is no causal link between the two or more symptoms of comorbidities. For example, when patients get lung cancer and cold at the same time, then colds and lung cancer are comorbidities, such as pregnancy with essential hypertension, diabetes with hepatitis B and so on. When patients suffer from comorbidities, it is usually necessary for doctors from multiple departments to diagnose and determine treatment plan.

For patients with comorbidities, communication and collaboration among multiple departments is an important operation to help patients with comorbidities to gain better quality of service and patient-centered service. Some patients are treated by different departments in the same hospital. In this case, general hospitals or patients will initiate communication and coordination between different departments. But if in a huge hospital (such as Beijing XieHe Hospital) (DR Lv),The work

of each department is almost saturated, then the communication between departments will be more difficult. Moreover, it is still difficult for hospitals to hire doctors and staff to complete the communication between departments at this stage (as Chinese healthcare system is still short of manpower). In addition, if a patient is being treated at a different medical facility (such as a patient with a heart disease who has surgery for another disease at another hospital), then coordination and information delivery among them can be difficult in traditional service supply chains.

For the above problems, many hospitals and medical institutions have proposed different solutions. In Internet hospitals, a co-delivery model has emerged to complete the communication and delivery of medical knowledge among doctors in different departments involved in comorbidities through the assisting of patients and the digital platform. When patients are diagnosed with comorbidities, they can upload their own health records and other medical data to seek help from doctors in different departments on the Internet hospital through asking questions about treatment plan and medication. If necessary, these two or several doctors in different fields and departments can get in touch on the Internet hospital with the help of the patient and discuss the patient's comorbidities. In this way, the patients are able to get the best, most suitable and most personalized treatment plan. Regarding this phenomenon, Interviewee 24, who is a doctor, described an example she encountered: a patient from Northeast China sought a doctor from Shanghai to consult with her about the patient's condition in the “ChunYu” Internet hospital. The consultation process was very quick (as long as both doctors were online and had time slots). They discussed the patient's condition for about ten minutes and gave suggestions on the final treatment plan. Interviewee 11, who is a doctor, said: *"There should be more and more examples of this kind of online consultation as an increasing number of patients start to accept the digital platform of Internet hospitals."*

"(These communications) are mainly between large hospitals and small hospitals. For example, some medically underdeveloped areas in the west and areas with particularly high medical standards such as Beijing or Shanghai have carried out remote communication between hospitals. —— Interviewee 17, doctor."

In the case of co-delivery in comorbidities, the internet hospital provides a large number of doctor contact ways. These qualified doctors often come from large hospitals and various medical institutions all over the country. Directly connecting doctors for meeting and communication between Internet hospitals can reduce the complicated processed of communication between institutions, and can directly connect different service providers by contacting doctors in different institutions to delivery information, resources and knowledge for the variable service providers. This approach has great advantages in terms of communication. At the same time, it does not require the patient to wait too much time. However, sometimes patients may not be able to find the corresponding doctor on the platform, and the risk will also increase.

"Remember when we used another platform (Internet hospital), the child was treated in Beijing. And then, because I'm in Tianjin, which is very close to Beijing. However, there were some special reasons at that time (the child had some other symptoms). The patient needed to be transferred to Tianjin for treatment later. But he felt he could not articulate it himself. So I was able to communicate with the doctors in Beijing through the Internet hospital platform. Doctors and patients from our side and doctors from Beijing side communicate on the same platform at the same time. The overall situation of the patient was handed over. During the communication, the patient

also explained his own concerns clearly. In this way, our doctors and doctors from Beijing connected. This allows us to understand the overall early treatment process in Beijing. The patient can also have a good communication with the doctors on both sides. -- Interviewee 17, doctor."

8.1.2 Before-treatment, treatment and after-treatment

In addition to the need for communication among multiple departments for patients with comorbidities, it is also necessary to strengthen the connection between patients and relevant healthcare service providers during the stages of treatment and before and after treatment.

The service generally involved in the stage of before treatment is before treatment consultation. The after treatment stage refer to the after treatment rehabilitation and long-term medical management. In the process of providing medical services, DR Shen and others who are from hospitals mentioned that in the past, doctors basically only paid attention to the treatment process itself in the hospital. Generally, few doctors have time to track their patients before and after treatment for the better and personalized service. Regarding the reasons for the phenomenon, Interviewee 15, who is a doctor, stated that, *"firstly, the hospital had insufficient doctor resources; secondly, the patients' compliance after treatment was not very good. Some patients might feel completely better after treatment and will not be willing to put in the effort to do something after treatment."*

However, with the improvement of medical level and residents' demand for more refined medical services. Medical companies in the market and newly developed departments in hospitals have begun to gradually improve the work related to before and after treatment services. For before treatment consultation, hospitals and many digital platforms launched health education and

consultation services to provide services for patients in the state before treatment. These services include psychological consultation for anxiety caused during the waiting process of treatment, science popularization of illnesses, and explanations of the impact that illnesses may have on future life (Interviewee 16). For after treatment rehabilitation, such services are generally available to patients with diseases or medical conditions that require long-term monitoring and maintenance. For example, patients with heart disease usually have to go home to record heart rhythm, blood pressure, electrocardiogram and other data for a long time after treatment in the hospital. For the recording, monitoring and analysis of these data, there are many platforms that patients can choose. Some patients use health-monitoring apps to keep track of their records, while others buy medical wearables and monitor their data in real-time using softwares provided by the wearables companies.

At present, for these medical companies and platforms that provide “before and after treatment services”, they have no official connection with the hospital that provides treatment. However, the services they provide and the data recorded on the platforms play a significant role in assisting the hospital to provide treatment. For example, for patients with heart disease, after providing the medical information recorded by the digital platforms, it can help the doctor in the hospital to better understand the current condition of the patient, and then adjust the type and dosage of drugs in the treatment. Therefore, in this case, it is crucial for patients to participate in the delivery of information and resources, and to connect medical institutions that provide before-treatment consultation, treatment and after-treatment rehabilitation through co-delivery.

(Ps: Medical wearables can track patient physiology in acute, convalescent and chronic cases. The collected health data is viewed remotely by the user or health care provider through a Bluetooth

connection or on a smartphone app. Wirelessly connected medical devices are critical to enabling efficient and patient-friendly tele-care services, reducing healthcare costs, preventing the spread of viruses of disease, and enabling more people to access care while enjoying everyday life at home.)

Regarding the co-delivery of patients between different hospitals and healthcare institutions, Interviewee 37, Interviewee 41 and Interviewee 24 who are doctors, respectively mentioned examples in orthopedics, obstetrics, cardiovascular and cerebrovascular departments, and chronic disease management.

Co-delivery in Orthopedics

In orthopedics, patients need a period of time to complete rehabilitation treatment after orthopedics surgery, which mainly includes physical therapy, occupational therapy, functional exercise, psychological rehabilitation, etc. As for these rehabilitation treatments, Interviewee 37, an orthopedic doctor, mentioned that, *"Given the current shortage of hospital staff, it is generally impossible for doctors to track the rehabilitation treatment of every patient at home after surgery, especially for some functional exercise, psychological rehabilitation and other aspects of treatment. But there are a lot of Apps and digital platforms out of the hospital doing this part of work"*

“KangBanXing" or "Orthopedic Rehabilitation" is an APP dedicated to helping orthopedic patients complete the treatment and rehabilitation after surgery and discharge. In "Orthopedic Rehabilitation", patients can: 1, obtain the whole process of rehabilitation education, follow-up, guidance and monitoring of intelligent limb operation. 2. Obtain key information such as disease-related knowledge, treatment information, and hospitalization and operation arrangements before

surgery. 3. Obtain a personalized rehabilitation plan sent by the competent doctor on the platform for special and effective rehabilitation exercises. At the same time, doctors on the platform can monitor patients' rehabilitation status, joint function, strength, dangerous movement warning, fall warning, infection warning and other rich information through the app and supporting wearable devices at any time. It greatly satisfies the medical requirements of orthopedic patients who need after treatment rehabilitation after discharge.

Therefore, in orthopedics, patients need to contact different medical organizations to receive different stages of medical services from treatment to after treatment. And patients will also actively share and co-deliver information and medical resources among these different medical organizations to achieve the optimization of their own medical goals. Regarding the co-delivery of information, Interviewee 37 said, *"Patients will actively share with us the data of the app they use after treatment to help us make some judgments."* In this case, with the help of co-delivery of the patients, the patient's information about after treatment rehabilitation and data on the digital platform can be linked to the doctors who provide treatment. This information includes daily monitoring data, rehabilitation exercise data, rehabilitation status, follow-up data, etc. Regarding the co-delivery of medical resources, it refers to the situation when some APPs provide doctors and nursing resources, such as door-to-door nursing services. Although there is no similar service in the hospital, the doctor can still formulate a complete medical plan for the patient according to the patient's condition and the patient's medical goals. And then the patient can find such nursing services from other companies/APPa with the help of doctors which means the treatment plan the doctors from hospital give need to complete by co-delivery of patients with other medical platforms.

Co-delivery in gynecology

The same happens in obstetrics and gynecology. Interviewee 41 and Interviewee 24 all mentioned the continuous and delicate medical services and consulting services that obstetric patients receive through co-delivery in hospitals and Internet hospitals. co-delivery in obstetrics refers to the behaviors that some pregnant women and special pregnant women (such as ectopic pregnancy and hypertensive pregnant women, etc.) receive the services provided both in hospitals and Internet hospitals during the pregnancy stage, and transfer information, data, knowledge and resources between the two organizations to achieve their medical goals.

In obstetrics, Internet hospitals provide medical consultation services and medical data recording services. All three interviewees mentioned that since the consultation in the Internet hospital can be carried out at any time, in the online consultation of pregnant women, the services obtained by the patients in the Internet hospital are continuous. First of all, there are continuous monitoring data records and continuous healthcare education for pregnant women in different pregnancy periods on the platform. In addition, pregnant women can designate the only doctor to provide medical consultation services for their entire pregnancy on the internet hospital, which enables the doctor to better understand the situation of pregnant women and provide more personalized services. Offline hospitals provide medical check-up services and prescribing medicines, medical education and medical consultation services. Compared to the service from internet hospital, these services are punctuated. In this context, the punctuated services refer to services that patients can only receive at a certain time, which means that pregnant women will only go to the hospital for such services in the first month, fifth month, and ninth month of pregnancy.

The co-delivery of pregnant women link the continuous services provided by Internet hospitals with the punctuated treatment provided by hospitals. This can help doctors from both sides to better understand the patient's situation and provide more personalized services for patients.

Co-delivery in CDM

As mentioned above in Chapter 6, the patients in CDM are delivering their own medical reports, monitoring their body information and co-delivery with the service provider of CDM. The content of co-delivery in CDM in this chapter will explain the phenomenon that patients transfer information and resources between different service providers. That is to say, the co-delivery in CDM in Chapter 6 is a collaboration of patients with the same service provider, which is a vertical co-delivery, while the co-delivery in this chapter means the information delivery between various service providers, which is a horizontal co-delivery.

With the development of digital tools and digital platforms that assist CDM, such as medical wearables and Internet hospitals, most chronic disease patients do not only receive treatment for chronic diseases from one service provider. In the interview and data collection, we found that the CDM service that patients need is an integrated chronic disease management and a chronic disease management plan involving multiple service providers which is an integrated care approach to managing illness which includes screenings, check-ups, prescription, treatment adjustment, monitoring, data monitoring reminder, data abnormality reminder, health consultation, and and patient education. That is to say, from the perspective of patients, CDM is a management method that provides services from multiple service providers and is controlled and adjusted by the patient

himself. Especially suffering after many years of chronic disease, patients usually have a certain understanding of chronic disease knowledge, and they have great autonomy in their CDM from drugs to monitoring methods to whole treatment plans.

Internet hospitals and digital platforms can provide services such as treatment adjustment, monitoring, data monitoring reminders, data abnormality reminders, health consultation, and and patient education, while offline hospitals can provide screenings, check-ups, prescribing medicines, treatment adjustment, health consultation, and patient education and other services.

In the above cases, patients co-delivery in internet hospitals and offline hospitals and other digital platforms is the integration of resources and functions provided by online and offline service providers. In the information transmission of hospitals and Internet hospitals, patients can record and analyze blood sugar, blood pressure and other health data measured at home through the Internet hospital, and synchronize these data with doctors in the hospital. When there is a health problem, the patient will receive an abnormal indicator reminder from the Internet hospital. This patient can choose to consult the contracted doctor on the Internet hospital or choose to take these data and abnormal reminders to the offline hospital to seek help from the doctor. In addition, the intelligent reminder system of the Internet hospital will also guide users to carry out health management, including blood sugar monitoring reminders, blood pressure monitoring reminders, health consultation reply notifications, abnormal warnings, etc. Therefore, the co-delivery of information and medical data by patients can help Internet hospitals, hospitals and other digital platforms to share data and knowledge and to connect more closely.

Regarding the future development of CDM functions in the Internet hospital, Interviewee 14 said, *"We are actively developing new CDM functions for patients, and we are also working with medical wearables companies. The medical wearables companies and our digital platform are sharing resources to provide better service to patients." As for co-delivery of patients, the new functions of Internet hospital make the information and resources of co-delivery more abundant.*

"Then if the patient is tested and uploaded, the data must be saved. at least when needed later, the data can be found. Because the patient is actually the only person responsible for monitoring the data. These daily monitoring data will be used in the future. It is still very useful in the process of later diagnosing and so on. —— Interviewee 42, doctor."

Conclusion

According to the above description and the data of interviews, we got the following figure 7.1.1, which mentioned the services that patients need at different stages in the treatment process and the organizations that need to provide services. In the following process, co-delivery of patients exists between organizations that provide different services.

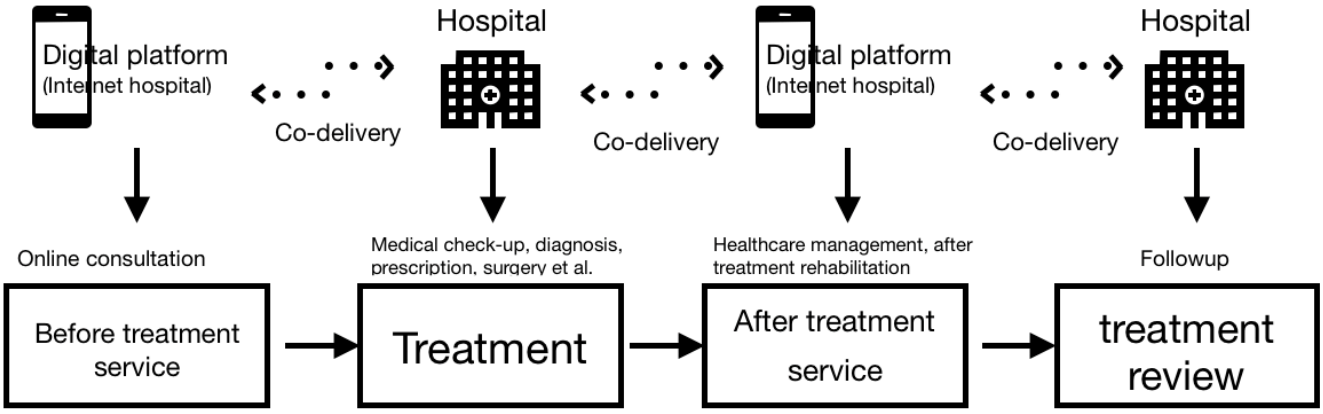

Figure 7.1.1: co-delivery in patient perspective SSC

The type of treatment where this co-delivery exists generally requires long-term recovery and treatment, such as the above-mentioned examples of orthopedics, obstetrics, and chronic disease management. Regarding the content of patient co-delivery, patients disseminate information and knowledge on digital platforms and connect online and offline resources. In the co-delivery from before treatment service to treatment, the main situation involved is that the knowledge and advice acquired by the patient on the Internet hospital in the before treatment stage can be connected with the doctor in the offline hospital. These data can help the doctor in the hospital understand the patient's current situation faster and collect more comprehensive information about the patient.

Co-delivery in the stage from treatment to after treatment service means that firstly, patients update their records and the status of treatment obtained in the hospital on APPs and digital platforms about health management, which enables doctors/AI doctors on digital platforms to design the recovery plan based on these data. In addition, from the direction of after treatment service to treatment, the digital platform that provides after treatment service can also establish contact with

hospital doctors on digital platforms through patients to help patients complete after treatment rehabilitation. This situation occurs in the above-mentioned orthopedic postoperative recovery.

The co-delivery in the stage from after treatment service to treatment review is mainly about sharing the data of the patient after treatment with the doctor in the hospital. These data include the daily monitoring data of patients on digital platforms and the data of other rehabilitation services received. This helps the doctor in the hospital to grasp the current situation of the patient more quickly when making a medical return visit, and make a judgment for the next stage of treatment for the patient. This part of co-delivery mainly occurs in chronic disease and long-term diseases management.

The co-delivery of information and resources between service providers is mainly due to the development of online platforms, 1, making it easier for patients to contact the doctors, so that patients can communicate with doctors in digital platforms or hospital at any time at any stage of treatment. 2, making patients have a better way to record and analyze the data of daily medical monitoring on digital platforms 3. Allowing patients to have more channels to obtain the medical resources they require.

8.1.3 Efforts from government and digital platforms

According to the above description, the same patient will receive services from different service providers about his treatment, including service from hospitals, digital platforms, medical wearable companies, etc. And patients themselves, with the help of digital platforms, can provide these

different service providers with information and resource through co-delivery which can help connect the functions of online hospitals and resources of offline hospitals for their own better medical goals.

Regarding the interconnection of information and resources between different service providers, in addition to the way of patient co-delivery, the government and enterprises are also making efforts in this area. For example, according to the goal of online and offline integration proposed by the Chinese government for the construction of Internet hospitals, policies have been formulated to help large Internet hospitals, such as “Chunyu Doctor" and “Dingxiang Doctor”, to connect with the data of large offline hospitals. In addition, the Chinese government is also encouraging public hospitals to quickly build their own Internet hospital platforms, so that patients can contribute information and resources on their digital platforms.

In addition, some medical companies are also doing the same thing. "Doctor A Liang" is a digital platform to assist chronic disease patients and doctors in chronic disease management. It is the first medical platform in China that combines online and offline to practice in-depth medical services. Patients who have chronic disease and receive services from offline hospitals can upload their health data to the cloud platform through various medical equipment (sphygmomanometer, blood glucose meter, ECG monitor, etc.) without being in the hospital. Remote medical workers monitor the health status of patients through data, communicate with patients through the platform, adjust treatment plans, and send medicines through electronic prescriptions. In this virtual ward, patients can live, work, and study like normal people every day, and at the same time, they can receive high-quality medical services.

8.1.4 The necessity of co-delivery

Even as both the government and digital platform make efforts for connectivity between different healthcare facilities, co-delivery of patients between different healthcare facilities is crucial because of the following two aspects:

1. The type of data. Due to the data storage and processing methods of different medical institutions, the data types of each patient in different institutions are various. Therefore, it is very difficult for this part of the connection to be completed by organizations.

"So even if the later cases are digitized, we still need to spend a lot of work to standardize its pharmacological analysis. This is equivalent to standardizing the data structure, which is difficult and time-consuming. As for the older data, there is no electronic version, and we have to do some data entry manually. The possibility of completing this kind of work is basically very small. —— Interviewee 31, IT Developer."

The co-delivery method makes patients become human resources for communication between different medical institutions, making high-quality data connection between medical institutions and rapid communication of professionals possible.

2. The goal of co-delivery is to better treat patients and manage diseases. This is not exactly the same as a medical facility that provides individual services. The co-delivery is to better realize PCC and provide patients with higher quality services. However, due to the high labor cost of providing

such PCC, and the current Chinese medical system cannot afford such refined medical services. Therefore, it is necessary for co-delivery to help complete such PCC.

8.1.5 Digital transformation of co-delivery

The “co-delivery” mainly credit to the development of “online communication” function and wide range of doctor resources in APPs. The concept of “online communication” function is hot among the internet companies in healthcare industry in recent years which usually provide online channel to patients to contact doctor directly and help patients to ask for some treatment suggestion, pre-diagnosis and after treatment rehabilitation according to the symptoms described and some proper medical imaging and data.

The development and popularization of the Digital platforms enables patients to use the platform that provides various services faster and more conveniently, to find doctors in charge of different fields, and making it possible for patients to complete co-delivery online. In fact, the behavior of patient co-delivery is not due to the emergence of Internet hospitals and other digital platforms. In traditional treatment, patients also take a natural role of co-delivery because when patients face multiple medical institutions, they naturally need to share their physical condition and health report with everyone. In this part, Internet hospital not only enhances the co-delivery between the states of pre-illness, treatment and post-illness, but also replenishes the lack of services provided by many medical institutions in the conditions of pre-illness and post-illness. As a result, the emergence of Internet hospitals do not create the “co-delivery”,but facilitate this co-delivery process from the following aspects.

1 speed up communication of doctors and doctors to patients in different institutions. Patient are able to direct contact doctors to communicate and show any report on internet hospital which are much faster than communicating through the Inner channels of hospitals.

2 Reduce the waste of human resources and money that the hospital brings to maintain coordination with other institutions. At the same time, the Internet hospital also reduces the waiting time during the coordination process.

3 As mentioned above, Internet hospitals can enable patients to obtain better medical resources and treatment suggestions through "cross hospital communication". That is to say, co-coordination in this case can increase the quality of service for patients in traditional medicine and reduce health inequality.

Judging from the various forms of patient co-delivery above, in Internet hospitals, co-delivery of patients to different departments and medical institutions is a very free, random and creative process. There are many ways to connect and use it. This is not a fully designed service process by the medical institution. Therefore, in this process, the Internet hospital does not provide co-delivery SSC, but directly provides the resources that make up the SSC, and the patient is the interested party responsible for connecting these resources. Therefore, we think that both of the the operation and application of the Internet hospital and the co-delivery model are innovations and creation of the operating model by patients after obtaining these resources.

8.2 Co-delivery and Patient-centered service

According to the above discussion of the co-delivery in HSSC from the patients perspective, we knew that Internet hospitals can not only help support the co-delivery of information and resource in SSCs among different service providers, but also replenish traditional medical services for the lack of before treatment and after treatment services. In this case the Internet hospital not only acts as a platform supporting co-delivery in the service supply chain, but also acts as a service provider to provide patient-centered service.

In the literature review, we have reviewed the definition of PCC and the solution about PCC involved in SSC management. During the interviews and research for this article, we found that, In the current medical system, in SSC, there is a lack of consultation before treatment and follow up management after treatment. Many patients do not fully understand their condition in the brief communication with the doctor. Ford (2006) estimates that approximately 50% of patients referred to a mental health specialist fail to follow-up after the first visit. Patients and potential patients like sub-healthy population begin to hope for more convenient and fast and patient-centered medical consultation, diagnosis and even daily health monitoring services. However, the demand for PCC has put a lot of pressure on supply chain management on the account that PCC traditionally usually means more medical personnel involved and more elaborated services (WHO, 2016, Granström et al.,2020).

In the process of data collection, we find several cases of co-delivery in SSC from patients perspective by applying integrated digital technologies to achieve the goal of PCC. The patients,

hospital and digital platform work together to form, provide and facilitate PCC, including integrated service and resources for patients and customers.

8.2.1 The effect of co-delivery and digital platform in PCC

Optimize the utilize of medical resources in service supply chain and promote the development of graded diagnosis and treatment.

Patient co-delivery allows for transferring diagnosis and treatment from offline to online, expanding medical services and business scope, and accurately matching doctors and patients. In addition, it can enhance the distribution of top-notch medical resources and boost the hospitals' reputation. Furthermore, providing technical assistance and training for primary care physicians can enhance their diagnostic skills.

It is convenient for patients to find medical treatment and reduce medical expenses.

Internet hospitals can break the constraints of time and space by optimizing the medical service process. This saves time for patients by eliminating the need to queue for registration and wait for medical treatment. Additionally, it improves the efficiency of diagnosis and treatment. In rural and remote areas, patients can conveniently seek medical treatment at their doorstep. This allows them to access famous doctors without having to leave home, and helps address the imbalance of medical resources among regions in light of the sharp increase in medical demand.

Increase the income of doctors, broaden the channels for multi-site practice, and promote the flow of physician resources.

The use of Internet hospitals and their service supply chains can alleviate the work pressure on doctors, compensate for the shortage of medical personnel, improve the work efficiency of doctors, and maximize their value. It realizes the better utilization and distribution of limited medical resources.

Promote the construction of hospital electrical information system and speed up the sharing of medical big data.

With the use of a cloud platform and mobile intelligent terminal, patients' health data and past cases can be accessed on a single platform. This enables health monitoring and sharing of medical records, which is convenient in overcoming information barriers and asymmetry between hospitals.

8.2.2 Co-delivery in Internet hospital and sustainable healthcare service

The development of internet hospitals and patient co-delivery increase both business and social value, leading to sustainable healthcare and societal development (Pappas et al., 2018; Mikalef et al., 2019). This is because the practice of PCC care in the supply chain refers to the supply chain for daily medical care and the concept of “large medical care” refers to the supply chain for a sustainable healthcare. Besides the internet hospital, others platforms such as the digital platform for door-to-door medical care ordering, daily heart disease, diabetes monitoring platform, “mind” for mental health help, and AI-recommended chronic disease control methods, etc., can also help achieve the goal of sustainable healthcare.

The current pattern of medical institutions is still mainly based on treatment, and there are still deficiencies in the prevention, rehabilitation and health management of chronic diseases and

common diseases. As illustrating in the figure7 and 8, For the proper hospitals and medical institutions, they can use the Internet hospital as a tool to cooperate with service providers such as drug suppliers and their pharmacies to realize drug distribution, connect with payment institutions to realize intelligent online payment, and connect with rehabilitation institutions to solve the problem of postoperative rehabilitation of patients. At the same time, hospitals can also introduce wearable devices to monitor and manage the health of residents. Through these new resource allocation methods, the Internet platform can realize a more optimized and smarter consultation process and service model.

For the future development direction, the current construction of smart hospitals is more from the perspective of medical institution informatization to improve the efficiency of diagnosis and treatment. In the future, It should rely on the integrated technologies like 5G, Internet of Things, "Internet +" and other technologies to realize the intelligent matching of patients' needs and medical resources.

8.2.3 *Data security*

From the data collection in the interviews, informants also stressed the issue of data security many times. They pointed out that the data security will be an important challenge in the operation of medical digital platform. However, until now, there are still a lot of medical digital platforms have not carried out the construction of data security graded protection. Some medical institutions are unable to cope with the security risks brought by the Internet when their network security protection capabilities are insufficient, and the overall security risks of medical institutions will further

increase. This problem is mainly caused by the shortage of data security staff and insufficient investment in data security.

From the Chinese digital medicine annual report(2021), for the problem of data security, the government has also begun to take the lead in promoting the construction of the security system, clarifying the responsibility for the construction of data security in medical institutions, and ensuring a safe environment for the digital medical platform.

8. 3 Conditions of co-delivery in SSC from patient perspective

We still analyze the conditions of co-delivery in SSC from patient perspective. We have constructed the conditions of co-delivery in SSC from patient perspective (figure 7.3.1) shown in the figure below from the perspectives of policy and social, patient requirement, suppliers requirement and digitalization. The specific data are shown in the table below (figure 7.3.2).

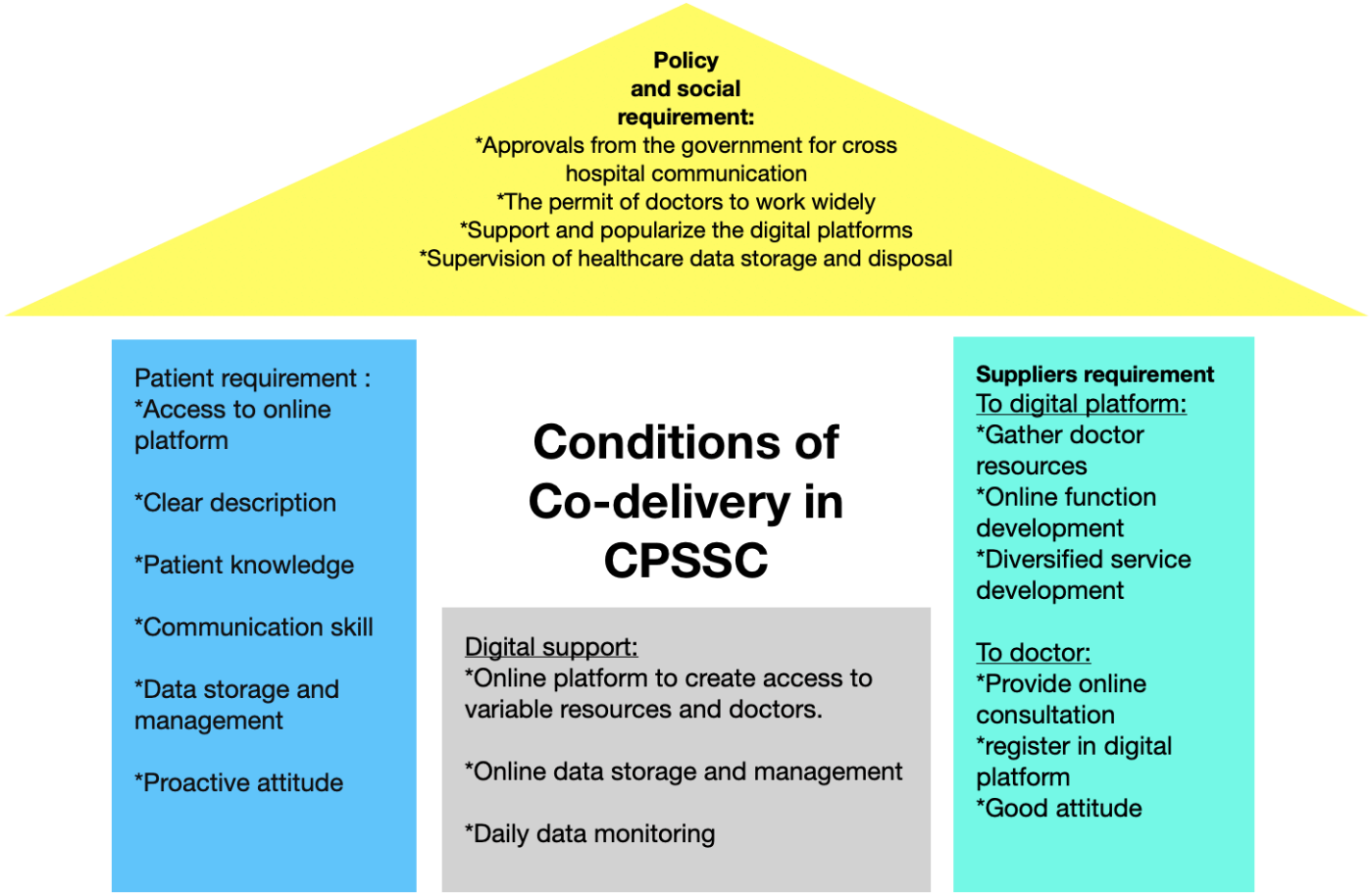

Figure 8.3.1: conditions of co-delivery in CPSSC

Compared with co-design and co-delivery conditions, co-delivery from the patient perspective has many similarities and differences.

First of all, in terms of patient requirements, conditions of co-delivery from the patient perspective are similar to the previous conditions of co-design and co-delivery. The aspects of patient education, patient knowledge, communication, and data storage have all been emphasized in the previous article. In interviews about conditions of co-delivery from the patient's perspective, interviewees focused more on emphasizing the importance of a clear description of the co-delivery process. This

is because co-delivery from the patient perspective requires patients to pass some more critical information between medical organizations, such as symptoms, diagnoses from other organizations, and medical plans from other medical organizations. It places high demands on the patient's communication skills.

"I think that if you want to achieve better results, you must have clear description, that is to say, as a doctor, you must first answer the doctor's questions directly —— Interviewee 43, Doctor."

Compared with co-design and co-delivery conditions, the difference between conditions of co-delivery from the patient perspective is that it pays more attention to integrating resources in the co-delivery process.

Regarding policy, since co-delivery from a patient perspective involves communication across hospitals and healthcare organizations, this co-delivery requires policy support. During the interview, all seven interviewees expressed the considerable impact of policy changes on the co-delivery operating model. Regarding doctor human resource management, the Chinese government has introduced policies that allow doctors to work widely in various organizations. In terms of medical prescriptions, Chinese medical institutions allow the outflow of prescriptions from public hospitals. It allows online digital platforms to obtain more doctor resources and provides the cornerstone for patient co-delivery across hospitals. Under the policy of co-delivery, this can better enhance healthy communication between hospitals, doctors, and medical resources (medical prescriptions). Product manager Huang also expressed the role of the outflow of electronic prescriptions in promoting digital health and co-delivery development in China.

"So how does the current government change? It is the outflow of prescriptions and the outflow of electronic prescriptions. Then do it in this way, that is, for recovery, for recovery from chronic diseases. The government encourages an outflow of prescriptions. ——Interviewee 44, Product manager."

In addition, in terms of policy, Interviewee 31, who is an IT developer, said that regarding the use of medical data, storage, and other issues, China is also actively legislating and regulating. *"China's Personal Information Law was implemented on September 1 this year, and it must be much better. Now the state is also investigating many of these companies, and fined many of these companies. Companies with improper information protection will be subject to such punitive measures. —— Interviewee 31"*

The difference between co-delivery conditions from the patient perspective and co-design and co-delivery conditions is also reflected in the suppliers' requirement for digital platforms. Co-delivery requires the digital platform to accumulate more resources from doctors and other medical organizations (such as wearable suppliers) so that patients can complete the transmission of medical information and access various medical services on the same platform. Operation manager of Ping An Health Interviewee 30 expressed, "Our Ping An platform is promoting a lot of functions including chronic disease management and rehabilitation during recovery. For the platform, the richer the services it can provide, the more attractive it will be, and it will also allow patients to have more choices. In short, we still need to develop more functions. —— Interviewee 30"。In other words, to display the digital platform's accumulated medical resources on the platform, IT

developers also need to actively develop more functions to assist the co-delivery process and provide medical resources.

Conditions I	Conditions II	Main content
conditions for co-delivery		
Policy and social requirement	Government	So how does the current government change? It is the outflow of prescriptions and the outflow of electronic prescriptions. Then do it in this way, that is, for recovery, for recovery from chronic diseases. The government encourages an outflow of prescriptions. —— Interviewee 44
Policy and social requirement	Government	The government allows us to practice in multi sites - Interviewee 10
Policy and social requirement	Government	Because domestic doctors can practice in multi sites. —— Interviewee 27
Policy and social requirement	Government	The government encourages the development of such a platform. I think this kind of platform is very good. It is convenient for many people. In fact, patients also get better services. The government should encourage it and give more preferential policies. Funding is the best . —— Interviewee 21
Policy and social requirement	Government	We definitely need the encouragement of the government and policies. Because the current government also encourages this kind of inter-regional and inter-hospital communication. In fact, the essence of this is to cancel part of the medical inequality. So now the government encourages it—— Interviewee 16

Policy and social requirement	Government	In fact, data security has recently been legislated, and I participated in this matter some time ago. Because a large number of wearable devices, including the data management centers on Internet hospitals, these functions will generate a large amount of data, which is more important. Questions. - Interviewee 44
Policy and social requirement	Government	Let's do this step by step now, because China's Personal Information Law was implemented on September 1 this year, and it must be much better. Now the state is also investigating many of these companies, and fined many of these companies. Companies with improper information protection will be subject to such punitive measures. —— Interviewee 31
Patient requirement	Communication skill	A clear description is needed. Some family members only think about their own problems. If they don't speak clearly, things will be very troublesome. It is very important to be able to communicate. —— Interviewee 19
Patient requirement	Clear description	I think it is best for the patient to be able to sum up a clear and simple description. Because sometimes he will send you a very long paragraph, using hundreds of words, the key points in it are not prominent, and he will talk about back pain for a while, and chest tightness for a while. In this way, if the focus is not highlighted, the effect of the consultation will not be very good. —— Interviewee 18
Patient requirement	Clear description	The first one is that I hope they can all share and describe their problems very clearly, some of their current questions or their current situation. —— Interviewee 16
Patient requirement	Clear description	Basically, it is the simplest main symptom, and you should tell the doctor clearly how long the onset has been. —— Interviewee 17
Patient requirement	Clear description	I think that if you want to achieve better results, you must have clear description, that is to say, as a doctor, you must first answer the doctor's questions directly —— Interviewee 43
Patient requirement	Communication skill	You can't see your children online, so it's more difficult to eliminate them, and sometimes you can only rely on patients. We can only tell him some possible diseases that need to be ruled out by family members, so this requires the family members to have a certain ability to identify. —— Interviewee 19

Patient requirement	Patient knowledge	It would be much better if you have a little medical knowledge. Some family members do not have this knowledge, so they are not very satisfied with the results of the online consultation. —— Interviewee 11
Patient requirement	Attitude	Therefore, this matter actually needs the patient's proactive attitude, because in the end it is their own business, and we are just assisting. They need to have such awareness, and then go to find and receive such services. The hospital and our doctors themselves What can be provided is also limited,—— Interviewee 42
Patient requirement	Data storage and management	Then, if the patient is tested and uploaded, the data must be saved, at least the data can be found later when needed. Because the patient is actually the only person responsible for monitoring the data. These daily monitoring data will be used for future diagnosis It is still very useful in the process of what. —— Interviewee 42
Digital support	Digital support	Technically, we need to develop this platform first, and then we can have these resources on the platform. For example, we need these software and experts to do this when we do physiological indicators. —— Interviewee 33
Digital support	Digital support	Then, if some wearable devices need to be connected to this platform, it is best to attract patients to buy these wearable devices. —— Interviewee 33
Digital support	Data storage and management	That is, when we make data, we may use background encryption to protect user information. Because many platforms now want to provide data management services, they must do online data management and storage functions. Now many platforms are doing this , patients can generate a lot of data.—— Interviewee 31
Digital support	Digital support	In addition, for chronic disease management, it is best to have some daily monitoring data for online consultation, such as blood pressure, blood sugar, heart rate and other indicators. In fact, it would be much more convenient for patients to have some measuring instruments and wearable devices. —— Interviewee 24

Supplier requirement	For digital platform	As I said just now, it's all about the integration of resources. The most important thing in Internet hospitals now is famous doctor resources, as well as patient resources. But in fact, patient resources are doctor resources. As long as the doctor resources are good, patients will naturally come. .The current Internet hospitals in our country are also robbing people from various hospitals.—— Interviewee 25
Supplier requirement	For digital platform	The platform mainly gathers doctor resources from various major hospitals. Most of the well-known doctors now work in many hospitals, including the online platform. —— Interviewee 30
Supplier requirement	For digital platform	In addition, our Ping An platform is promoting a lot of functions including chronic disease management and rehabilitation during recovery. For the platform, the richer the services it can provide, the more attractive it will be, and it will also allow patients to have more choices. In short, we still need to develop more functions. —— Interviewee 30
Supplier requirement	For doctor	Good attitude, I have been complained many times because of bad attitude. Profession must be professional, and attitude must be kind and patient. Other basics are the same as offline, professional ability is strong, and then it is to provide consultation services. —— Interviewee 18

Figure: 8.3.2: Codes of conditions for co-delivery from patient perspective

8.3 Summary of chapter co-delivery in SSC from customer perspective

This chapter mainly introduces the current phenomenon of co-delivery in SSC from customer perspective in the medical field. From the beginning, this chapter distinguishes co-delivery in SSC from a customer perspective and co-delivery in SSC from service providers perspective. This chapter has two parts in total. First, this chapter introduces the phenomenon of co-delivery in

Internet hospitals. From two aspects, comorbidities, before-treatment and after-treatment, it shows how customers transfer information, knowledge, resources, and other content between medical organizations through digital means. This part analyzes this co-delivery from the perspectives of necessity, digital transformation, government, etc. The second part of this chapter is co-delivery and patient-centered service. The content of this part is mainly based on the current needs and research on patient-centered care in the medical field. This section provides an operational solution for patient-centered care from a co-delivery perspective.

The contribution of this chapter to literature is divided into two parts: one is the contribution to service operation research, and the other is the contribution to patient-centered care. In service operation, this article innovatively explores and proposes co-delivery in SSC from a customer perspective, which is significantly different from other forms of co-creation from a service provider perspective based on SSC from the customer perspective.

In service operations, some scholars are still conducting research on patient-centered care. Huetten et al. (2019) first proposed human-centered service systems to help hospital internal management achieve better goals. Patrício and his colleagues (2020) are the first scholars to provide solutions for PCC from the perspectives of service research and service operation research. Comparing the research of Patrício and his colleagues (2020), the research of Patrício and his colleagues (2020) designed three ways to implement PCC (human-centered participation approach, digitalization approach, and service system approach) from the perspective of service design and The research of this article is from the perspective of co-delivery, exploratory discovery and explanation of the phenomenon of patients achieving PCC through co-delivery in current digital platforms. Therefore,

this article, together with the research by Huetten et al. (2019) and Patrício and his colleagues (2020), provides operational ideas and solutions for summarizing the development of service research in the medical field, especially in the field of PCC.

8.4 summary of key findings in this research

In finding chapters (chapter 5, chapter 6, chapter 7, and 8), this study finds the phenomenons of co-design, co-delivery, and co-delivery in SSC from the patient perspective with three cases, which are digital orthodontics practice, integrated primary care in internet hospitals and digital chronic disease management. In order to make the findings in these three parts clear, visible and comparable, this study creates Table 8.4.1 “Summary of findings” as follows.

	Content	Content type	Participants	Digital technologies
Co-design				
Digital orthodontics				
Treatment plan co-design	Treatment plan	knowledge, information	Orthodontist, patient	orthodontics treatment system, 3D scanning
Teeth arrangement (alignment) co-design	Treatment plan	Information	Orthodontist, patient	orthodontics treatment system, 3D scanning
CDM				
Therapy co-design	Doses adjust	Information	Doctor, patient	Digital platform
Daily health co-design	Health plan	knowledge	Doctor, AI software, patient	Digital platform, AI software
Co-delivery				
Digital orthodontics				
Co-delivery in "co-design"	Treatment plan	Knowledge	Orthodontist, patient	orthodontics treatment system, digital platform
Co-delivery in "receiving aligner"	Aligners	Physical materials	Factory, patient	logistics system
Co-delivery in "regular supervision"	Medical data	Information	Online orthodontist, patient	Digital platform
CDM				
knowledge dissemination of "Prevention and screening"	healthcare education	knowledge	Hospital, patient	Digital platform
CD data monitoring	Medical data	Information	Hospital, patient	Digital platform, digital wearable
Digital health records	medical data and healthcare report	Information	Hospital, patient	Digital platform, digital wearable
Internet hospital				
Online prescription for CD	Medical data	Information	Online doctor, patient	Digital platform
Online consultation	Healthcare reports	Information	Online doctor, patient	Digital platform
Online consultation	Doctor resources	Human resources	Online doctor, patient	Digital platform
Co-delivery in CPSSC				
Internet hospital				
Comorbidities	Treatment plan, doctor resources	knowledge, human resources, information	Doctor from different hospitals, patient	Digital platform
Before-treatment, treatment and after-treatment	Treatment plan	Information	Hospital, patient	Digital platform

Table 8.4.1 Summary of findings

In Table 8.4.1, this study presents a comprehensive summary of the salient co-creation phenomena observed across diverse case studies. Amidst the diverse manifestations of co-creation, this research further categorizes them based on their content, content type, participant involvement, and the utilization of digital technologies. A scrutiny of the table reveals that in the instances of co-design

and co-delivery, the primary content types disseminated encompass knowledge, information, materials, and human resources, with knowledge and information being the most prevalent. Among the participants, most co-design and co-delivery phenomena involve doctors, hospitals and patients. It is worth noting that the co-creation of AI software and patients is involved in the daily health co-design, which is also an interesting part found in this study. In digital technologies, as can be seen from the table, most co-design and co-delivery require the support of digital platforms. In addition, in some different scenarios, the help of other digital technologies is also needed, such as digital wearable, AI software, orthodontics treatment system…

CHAPTER 9: DISCUSSION

To empirically explore the digital transformation in service delivery and the relationship between the service providers and customers this PhD research study investigates the co-creation phenomenon in the healthcare service supply chain. As we strive towards achieving our objectives, it is prudent to revisit the three research objectives that were identified in Chapter One at an operational level. The first research objective is to seek the types of co-creation in SSC under the digital environment. Since co-creation does not appear alone in SSC, the second research objective of this study is to find the requirements and conditions of this co-creation from the inside. The last research objective is to explore the understanding of co-creation in SSC based on digitalization and patient-centered care. Three cases are introduced in Chapter 5 of this thesis. Chapter 678 introduces and deeply analyzes three types of co-creation through single-case analysis and cross-case analysis respectively. Emergent propositions explicitly address theoretical concerns in this chapter, while practical answers are presented in chapter 10.

Key contributions from the study

9.1 Concept for co-creation in service delivery

This part of the writing try to distinguish the collaboration phenomenon in the literature of service and service operation research and find out the contribution position of this research.

Service, due to its characteristics of intangibility, inconsistency, inseparability, inventory, and involvement, makes it naturally different from industrial products (Hemilä and Vilko, 2015). Likewise, it is essential to study services based on their characteristics and to distinguish “services" from "industrial products" management. Therefore, based on the fact that the service industry is the most significant economic industry in the world today, the research on the nature, quality, efficiency, and value of services has always been regarded as a critical research project by researchers (Cai et al., 2017; Schorsch et al., 2017).

In the research on improving service quality efficiency, and reducing service costs, a series of concepts such as "co-creation", "co-production", and "co-innovation" about the collaboration between customers and service providers have gradually been mentioned by researchers as the collaboration with customers is proved to be an essential solution to the challenge of high-quality and low-cost services. However, there are also similarities and differences between the concepts of collaboration ("co-creation", "co-production" and "co-innovation"). Table 1 illustrates the definitions of "co-creation", “co-production", and "co-innovation".

By understanding the phenomenon of collaboration, this part of the writing analyzes the classification, similarities and differences of current literature and the position of this research, mainly from the following aspects: SSC type in co-creation, co-creation result and co-creation position in SSC.

9.1.1 SSC type: PSSC and SOSC

The existing researchers have studied that collaboration occurs in the whole service process, including the overall process of selling service, after-sales service and the overall process of service industries (such as education, legal advice, healthcare, etc.).

From the perspective of marketing research and service management, the collaboration between customer and service providers is an independent process that usually happened in the service selling and after-service service, and the customer contacts the stuff at the front desk (Prahalad and Ramaswamy, 2004; Pham et al., 2022). But from the service delivery perspective, the collaboration between customers and providers must be placed and studied in the whole service supply process, including the technological suppliers and delivery process. As collaboration does not exist alone in the service supply process, this collaboration process is a sub-process that is incorporated into the supply chain supply process. The collaboration process in SSC refers to the behaviour that the customer generated in the service delivery process, contributing to a specific step in the service supply chain.

According to Wang (2015), a service supply chain includes SOSC (service-only supply chain) and PSSC (product service supply chain). SOSC is the supply chain system in which the “products” are pure services, and physical products do not play a role. At the same time, the PSSC should be both “services” and “physical products” in these supply chain systems. Like Figure 2.1, the telecommunication, finance, and Internet service belong to the SOSC, while the restaurant and food the product design belong to the PSSC because the supply process relates both the physical product and service (Wang et al., 2015). The classification could also be established in the health care industry. Apart from the research on the supply of equipment and materials (Holmström, 2014), a

study on the SOSC transformation is currently needed with increasing public attention to the customer/patient service quality improvement.

From the perspective of SSC type, in the term “co-creation”, the cases mentioned in the pure service product or service of selling process (Kao et al.,2016), while the term “co-production” mainly refers to the process of collaboration in PSSC (Alzaydi et al.,2018). In other words, research on co-production generally occurs when the product involved is a physical product or a physical product involved in the service process. In co-production, the process of collaboration activities on is mainly about in the service of selling and producing a physical product rather than pure service. For example, In the process of customizing house furniture, the customer can discuss the details of furniture customization with the furniture manufacturer by providing their requirements (Sichtmann et al., 2011). This kind of behaviour that generally involves the production of physical products or the behaviour of collaboration involving many physical products in the service process is generally summarized as co-production.

9.1.2 The result of collaboration

In sorting out the literature on co-creation, production, and innovation, we found that different collaborations and degrees of collaboration lead to different results. This result can be divided into the following categories in terms of various levels of impact: the collaboration with the result of customer participation, the collaboration with the result of value creation, and the collaboration with the result of new product (new versions and generation of service).

Collaboration with the result of customer participation refers to the mode and behavior of this collaboration that both the customer and the service provider are willing to conduct, or only the customer is willing to conduct. After this kind of collaboration occurs, it may have a good or bad or neutral impact on the service provider and customer (Torfing et al.; 2019). For example, in the medical industry, when patients are waiting for treatment, patients or family members often feel sad because of inner anxiety and waiting, resulting in constant phone inquiries and urging. Another example is that in the era of rich social media, customers can easily post comments on service/ product on social media. Similarly, many scholars have also expressed similar views, that is, the behavior of collaboration is not necessarily the behavior expected by the service provider, and may cause some negative effects (Barrutia and Gilsanz, 2013). Therefore, we summarize this type of collaboration as the collaboration with the result of customer participation.

The other type is the collaboration that results in value creation, which is a collaboration that can provide value and benefits to customers or both customers and service providers. Value creation refers to the creation of products and services that are valuable to customers. It includes not only the manufacture and sale of tangible products, but also the creation of intangible services, processes and relationships related to customers (Payne et al., 2008). That is to say, the result is the collaboration of value creation, which means that customers can participate in service/goods consumption for mutual benefits through symbiotic relationship to create, deliver and exchange value by providing channels and conditions for customer collaboration through collaboration or service provider. This type of collaboration is different from the aforementioned customer participation collaboration because the result of this kind of collaboration is positive, and obviously beneficial to both the customer and the service provider.

The last type is a collaboration which the result is a new product/ new model of service product. Lehtimäki & Komulainen(2021) and Tekic & Willoughby (2019) have all proposed collaborations whose results or goals are new product innovations. Chen et al, (2019) think that the process of integrating the contribution of customer collaboration into new product development is similar to the traditional new product development process. The new ideas in new product development does not only come from the company's Internally, but also from outside the company. For enterprises, this type of collaboration means that customers put forward their own opinions and experiences on the subsequent product development through the communication channel with the company and their own consumption experience. As for the public sector, this type of collaboration refers to the citizens' suggestions and improvement directions for urban services, which will lead to future public service reforms. In conclusion, the result of new product/new model of service product collaboration is an impact of the consumed consumer on the future service.

9.1.3 Positions in service supply chain

Understanding collaboration from the perspective of service supply chain, we find that different researchers' studies on collaboration actually take place in different positions of the service supply chain. The actions of collaboration across these different positions can be broadly divided into two categories. One is the collaboration in the service supply chain from suppliers to service providers to customers (Sampson & Spring, 2012; Alzaydi et al., 2018). The other type is collaboration in the form of feedback, suggestions, and ideas for improvement on the product or service after the

customer receives the service or other product (Rodriguez Müller et al., 2021). Therefore, in the SSC we describe the former as operational collaboration and the latter as strategical collaboration.

According to Saunila & Rantala (2019), from the perspective of SSC, most of the customer's collaboration activities and behaviors appear in the process of selling and after selling. Similarly, he also distinguished that the customer's collaboration in the process of service supply in SSC is very different from the collaboration in the process of after selling at the end of the service. In addition, some scholars have proposed that service supply chain not only includes suppliers, customers and service providers in the current process of service supply, but also includes the "after-sales" after the service is completed (Avery & Swafford,2009; Sampon, 2012). For example, in strategical collaboration, Unilever collects feedbacks from customers to improve its service Mazurek-Łopacińska., 2021).Unilever launched its Open Innovation platform in 2010, which invites individuals to submit responses to specific challenges for potential adoption by the company.

Operational collaboration is the collaboration on the service delivery part in the service supply chain, which has an impact on the service experienced by the current customer. For example, when customers receive housing design services, they design the placement and structure of rooms together with designers. This is the collaboration at an operational level. Comparing it to the strategical collaboration, following the above example, after the customer completes the design and decoration of the house with the designer, the behavior that customer gives designer the opinions and improvement ideas of the company's service process is the collaboration in a strategical level.

9.1.4 Position of this research

Based on the above classification of collaboration and the analysis of co-production, co-creation and co-innovation in the literature, We find the following detailed classification table about the specific content of "co-production", "co-creation" and "co-innovation". Table 9.1.1 introduces the concepts and definitions, and table 9.1.2 introduces the position of the concepts.

Co-creation
Co-creation is a joint collaborative activity of stakeholders involved in direct interaction with each other. (Gronroos, 2012)
Co-creation is a process through which two or more public and private actors solve a shared problem, challenge, or task through a constructive exchange of different kinds of knowledge, resources, competences, and ideas that enhance the production of public value [. . .], or services. (Torfing et al., 2019)
Co-creation is a process that allows clients to share their own knowledge and resources they own. In this process, the customer himself provides value for the service itself. (Hollebeek, 2019)
Co-innovation
Co-innovation refers to the process of developing new ideas and technology together with one or more partners. Here, the traditionally closed innovation process, which takes place in-house in a company, is opened up. This means that external knowledge is internalized or internal knowledge is outsourced. Partners in this context can be research institutions, experts, other companies such as startups, suppliers or even customers. (Chen et al.,2019)
Co-innovation can be defined as the ideation, development and commercialization of innovative new offerings between organizations that actively and interactively work together, The process of co-innovation borrows from new product development (NPD) process descriptions, since often in supplier-customer co-innovation the activities are not that different from internal innovation or product development (Buur and Matthews, 2008)
Co-production
Co-production: consumers participate in the performance of various operational activities of a company resulting in valuable outcomes to be consumed. (Etgar, 2008)
Co-production of goods, is a process in which customer organisation interactions transform the organisation's resources (rather than customer resources) into the customer's product. (Alzaydi et al., 2018)
Co-production means a relationship between the employees of an organization and (groups of) individual citizens. It requires direct and active inputs from these citizens to the work of the organization. The professional is a paid employee of the organization, whereas the citizen receives compensation below market value or no compensation at all. (Brandsen et al., 2016)

Figure 9.1.1: co-creation co-production and co-innovation

	SSC type	Result	Position in SSC
Co-production	PSSC	Customer participation & Value creation	Operational
Co-creation	SOSC	Value creation & New product	Strategic/ operational
Co-innovation	PSSC and SOSC	New product	Strategic

Figure 9.1.2: comparison of co-production/creation/innovation

The similarities of co-production/creation/innovation is that these concepts all express a kind of collaboration between customers and service providers. However, the results of the three concepts are somewhat different. In addition to having a different meaning in itself, In the research on the concepts of collaboration such as co-creation, co-production, and co-innovation, we found that these concepts of collaboration were not proposed in a unified context.

Comparing to the co-production, co-creation and co-innovation both emphasize the impact on the results of the service itself. Co-creation refers to the creation of value, and the value here mostly refers to the current value for their customers. And co-innovation is directly caused by collaboration activities to produce important changes to the service itself, and more emphasis on the macro impact on future services (such as the development of new versions of service products) (Buur and Matthews, 2008; Chen et al.,2019; Torfing et al., 2019).

In this research, comparing the co-creation phenomenon in service research, co-creation in SSC specifically focus on the supply process and supply relationship which result the value creation

rather than the new product in an operational level rather that in a strategic level. Therefore, we have the P1:

P1: the co-creation in SSC is the collaboration process in service only supply chain which customer and service providers work together to create value in supply chain in an operational level.

Compared to the above concept of co-creation/production/innovation, this research on co-creation in service delivery has following differences and contributions:

This study creatively carried out research on co-creation in the field of service delivery with regard to the service supply chain factors and service operation point of view. This research also unify and establish an accurate concept for the research on co-creation in the field of service delivery.

The research on co-creation in the field of service delivery is significantly different from “co-production" in service delivery, because co-production generally refers to the collaboration between customers and producers in the service part of physical production (PSSC (product service supply chain)) , while co-creation in service delivery refers to the research on collaboration in SOSC (service only supply chain).SOSC is the supply chain systems in which the “products” are pure services, and physical products do not play a role. While the PSSC should be both “services” and “physical products” in these supply chain systems. The tele-communication, finance, Internet service, healthcare service belong to the SOSC while the restaurant and food, the product design belong to the PSSC because the supply process relate both the physical product and service (Wang et al., 2015). Besides, the originals literatures on co-production in the service supply chain

emphasized more on the functionality of the customer, while the co-design, co-coordinate, and co-manage in my co-creation in service delivery emphasized customer knowledge sharing, active participation, joint decision-making, and joint management.

In addition, the research on co-creation in the field of service delivery is also significantly different from the current “co-creation" as most of the current researches on co-creation are about the point of after service and before service while this research is about the whole process of the service including front-stage customer-oriented service and back-stage suppliers, stakeholders communication. That is to say, this research is a co-creation research carried out in service only supply chain. The factors involved in this research on co-creation in service delivery are also different from other co-creation research. This research focus on supply process through blueprint analysis methodology including technology suppliers, support process, supplier actions et al.

In summary, the first contribution of this research is to systematically define and study the phenomenon of co-creation from the perspective of service delivery, distinguish between co-creation in service delivery and co-creation/production, and discover the three forms of co-creation (co-design, co-delivery and co-delivery from customer perspective) in service delivery, carry out the conditions required for these various forms of co-creation.

9.2 Types of co-creation in SSC

In the above chapters 6 & 7 & 8, this article explores and explains the co-design, co-delivery and co-delivery from customer perspective in SSC. This part of the discussion will make an in-depth

comparison of the three types of co- creation and current literature on types of co-creation and co-design, co-delivery and find the position of contribution in this research.

Regarding to the studies on the forms of co-creation, the meanings expressed by co-design, co-delivery, and co-evaluation are not completely the same. The following table expresses the specific situation of the research on the forms of co-creation in the existing literature (including co-design, co-evaluation, co-delivery)

Explanation	Method	Time	Attribute to	Reference
Co-design				
In the medical field, co-design means that in the process of decision-making and planning, patients can communicate with professionals to affect the treatment plan and planning. Patients play the role of co-design and co-planning.	Interviews	Before service	S	(Fugini and Teimourikia, 2016b)
Co-design allows the inclusion and consideration of users' requirements, and it is prevalent in co-creation processes since it is more feasible to include users in this stage than in, e.g., the service delivery	N			(Rodriguez Müller et al., 2021)
The process of taking public opinion into account when making decisions in government and the public sector.	Forum/Meetings	Before service	C	(Fugini and Teimourikia, 2016c)
People's different degrees of co-design for public services have transformed public services from traditional service to self-organized service provision process.	N	In service	C	(Bovaird, 2007)
Citizens are involved in service improvement (like co-design a public policy) when using public services without costing them extra time or effort.	Online communication	After service	C	(Huang and Yu 2019)
	Interviews	After service	C	(Trischler and Scott 2015)
Co-evaluation				
Co-evaluation is examined in two ways: (1) co-evaluation processes in the evaluation phase of the public service cycle, and (2) as a final phase in co-design processes.	Forum/Meetings	After service	C	(Rodriguez Müller et al., 2021)
The government invites citizens to participate in the supervision and evaluation of government affairs through open government data.	Open Government Data	After service	C	(Linders, 2012)
Co-delivery				
Facilitating public and government agency communications through digital platforms and other digital technologies. inviting everyday citizens to use their skills and expertise to solve government challenges.	Digital platform	Before service	C	(Linders, 2012)

Result/Aims: "S" means specified service for customer themselves ; "C" means comprehensive service for public/future service "N" means not mentioned

Figure 9.1.3: literature on co-design/evaluation/delivery

From the above table, we can find:

For co-design most of the research (attributed to C) on co-design occurs in the stages of after-service and before-service. Similarly, the co-design referred to the service collaboration which attributes to comprehensive service for public/future in this part of the literature (Bovaird, 2007; Fugini and Teimourikia, 2016c; Huang and Yu 2019). That is to say, the concept in "C" literatures refers to the phenomenon that public sectors and government create channels to adopt the feedbacks from citizens and listen to the suggestions and opinions related to the provision of public services(Bovaird, 2007; Trischler and Scott, 2015; Huang and Yu, 2019). The two sides of co-design here refer to citizens and public sectors. Therefore, citizens/customers provide opinions and suggestions on the design of future comprehensive public service through the communication channel provided by the service provider.

In addition, unlike the co-design of attributing to comprehensive service, Fugini and Teimourikia, (2016b) mentioned the co-design and co-plan treatment plan in the healthcare industry which doctors and nurses will discuss with the patient and the patient's family members through communication and interviews before treatment. The difference between this study and other studies on co-design is that this study is the co-design attributing to specific service for customers themselves in which the customers participate in the process of providing services to themselves.

For co-evaluation, Linders (2012) and Rodriguez Müller et al., (2021) both mentioned the co-evaluation of citizens for public policy. This involves the problems of transparency and credibility of the government service platform. This part of the literature is also about the collaboration activities attributed to the public future comprehensive service. As for co-delivery, it can be seen

from the above table that there is very little research on co-delivery. Linders (2012) studied the promotion of communication between customers and service providers, citizens and government through digital platforms.

According to the above analysis and the description in the finding chapters, this research has the second proposition:

P2: There are three forms of co-creation in SSC: co-design, co-delivery and co-delivery from customer perspective.

Compared to the current literature, this research proposed three types of co-creation which distinguish the co-design and co-delivery proposed from other research(Rodriguez Müller et al., 2021; Huang and Yu, 2019; Linders, 2012). According to the classification in the above table, these three types of co-creation belong to co-creation in service, attributing to the “s”, which is a specific current service.

9.3 Conditions of co-creation in SSC

In the chapter on conceptual development, this paper has discussed the existing literature on the research of conditions of co-creation. Compared with the research on co-creation condition in other literatures, our research provides a more comprehensive, detailed and systematic interpretation of co-creation condition. From the above table 3.2.2 and table 3.2.3, other researchers only focus on one or one aspect of the conditions in co-creation failing in the comprehensive summary of

conditions. And as this research is based on the co-creation in the whole process of service delivery, this research is able to summarize the conditions including co-design, co-coordinate, and co-manage from a higher and more comprehensive perspective with regarding to the factors from cutsomers, suppliers, social institutions and digitalizations.

Compared to the literatures in discussing the conditions of co-creation, social support and patient requirements had been discussed by this study and other literatures (Coulter et al., 2013; Barrutia and Gilsanz, 2013; Yao et al., 2015; Pham et al., 2022). It can be found from Table 3.2.2 and Table 3.2.3 that other literature about co-creation conditions is basically distributed in the aspect of patient requirements (Nutbeam and Lloyd, 2021;Coulter et al., 2013). Very few studies have successfully taken the social support and supplier requirements into account. The research on social support and supplier requirements in these literatures is also one-sided and unsystematic (Payne et al., 2008; Yao et al., 2015). Among them, only Payne et al, (2008) tried to analyze the co-creation process and co-creation conditions from the two perspectives of customer and supplier. My model on conditions of co-creation not only considers requirements from customers and suppliers, but also factors such as digital technology, digital support, social support, and social policy in co-creation.

Reference	Co-creation Factors
To customer	
(Fawcett et al., 2014)	Sharing experiences
(Kao et al., 2016)	emotional engagement, knowledge sharing and
(Prahalad and Ramaswamy, 2004)	Dialogue, access, risk assessment
(Payne et al., 2008)	Emotion, Cognition, Behavior
(Le et al., 2022)	customers' knowledge
To supplier	
(Payne et al., 2008)	Providing co-creation opportunity, planning, implementation and metrics
(Kao et al., 2016)	Positive surprise

Table 3.2.2: Co-creation factors

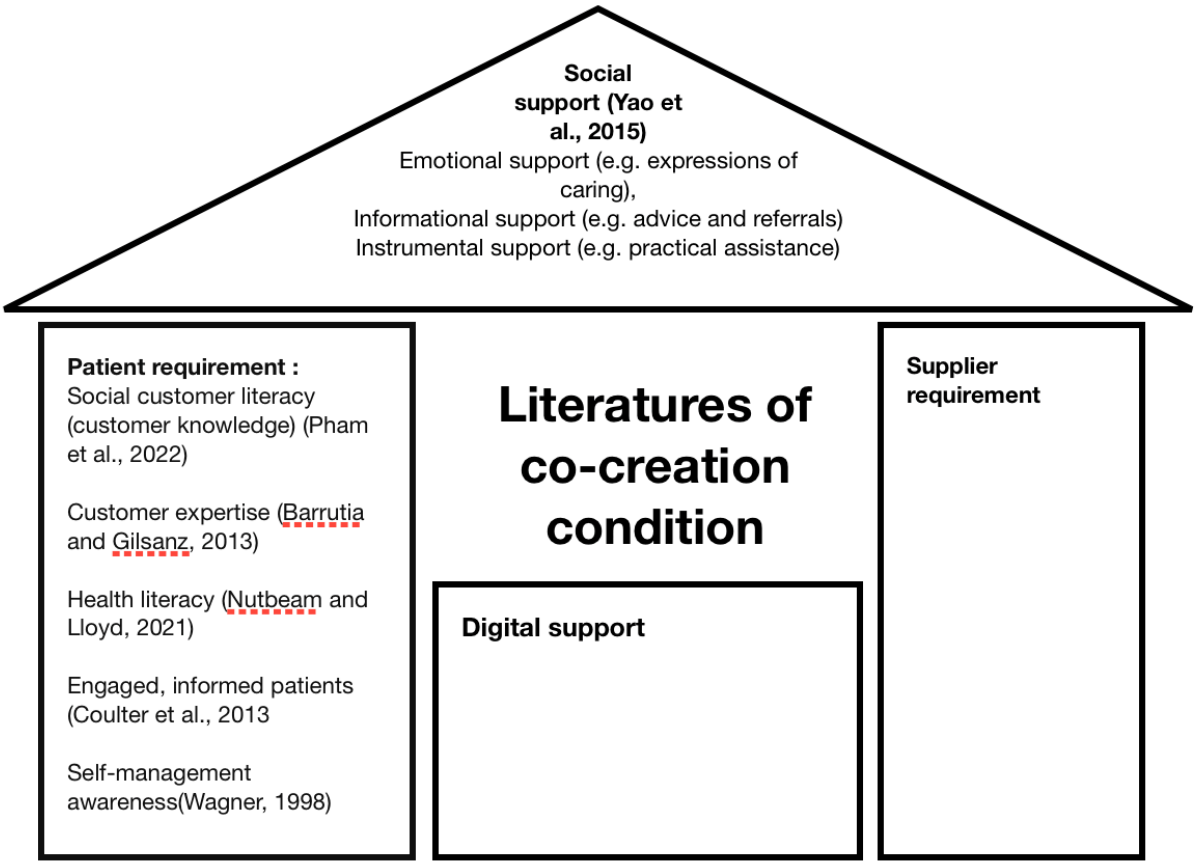

Figure 3.2.3: literature of co-creation conditions model

While noting the social support and patient requirements in co-creation conditions, this study also noted the important role of supplier requirements and digital support in co-creation, which is different from the literature mentioned above. The main reasons why this study's findings are richer and more comprehensive than other literature are as follows: 1. This study studies the co-creation phenomenon in the service supply chain. Therefore, this study will not only focus on the customer but also pay attention to the supplier's contribution to co-creation. 2. This study studies co-creation in the context of digitalization. Therefore, this study found the role of digital technology in promoting co-creation and the importance of digital support for co-creation conditions.

According to the contents of the model of conditions of co-creation in the above chapters for co-design， co-delivery and co-delivery from the customer perspective, we can claim our propositions in the following aspects:

P3： *The joint efforts from customers, service providers and digital support and social support are needed to achieve co-creation in SSC*

In terms of the model of “conditions of co-creation“, this model is effective in identifying the co-creation phenomenon in the service supply chain because

1) the model of "conditions of co-creation" is able to define the co-creation as a state in a specific situation and show this state of the patient, supplier and other stakeholders in more detail.

2) the model of “conditions of co-creation” is able to present the requirements from different parts of the service supply chain when the customer co-creation occur.
3) the model of “conditions of co-creation” conforms to the new understanding of service that service is not a product but a process, a collection of various resources. In this way, the role of the patient in the service supply chain is not helping to deliver the service “product”, but achieving its own benefits and goals through external help and resources.
4) In the digital environment, the model of “conditions of co-creation” not only emphasizes the requirements required in digital support, but also emphasizes the coordination of digitalization in patient, supplier and social support in order to achieve co-creation . For example, the digital education, digital guidance are needed from service supplier to achieve co-creation, etc.

9.4 Digitalization in co-creation

In terms of the co-creation in the healthcare supply chain, there are three types of co-creation based on the digitalization in healthcare service supply chain with the research in orthodontics industry, internet hospital and chronic disease management. Compared with the traditional treatment, the application of digital technologies brings advantages to service supply chain which increase the service efficiency, quality and agility.

According to the chapters 5 & 6 & 7 & 8, the application of digital technologies greatly increases the interactivity in the process of healthcare service supply process, solves the problem of opacity brought to patients by traditional medical treatment due to the lack of professionalism of patients, and shortens the knowledge gaps between patients and professionals, and therefore enables patients

to participate, contribute, co-produce and co-create in the medical service supply chain to a greater extent. Therefore, we have the following proposition.

P4: *Digitalization in healthcare has a positive effect to facilitate the co-creation in healthcare service supply chain.*

For example, digital 3D scanning technology is able to give a full image of one's teeth and show the 3D image on their online platform. The built-in brushing software camera scans the images, then connects the APP to a mobile phone, and provides suggestions to guide the customers. There is also artificial intelligence to help patients with chronic diseases in their daily medication, diet, etc.. The above examples manifest that digital technologies can help promote co-creation by increasing the interactivity and visibility of healthcare treatments in HSSC.

These situation help to increase the Interactivity and visibility during the treatment. This makes it easier for customers to understand the treatment process, and "see" the treatment process with assistance of digital technologies and AI. It reduces the distance between patients and professional education. Therefore, patients have more opportunities to participate in providing advice and even co-design for their own diagnosis and treatment plans. Similarly, further improvements in interactivity and visualization are also a way forward to further improve the quality of care and enhance co-creation with patients.

The development of digital platforms reduces the physical distance to ”see a doctor“ and enables telemedicine. At the same time, it reduces the slow "in-hospital" communication and increases the

rapid "out-of-hospital" communication, which reduces the burden of the hospital and makes patients active "outside the hospital”

In addition, the medical industry has certain peculiarities with respect to the patient contribution. Because in the medical process, it is often the individual patient who receives the service. At the same time, the result of the service is directly linked to the patient's personal health, which makes the medical industry naturally require the participation of the patient compared to other service industries. Because of the concern for their own illness, patients are more likely to assume more roles in the service process to ensure that they can receive high-quality services.

9.5 service operation in PCC

The ground of this part of the contribution is bases on the healthcare system and delivery dilemmas and digital transformation happened in current healthcare industry in PCC, which lead to problems on how to implement the practice of the patient-centered care and telehealth(WHO, 2016; Papanicolas et al., 2018; Granström et al.,2020; Öberg et al.,2018; Patrício et al.,2020; Garagiola et al., 2020). Solutions have been discussed in the area of digitalization and service management which have been introduced in the chapter literature review(Kellermann and Jones, 2013; Roehrs et al.,2017; Zhou et al.2019; Deloitte, 2019; Patrício et al.,2020; Borja, 2017; Huetten et al., 2019).

About the PCC solution from service and service operation research, Patrício and his colleagues (2020) tried to associate PCC to service design and give solutions for PCC practice by leveraging service design. They concluded three approaches of service innovation to achieve PCC which are

human-centered participation approach, digitalization approach and service system approach. It is the first to propose a way to assist PCC in the field of service management.

Compared to the current literatures, in this research, the contribution to this part is mainly reflected in finding chapter-co-delivery from customer perspective. In Chapter 8, this paper discusses 1) patient co-delivery behaviour, which enables patients to provide knowledge and information exchange for different medical institutions during the treatment of comorbidities. 2) Internet hospitals and digital platforms provide patients with digital support for co-delivery in the process of daily care and daily management of chronic diseases. 3) Patients who need data monitoring can improve the efficiency of medical data monitoring and the quality of health self-management through co-delivery and digital wearables. Therefore, this research has the proposition:

P5：*Co-creation in SSC with digitalization positively affects the provision of patient-centered care.*

Compared to the above works of literature (Papanicolas et al., 2018; Granström et al.,2020; Patrício et al., 2020), scholars had the same claim to this research which they and this study all agree that the digitalization in co-creation could help the PCC provision. They discussed this problems in the research area of “healthcare management” and “service design”, while this study explored and proved this from the perspective of service supply chain management.

With this proposition, this research fills the gap and provides a patient-centred care practice through the perspective of service supply chain management by exploring the digital transformation of co-delivery from the customer perspective between patient and service suppliers. In this situation,

patients are recognized as the centre of the service supply chain and co-delivery of information, knowledge and materials for circular suppliers.

CHAPTER 10: CONCLUSION

The ultimate segment of this study references the dialogues presented in chapter 9 to address research gaps and propose research contributions related to co-creation within the service supply chain and its corresponding implications for practical application. This particular phase of study aims to evaluate the influence of research on the field of operations management, both in terms of theory and practice.

10.1 Key Contributions to Knowledge

This part of the writing provides a summary of conclusions reached in answering the study's research question:

Q1: What types of co-creation occurred with the application of digital technologies in the service supply chain?

Q2: What are the conditions for various types of co-creation under digitalization?

Q3: How does the co-creation in SSC in the healthcare industry under digitalization influence the achievement of patient-centered care?

According to the analysis of chapter discussion, This research mainly answers the above research questions from five aspects

10.1.1 Co-creation in SSCM

This research contributes to the concept of co-creation in SSCM. Through the analysis of the first part of the chapter discussion, this research clearly distinguishes the current co-creation research in three aspects: SSC type in co-creation, co-creation result and co-creation position in SSC and also posits this research. In SSC, this research clearly defines and explores co-creation, making co-creation research more detailed at the operational level.

10.1.2 Types of co-creation

This research also explore the explain three types of co-creation in SSC in healthcare industry. These three forms of co-creation in SSC answer the first research question of this paper. It answers the first research question from the following four aspects. Firstly, it proposes and describes three types of co-creation in SSC and the operation process of these three types of co-creation. In order to analyze the operation process of co-creation, it adopts the blueprint analysis methodology. Then, this research analyzes the advantages and challenges of three types of co-creation. In the SSC, our empirical findings expounds the digital technology needed in every type of co-creation and analyzes how digital technology promotes co-creation and makes co-creation. In addition, this research introduces the objects of customer and service provider in the process of co-design and co-delivery. In co-design, the objects are treatment plan and teeth arrangement design, while the objects of co-delivery are information, resources, knowledge, materials, etc.

10.1.3 Conditions of co-creation in SSC

Regarding the second research question of this paper, the empirical findings established the "conditions of co-creation" model for the three types of co-creation in SSC to analyze the

conditions of co-creation in SSC. They mainly answer the second research question from the following three aspects. Firstly, it divides the conditions of co-creation into four aspects: policy and social requirement, patient requirement, suppliers requirement and digital support. The model of "conditions of co-creation" structurally answers the second research question. Then, the empirical findings listed the specific conditions required for co-creation from the above four aspects according to data analysis, which answered the second research question in terms of content. In addition, it lists the stakeholders involved in each of the four aspects. Government departments, social medical insurance, and social environment are involved in policy and social requirement. The patient is involved in the patient requirement. Hospitals, Internet hospitals, digital healthcare companies, and doctors are involved in the suppliers requirement. Digital technology manufacturers and suppliers are involved in digital support.

10.1.4 Digitalization in service supply chain

This study makes a detailed and in-depth analysis on the types of digitalization, its effects on services and the significance of stakeholders involved in the service supply chain. First of all, this study lists the current digital technologies related to co-creation in the field of medical services and the role of these digital technologies. Secondly, in the context of specific conditions and healthcare Settings, this study focuses on exploring how these digital technologies influence and promote co-creation in service delivery. In this process, this study also points out the digital transformation involved from four aspects: patient, government, supplier and digital technology.

10.1.5 PCC and service supply chain management

With the increasing demand for medical quality in the world, how to provide and improve PCC has become an important topic in the field of medical and healthcare operations. This research explores and explains the service operation mode suitable for PCC from the perspective of service operation and co-creation. It argued that the co-creation in SSC has a positive effect on the achievement of patient-centred care. In Chapter 8, this study introduces the form of co-creation of co-delivery from a customer's perspective and explains how co-delivery under digitalization works in PCC provision under different medical situations.

10.1.6 Summary of contributions

According to the above, this study has five aspects of contributions in theories: distinguish and define the co-creation in SSCM, explore and explain three types of co-creation, create a model of "conditions of co-creation", explore conditions of three types of co-creation in SSC in four aspects, analyze the digitalization in SSC with co-creation, analyze service supply chain management practice to patient-centered care. This study summarizes the specific contributions of each part in different fields in the following table 10.1.1.

Contributions/ Areas of theory	**Service supply chain management**	**Co-creation theory**	**Healthcare management**

Co-creation in SSCM	Define co-creation and distinguish co-creation from other similar concepts in three aspects: SSC type in co-creation, co-creation result and co-creation position in SSC	Give clearly explanations and explore the “co-creation” in the field of service operation. Distinguish the “co-creation” in service operation from other area like marketing, service management…..	
Types of co-creation	Claim three types of co-creation regarding the features of service supply chain: co-design, co-delivery in SSC from service provider’s perspective, co-delivery in SSC from customer perspective.		This study provides implications for healthcare management in digital transformation from the perspective of service operation. In digital health, the analysis of this study is presented in a more detailed operational level, which is rare in the study of digital health services.
Conditions of co-creation in SSC	This study innovatively proposed the conditions of supplier requirement in the conditions of co-creation in SSC, which supplemented the issue of co-creation conditions from the perspective of SSC in SSCM research.	This study claim four aspects of conditions for co-creation. Compared with other literatures, this study improves the research on patient requirement and social support, and innovatively adds research on digital support and supplier requirement.	
Digitalization in service supply chain	co-creation is the biggest feature that distinguishes service supply chain from manufacturing supply chain. From the perspective of co-creation, this study profoundly demonstrates the transformation in the current service supply chain (the emergence and development of co-design and co-delivery) based on digital technologies application.		

PCC and service supply chain management			This study provides solutions for implementing PCC from the perspective of service supply chain management with digitalization while other researchers study this in the areas of service design, health management...

Table 10.1.1 Summary of Contributions

10.2 Suggestions to Practice

The current business and service delivery clarified in the literature review are about the urgent need for co-creation. These demands mainly come from two aspects. The first aspect comes from service providers. In today's aging society, the demand and quality of medical services are a big challenge. For service providers, co-creation with patients is a good way to improve their service quality without adding more manpower. Even in many scenarios (such as digital orthodontic), co-creation with customers can greatly reduce the clinic's employment cost, which realizes cost reduction with the dual assistance of digitalization and co-creation. On the other hand, comes from the patient. Due to the rapid development of digital technology, patients are gradually becoming interested in participating in the service process. Through a variety of digital platforms, patients can understand

their own data and doctor's advice in real-time. This makes patients' demand for co-creation more and more intense.

With the above two aspects coming from the market demand, this thesis researches and analyzes the co-creation phenomenon in SSC and gives co-creation suggestions for current medical organizations. Especially in the current stage of rapid development of digital medical care in China, this paper provides cases, experience and theoretical support for the development of online medical platforms and the operation mode of co-creation. Online platforms can rely on this study's co-design and co-delivery models to find their development direction. In addition, the conditions of the co-creation model in this thesis also help online medical platforms understand the operation mode of co-creation and find the direction of future development according to these conditions. Additionally, this study discusses the question of how the healthcare institution builds their supply chain around the patient to achieve the goal of patient-centered care and how they utilize digital technologies to assist their construction of a patient-centred supply chain. It is able to help public healthcare institutions Understand and build the co-creation operation model to improve the quality and personalization of medical services.

For developing a digital platform, this study gives suggestions according to the “digital support” part of the models of “conditions of co-design”, “conditions of co-delivery”, and “conditions of co-delivery from CPSSC.” Specifically, healthcare service providers are advised to use and build digital platforms to build connections with patients. Besides, this study also suggests that service providers link online connections to offline hardware to monitor health data and provide high-quality healthcare service. For example, the service providers can design their service by integrating

digital wearable equipment and cellphone cameras for data monitoring. It can greatly improve service efficiency, quality and competitiveness when developing a digital platform.

For the co-creation model with digitalization, both the service providers and patients are advised to collaborate in the healthcare service provision to co-create value. In the past, co-creation could not be easily achieved as healthcare service provision was almost always one-way at that time. This study explores and analyzes the co-creation phenomenon under the digital application and finds that digital development greatly enhances patient co-creation, which brings a lot of benefits to service providers and patients. Specifically, service providers are advised to upgrade their service supply chains which enable the patients to co-create and provide patient education and appropriate leading before services. service providers also need to construct the digital platform to gather doctor resources and diversified online service. For patients, patients are advised to receive patient education and fully understand the services which also need patients to be positive and insistent and responsible. Especially in digital orthodontics co-design, patients need to prepare for the co-design process to get the medical results they want most.

For the policy and social support, the government is advised to provide supervision in healthcare service provision under digitalization to protect data storage and dispersal. Besides, the government is also required to provide financial support. For example, expenses in Internet hospitals should be included in medical insurance like ordinary medical services to promote and encourage the development of convenient medical services. Finally, the government and propaganda departments are advised to increase the popularization of knowledge on early prevention and detection of common diseases. This will help the public increase their understanding of health knowledge, detect

diseases more quickly, and promote public participation in the process of early disease prevention and treatment.

10.3 Limitations and recommendations for further research

This study fills the gap in co-creation research in the service supply chain in the digital age by exploring three cases of digital orthodontics practice, digital chronic diseases management and primary care in internet hospitals and reviewing the existing literature, and provides an understanding of the service supply chain practice for patient-centered care. However, upon reflection, similar to any other study, the geographical location, context, and the research process - including the design and methods - presented challenges and limitations. Recognizing these limitations serves as the foundation for making recommendations, conducting further research, and moving forward.

This study was conducted in China under the Chinese digital healthcare service development in recent years, which is a relatively nascent digitalization context. However, since the healthcare service supply chain transformation caused by digital healthcare is a global phenomenon, it is wise to assume that the findings can be replicated in other settings. This is missing in this study, which brings the limitation that conclusions can be replicated in other countries and regions. Since China is a developing economy, it is also important for future research to examine the findings in less developed economy settings (parts of Africa) versus developed economies (the UK and the US). Validating and developing the conclusions of this study in different economic settings is a topic worth discussing in the future which will increase the confidence of service operation management experts in the findings.

This study uses the healthcare industry as an example to study the digital transformation of co-creation in the service supply chain. In the previous literature review chapter, this study pointed out that the healthcare industry has complexity, sensitivity, privacy and professionalism. However, since the co-creation phenomenon in the service supply chain is a phenomenon that exists in various fields of the service industry, whether the findings and conclusions of this study can bring inspiration to other service supply chains is the limitation of this study. Therefore, in future studies, it is necessary to compare the phenomenon of co-creation and the degree of digital application in the service supply chain in other service fields. This can help this study verify the findings and conclusions in different service fields. At the same time, in comparison with this study in the healthcare service industry, future research can explore more possibilities of co-creation in the service supply chain and contribute to the development of service operations.

List of References

Abernathy, W. J., and Utterback, J. M. (1978). “Patterns of Industrial Innovation,” Technology Review (80:7), pp. 40-47.

Abhari, K., Davidson, E. J., & Xiao, B. (2017). Co-innovation platform affordances: Developing a conceptual model and measurement instrument. Industrial Management & Data Systems, 117(5), 873–895. https://doi.org/10.1108/IMDS-05-2016-0156.

Ahmed, F. and Foster, G.R. (2010), “Global hepatitis, migration and its impact on Western healthcare”, Gut, Vol. 59 No. 8, pp. 1009-1011.

Aitken, J., Childerhouse, P., Deakins, E. and Towill, D. (2016), “A comparative study of manufacturing and service sector supply chain integration via the uncertainty circle model”, The International Journal of Logistics Management, Vol. 27 No. 1, pp. 188-205.

Al-Omoush, K. S., de Lucas, A., & del Val, M. T. (2023). The role of e-supply chain collaboration in collaborative innovation and Value-Co Creation. Journal of Business Research, 158, 113647. doi: 10.1016/j.jbusres.

Alzaydi, Z. M., Al-Hajla, A., Nguyen, B., & Jayawardhena, C. (2018). A review of service quality and service delivery. Business Process Management Journal, 24(1), 295–328. http://doi.org/10.1108/bpmj-09-2016-0185

Amorim, M., Moscoso, P., & Lago, A. (2015). Customer participation in services: a framework for process design. International Journal of Qualitative Research in Services, 2(1), 47. http://doi.org/10.1504/ijqrs.2015.069781

Anderson, S., Nasr, L. and Rayburn, S.W. (2018), “Transformative service research and service design: synergistic effects in healthcare”, Service Industries Journal, Vol. 38 Nos 1-2, pp. 99-113.

Anthony Jnr, B. (2020). Implications of telehealth and digital care solutions during COVID-19 pandemic: a qualitative literature review. Informatics for Health and Social Care, 46(1), 68–83. http://doi.org/10.1080/17538157.2020.1839467

Ardolino, M., Rapaccini, M., Saccani, N., Gaiardelli, P., Crespi, G., & Ruggeri, C. (2017). The role of digital technologies for the service transformation of industrial companies. International Journal of Production Research, 56(6), 2116–2132. http://doi.org/10.1080/00207543.2017.1324224

Arlbjørn, J.S., Freytag, P.V. and de Haas, H. (2011), “Service supply chain management: a survey of lean application in the municipal sector”, International Journal of Physical Distribution & Logistics Management, Vol. 41 No. 3, pp. 277-295.

Aujoulat, I., Marcolongo, R., Bonadiman, L., Deccache, A., 2008. Reconsidering patient empowerment in chronic illness: a critique of models of self-efficacy and bodily control. Soc Sci Med 66 (5), 1228–1239.

Barras, R. 1986. “Towards a Theory of Innovation in Services,” Research Policy (15), pp. 161-173.

Barras, R. 1990. “Interactive Innovation in Financial and Business Services: The Vanguard of the Service Revolution,” Research Policy (19), pp. 215-237.

Baltacioglu, T., Ada, E., Kaplan, M. D., Yurt, O., & Kaplan, Y. C. (2007). A new framework for service supply chains. The Service Industries Journal, 27(2), 105–124.

Barjis, J. (2011), “Healthcare simulation and its potential areas and future trends”, SCS MandS Magazine, Vol. 2 No. 5, pp. 1-6.

Bates DW, Wells S. Personal health records and health care utilization. J Am Med Assoc 2012 Nov 21;308(19):2034-2036. [doi: 10.1001/jama.2012.68169] [Medline: 23168828]

Barrutia, J.M. and Gilsanz, A. (2013), “Electronic service quality and value: do consumer knowledge-related resources matter?”, Journal of Service Research, Vol. 16 No. 2, pp. 231-246.

Bagheri, S., Kusters, R. J., & Trienekens, J. J. M. (2016). An integrated framework of knowledge transfer and ICT issues in co-creation value networks. Procedia Computer Science, 100, 677–685. https://doi.org/10.1016/j.procs.2016.09.211.

Batalden, M., Batalden, P., Margolis, P., Seid, M., Armstrong, G., Opipari-Arrigan, L., & Hartung, H. (2015). Coproduction of healthcare service. BMJ Quality & Safety, 25(7), 509–517. http://doi.org/10.1136/bmjqs-2015-004315

Barrett, M., Davidson, E., Prabhu, J., & Vargo, S. L. (2015). Service innovation in the digital age: Key contributions and future directions. MIS Quarterly, 39(1), 135–154. http://doi.org/10.25300/misq/2015/39:1.03

Bechtsis, D., Tsolakis, N., Vlachos, D., Iakovou, E., 2017. Sustainable supply chain management in the digitalisation era: the impact of Automated Guided Vehicles. J Clean Prod 142, 3970–3984. https://doi.org/10.1016/j.jclepro.2016.10.057.

Benitez, J.M., Mart´ın, J.C. and Roma´n, C. (2007), “Using fuzzy number for measuring quality of service in the hotel industry”, Tourism Management, Vol. 28, pp. 544-55.

Beaulieu, M., Roy, J., Landry, S., 2018. Outsourcing logistics activities in the health sector: lessons from a Canadian experience. Canadian J. Administrative Sci. 35 (4), 68–82. https://doi.org/10.1002/cjas.1469.

Bergerum C, Thor J, Josefsson K, Wolmesjö M. How might patient involvement in healthcare quality improvement efforts work—a realist literature review. Health Expect. 2019;22(5):952–64.

Bhat, A. (2023). Research design: What it is, Elements & Types. Retrieved from https://www.questionpro.com/blog/research-design/#what_is_research_design?

Blaikie, N. (2007) Approaches to social enquiry: Advancing knowledge. Polity.

Boyaci, T., & Gallego, G. (2004). Supply chain coordination in a market with customer service competition. Production and Operation Management, 13(1), 3–22.

Bowles KH, Baugh AC. Applying research evidence to optimize telehomecare. J Cardiovasc Nurs 2007; 22: 5.

Bovaird, (2007) Beyond engagement and participation: User and community co-production of public services. Public Adm. Rev. 67, 846–860

Borja, M. (2017). Smart Human-Centered Service Systems of the Future, Alexandra Medina-Borja, Program Director, NSF. In Future services & societal systems in society 5.0: held on Monday, November 7, 2016 (pp. 159–175). essay, Tokyo: Systems/Information Science and Technology Unit, Center for Research and Development Strategy, Japan Science and Technology Agency.

Boon-itt, S., Wong, C.Y. and Wong, C.W. (2017), “Service supply chain management process capabilities: Measurement development”, International Journal of Production Economics, Vol. 193 No. 1, pp. 1-11.

Boyer, K.K. and Swink, M.L. (2008) Empirical elephants—why multiple methods are essential to quality research in operations and supply chain management. Journal of Operations Management, 26: (3): 338-344.

Borges, G.A., Tortorella, G., Rossini, M., Portioli-Staudacher, A., 2019. Lean implementation in healthcare supply chain: a scoping review. J Health Organ Manag 33 (3), 304–322. https://doi.org/10.1108/JHOM-06-2018-0176.

Bryson, J., Daniels, P., and Warf, B. 2004. Service Worlds: People, Organizations, and Technologies, London: Routledge.

Brodie, R.J., Hollebeek, L.D., Ilic, A. & Juric, B. (2011), Customer Engagement: Conceptual Domain, Fundamental Propositions & Implications for Research in Service Marketing, Journal of Service Research, 14 (3).

Brandsen, T., and M. Honingh. 2016. “Distinguishing Different Types of Co-Production: A Conceptual Analysis Based on the Classical Definitions.” Public Administration Review 76 (3): pp. 427–435. doi:10.1111/puar.12465.

Bresciani, S., Ciampi, F., Meli, F., & Ferraris, A. (2021). Using big data for co-innovation processes: Mapping the field of data-driven innovation, proposing theoretical developments and providing a research agenda. International Journal of Information Management, 60, 102347. http://doi.org/10.1016/j.ijinfomgt.2021.102347

Britten, N., Ekman, I., Naldemirci, Ö., Javinger, M., Hedman, H., & Wolf, A. (2020). Learning from Gothenburg model of person centred healthcare. BMJ, m2738. http://doi.org/10.1136/bmj.m2738

Burton, L. (2018, February 23). Person-Centred Care Guidance. Retrieved April 2, 2021, from https://www.highspeedtraining.co.uk/hub/what-is-person-centred-care/

Burton-Jones, A., Akhlaghpour, S., Ayre, S., Barde, P., Staib, A., & Sullivan, C. (2020). Changing the conversation on evaluating digital transformation in healthcare: Insights from an institutional analysis. Information and Organization, 30(1), 100255. http://doi.org/10.1016/j.infoandorg.2019.100255

Bulmer, M. (2021). Types of research utilization: An overview. Social Science and Social Policy, 63–79. doi:10.4324/9781003246299-6

Cao, Z., Huo, B., Li, Y. and Zhao, X. (2015), “The impact of organizational culture on supply chain integration: a contingency and configuration approach”, Supply Chain Management: An International Journal, Vol. 20 No. 1, pp. 24-41.

Cai, S., Jun, M. and Yang, Z. (2017), “The effects of boundary spanners’ personal relationships on interfirm collaboration and conflict: a study of the role of guanxi in China”, Journal of Supply Chain Management, Vol. 53 No. 3, pp. 19-40.

Chen, S., Kang, J., Liu, S., & Sun, Y. (2019). Cognitive computing on unstructured data for customer co-innovation. European Journal of Marketing, 54(December), 570–593. https://doi.org/10.1108/EJM-01-2019-0092.

Charmaz, Kathy C. (2006) Constructing Grounded Theory: A Practical Guide through Qualitative Analysis. London: SAGE.

Chang, H., and M. Choi. 2016. “Big Data and Healthcare: Building an Augmented World.” Healthcare Informatics Research 22 (3): 153–155.

Christopher, M., 1998. Logistics and Supply Chain Management. Prentice Hall, London.

China Net News. Dialogue with Lu Qingjun, an expert from the National Health Commission: the role, opportunity and direction of "public Internet hospitals". Retrieved February 20, 2022, from http://china.36kr.com/p/854846158773123?column=%E6%9C%80%E6%96%B0&navId=8

Chernonog, T., & Levy, P. (2023). Co-creation of mobile app quality in a two-platform supply chain when platforms are asymmetric. European Journal of Operational Research, 308(1), 183–200. doi: 10.1016/j.ejor.2022.11.019

Coulter A, Roberts S, Dixon A. Delivering better services for people with long-term conditions: building the house of care. London, UK: Kings Fund, 2013.

Creswell, J.W. (2013) Research design: Qualitative, quantitative, and mixed methods approaches. Sage Publications, Incorporated.

Creazza, A., Colicchia, C., Spiezia, S., & Dallari, F. (2021). Who cares? Supply Chain Managers' perceptions regarding cyber supply chain risk management in the Digital Transformation Era. Supply Chain Management: An International Journal, 27(1), 30–53. doi:10.1108/scm-02-2020-0073

Czuszynski K, Ruminski J, Kocejko T, Wtorek J (2015) Septic safe interactions with smart glasses in health care. In 2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC) (pp. 1604–1607). IEEE.

Damanpour, F., Walker, R. M., and Avellaneda, C. N. (2009). "Combinative Effects of Innovation Types and Organizational Performance: A Longitudinal Study of Service Organizations," Journal of Management Studies (46:4), pp. 650-675.

Deloitte (2019), 2019 Global Health Care Outlook, Vol. 2019, available at: https:// www2.deloitte.com/ content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/gx-lshc-hc-outlook-2019.pdf .

Deloitte (2020), Digital transformation: Shaping the future of European healthcare, Vol. 2020, available at https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/public-sector/deloitte-nl-shaping-the-future-of-european-healthcare.pdf .

Deetz, S. (1996) Crossroads—Describing Differences in Approaches to Organization Science: Rethinking Burrell and Morgan and Their Legacy. Organization science, 7: (2): 191-207.

Easterby-Smith, M., Thorpe, R. and Lowe, A. (2002) Management research: An Introduction. London: Sage Publications.

European Commission (2018), The 2018 Ageing Report: Underlying Assumptions and Projections, Vol. 2019.

Edvardsson, B., Gustafsson, A. and Roos, I. (2005), “Service portrays and service constructions – a critical review through the lens of the customer”, International Journal of Service Industry Management, Vol. 16 No. 1, pp. 107-21.

Edelmann, N., & Mergel, I. (2021). Co-production of Digital Public Services in austrian public administrations. Administrative Sciences, 11(1), 22. http://doi.org/10.3390/admsci11010022

Eseonu, T. (2021). Co-creation as Social Innovation: Including ‘hard-to-reach’ groups in Public Service Delivery. Public Money & Management, 42(5), 306–313. http://doi.org/10.1080/09540962.2021.1981057

Etgar, M. (2008), “A descriptive model of the consumer co-production process”, Journal of the Academy of Marketing Science, Vol. 36 No. 1, pp. 97-108.

Fawcett, A.M., Fawcett, S.E., Bixby Cooper, M. and Daynes, K.S. (2014), “Moment of angst”, Benchmarking: An International Journal, Vol. 21 No. 3, pp. 450-480.

Fatodu, O. O., & Feizabadi, J. (2015). Implications of customer roles in engineer-to-order service supply chain. International Journal of Logistics Systems and Management, 22(3), 350. http://doi.org/10.1504/ijlsm.2015.072287

Farquhar, J. D. (2012). Case study research for business. Los Angeles, CA: Sage.

Flint, D. J., & Mentzer, J. T. (2006). Striving for integrated value chain management given a service-dominant logic for marketing. In R. F. Lusch & S. L. Vargo (Eds), The service dominant logic of marketing: Dialog, debate and directions (pp. 139–149). Armonk, NY: M.E. Sharpe.

Forza, C. (2002) Survey research in operations management: a process-based perspective. International journal of operations & production management, 22: (2): 152-194.

Fonferek, K.-M., Kleinaltenkamp, M., & Möller, J. (2019). Customer Engagement in the Process of Service Provision. Journal of Service Management Research, 3(1), 12–23. http://doi.org/10.15358/2511-8676-2019-1-12

Free C, Phillips G, Watson L, Galli L, Felix L, et al. (2013) The Effectiveness of Mobile-Health Technologies to Improve Health Care Service Delivery Processes: A Systematic Review and Meta-Analysis. PLoS Med 10(1): e1001363. doi:10.1371/journal.pmed.1001363

Frow, P., McColl-Kennedy, J.R. and Payne, A. (2016), “Co-creation practices: their role in shaping a healthcare ecosystem”, Industrial Marketing Management, Vol. 56, pp. 24-39.

Fry, J., Light, D., Rodnick, J., & Orton, P. (2018). The UK Health Care System. Reviving Primary Care, 23–37. http://doi.org/10.1201/9781315376592-3

Fugini, Mariagrazia, and Mahsa Teimourikia. 2016a. The Role of ICT in Co-Production of e-Government Public Services. Co-Production in the Public Sector, 119–39.

Fugini, Mariagrazia, and Mahsa Teimourikia. 2016b. Co-production in Healthcare: Moving Patient Engagement Towards a Managerial Approach. Co-Production in the Public Sector, Chapter 6.

Fugini, Mariagrazia, and Mahsa Teimourikia. 2016c. The Participatory Budgeting as a Form of Co-production. Co-Production in the Public Sector, Chapter 3.

Gallouj, F. (1998). Innovating in reverse: Services and the reverse product cycle. European Journal of Innovation Management, 1(3), 123–138. http://doi.org/10.1108/14601069810230207

Gallouj, F. 2002. Innovation in the Service Economy: The New Wealth of Nations, Northhampton, MA: Edward Elgar Pub- lishing, Inc.

Garagiola, E., Creazza, A., Porazzi, E., 2020. Literature review of managerial levers in primary care. J Health Organ Manag 34 (5), 505–528.

Gill PS. Patient Engagement: An investigation at a primary care clinic. Int J Gen Med 2013;6:85-98.

Gong, M., Gao, Y., Koh, L., Sutcliffe, C., & Cullen, J. (2019). The role of customer awareness in promoting firm sustainability and sustainable supply chain management. International Journal of Production Economics, 217, 88–96. http://doi.org/10.1016/j.ijpe.2019.01.033

Grajales FJ III, Sheps S, Ho K, NovakLauscher H, Eysenbach G. Social media: a review and tutorial of applications in medicine and health care. J Med Internet Res 2014; 16: e13.

Granström, E., Wannheden, C., Brommels, M., Hvitfeldt, H., & Nyström, M. E. (2020). Digital tools as promoters for person-centered care practices in chronic care? Healthcare professionals' experiences from rheumatology care. BMC Health Services Research, 20(1). http://doi.org/10.1186/s12913-020-05945-5

Gronroos, C. (1994), "From scientific management to service management: a management perspective for the age of service competition", International Journal of Service Industry Management, Vol. 5 No. 1, pp. 5-20.

Gronroos, C. (2008), "Service logic revisited: who creates value? And who co-creates?", European Business Review, Vol. 20 No. 4, pp. 298-314.

Gronroos, C. (2012), "Conceptualising value co-creation: a journey to the 1970s and back to the future", Journal of Marketing Management, Vol. 28 No. 13-14, pp. 1520-1534.

Gronroos, C. and Voima, P. (2013), “Critical service logic: making sense of value creation and co-creation”, Journal of the Academy of Marketing Science, Vol. 41 No. 2, pp. 133-150.

Gustafsson, A., Kristensson, P., & Witell, L. (2012). Customer co−creation in service innovation: A matter of communication? Journal of Service Management, 23(3), 311–327. http://doi.org/10.1108/09564231211248426

Guba, E.G. and Lincoln, Y.S. (1994) Competing paradigms in qualitative research. Handbook of qualitative research, 2: 163-194.

Hakim AA, Kellish AS, Atabek U, Spitz FR, Hong YK. Implications for the use of telehealth in surgical patients during the COVID-19 pandemic; 2020.

Henfridsson, O., and Bygstad, B. 2013. “The Generative Mechanisms of Digital Infrastructure Evolution,” MIS Quarterly (37:3), pp. 907-931.

Healy, M. and Perry, C. (2000) Comprehensive criteria to judge validity and reliability of qualitative research within the realism paradigm. Qualitative market research: An international journal, 3: (3): 118-126.

Hemilä, J. and Vilko, J. (2015), “The development of a service supply chain model for a manufacturing SME”, The International Journal of Logistics Management, Vol. 26 No. 3, pp. 517-542.

Healthcare innovation network, S.L. (2016). what is person-centred care and why is it important? Retrieved April 1, 2021, from https://healthinnovationnetwork.com/system/ckeditor_assets/attachments41what_is_personcentred_care_and_why_is_it_important.pdf

Hernandez, S.E., Conrad, D.A., Marcus-Smith, M.S., Reed, P. and Watts, C. (2013), “Patient-centered innovation in healthcare organizations: a conceptual framework and case study application”, Healthcare Management Review, Vol. 38 No. 2, pp. 166-175.

He, T., Ho, W., Zhang, Y. and Dey, P. (2016). Organising the business processes of a product servitised supply chain: A value perspective. Journal of Production Planning and Control, vol. 27, no. 5, pp. 378-393. https://doi.org/10.1080/09537287.2015.1128571

Hitt, M.A., Xu, K. and Carnes, C.M. (2016), “Resource based theory in operations management research”, Journal of Operations Management, Vol. 41 No. 1, pp. 77-94.
Hirschheim, R., & Klein, H.K. (2012). A Glorious and Not-So- Short History of the Information Systems Field, Journal of the Association for Information Systems, 14 (4), 188–235.

Holmen H, Torbjørnsen A, Wahl AK, Jenum AK, Smastuen MC, Arsand E, Ribu L. A mobile health intervention for self-management and lifestyle change for persons with Type 2 diabetes, part 2:

One-year results from the Norwegian randomized controlled trial RENEWING HEALTH. JMIR mHealth uHealth 2014; 2: 1–15.

Hollebeek, L. D., Glynn, M. S., & Brodie, R. J. (2014). Consumer brand engagement in social media: Conceptualization, scale development and validation. Journal of Interactive Marketing, 28(2), 149–165.

Hollebeek, L. D., Srivastava, R. K., & Chen, T. (2019). S-D logic–informed customer engagement: Integrative framework, revised fundamental propositions, and application to CRM. Journal of the Academy of Marketing Science, 47(1), 161–185. http://doi.org/10.1007/s11747-016-0494-5

Honingh, M., E. Bondarouk, and T. Brandsen. 2018. "Co-Production in Primary Schools: A Systematic Literature Review." International Review of Administrative Sciences. doi:10.1177/0020852318769143.

Huang, Biao, and Jianxing Yu. 2019. Leading Digital Technologies for Coproduction: The Case of "Visit Once" Administrative Service Reform in Zhejiang Province, China. Journal of Chinese Political Science 24: 513–32.

Huo, B. (2012), "The impact of supply chain integration on company performance: an organizational capability perspective", Supply Chain Management: An International Journal, Vol. 17 No. 6, pp. 596-610.

Huetten, A. S., Antons, D., F. Breidbach, C., Piening, E. P., & Salge, T. O. (2019). The impact of occupational stereotypes in human-centered service systems. Journal of Service Management, 30(1), 132–155. http://doi.org/10.1108/josm-12-2016-0324

Huy, Q.N. (2002), "Emotional balancing of organizational continuity and radical change: the contribution of middle managers", Administrative Science Quarterly, Vol. 47, pp. 31-69.

IPFCH (Institution for people, family-centered healthcare),2004. Patient- and Family-Centered Care. Retrieved June 9, 2021, from https://www.ipfcc.org/about/pfcc.html

Jacobs, Carl, Ulrike Rivett, and Musa Chemisto. 2018. Developing capacity through co-design: The case of two municipalities in rural South Africa. Information Technology for Development 25: 204–26.

Jaakkola, E., & Alexander, M. (2014). The role of customer engagement behavior in value co-creation. Journal of Service Research, 17(3), 247–261. http://doi.org/10.1177/1094670514529187

Johnson, B. H. & Abraham, M. R. (2012). Partnering with Patients, Residents, and Families: A Resource for Leaders of Hospitals, Ambulatory Care Settings, and Long-Term Care Communities. Bethesda, MD: Institute for Patient- and Family-Centered Care.

Johnson, P. and Duberley, J. (2000) Understanding management research: An introduction to epistemology. Sage.

Kao, T.Y., Yang, M.H., Wu, J.T.B. and Cheng, Y.Y. (2016), “Co-creating value with consumers through social media”, Journal of Services Marketing, Vol. 30 No. 2, pp. 141-151.

Kaplan, R.S. and Porter, M.E. (2011), “How to solve the cost crisis in health care”, Harvard Business Review, Vol. 89 No. 1, pp. 46-52.

Kellermann, A.L. and Jones, S.S. (2013), “What it will take to achieve the as-yet-unfulfilled promises of health information technology”, Health Affairs, Vol. 32 No. 1, pp. 63-68.

Kharas, H. (2017), “The unprecedent expansion of the global middle class: an update”, Global Economy and Development, Brookings, pp. 1-29, available at: https://www.brookings.edu/wp-content/ uploads/2017/02/global_20170228_global-middle-class.pdf.

Khorasani, S.T., Cross, J., Maghazei, O., 2020. Lean supply chain management in healthcare: a systematic review and meta-study. Int J. Lean Six Sigma 11 (1), 1–34. https://doi.org/10.1108/IJLSS-07-2018-0069.

Khan, S. and VanWynsberghe, R. (2008) "Cultivating the under-mined: Cross-case analysis as knowledge mobilization". Forum Qualitative Sozialforschung/Forum: Qualitative Social Research.

Klinker, K., Wiesche, M., & Krcmar, H. (2019). Digital Transformation in Health Care: Augmented Reality for Hands-Free Service Innovation. Information Systems Frontiers. http://doi.org/10.1007/s10796-019-09937-7

Kilay, A. L., Simamora, B. H., & Putra, D. P. (2022). The influence of E-payment and e-commerce services on Supply Chain Performance: Implications of Open Innovation and solutions for the digitalization of micro, small, and Medium Enterprises (msmes) in Indonesia. Journal of Open Innovation: Technology, Market, and Complexity, 8(3), 119. doi:10.3390/joitmc8030119

Kostopoulos, G., Gounaris, S., & Boukis, A. (2012). Service blueprinting effectiveness: Drivers of Success. Managing Service Quality: An International Journal, 22(6), 580–591. doi: 10.1108/09604521211287552

Kumar, V., & Pansari, A. (2015). Competitive advantage through engage- ment. Journal of Marketing Research . doi:10.1509/jmr.15.0044. In Press

Lau, A.K., Tang, E. and Yam, R. (2010), “Effects of supplier and customer integration on product innovation and performance: empirical evidence in Hong Kong manufacturers”, Journal of Product Innovation Management, Vol. 27 No. 5, pp. 761-777.

Lehtimäki, T., & Komulainen, H. (2021). Matching Co-innovation project types to diverse customer relationships: Perspective of an industrial technology supplier. International Journal of Innovation and Technology Management, 18(01), 2050048.

Le, H.N., Pham, T.A.N. and Pham, T.N. (2022), "The transformative outcomes of frontline employee adaptability for service value co-creation: a study of the banking sector", International Journal of Bank Marketing, Vol. 40 No. 3, pp. 401-424.

Lee, T. (2010), "Turning doctors into leaders", Harvard Business Review, Vol. 88 No. 4, pp. 50-58.

Lember, V., Brandsen, T., & Tõnurist, P. (2019). The potential impacts of digital technologies on co-production and co-creation. Public Management Review, 21(11), 1665–1686. http://doi.org/10.1080/14719037.2019.1619807

Leite H, Hodgkinson IR, Gruber T. New development: 'Healing at a distance'—telemedicine and COVID-19. Public Money & Manage. 2020;40(6):483–85. doi:10.1080/09540962.2020.1748855.

Liu, H., Wei, S., Ke, W., Wei, K.K. and Hua, Z. (2016), "The configuration between supply chain integration and information technology competency: a resource orchestration perspective", Journal of Operations Management, Vol. 44 No. 1, pp. 13-29.

Linders, Dennis. 2012. From e-government to we-government: Defining a typology for citizen coproduction in the age of social media. Government Information Quarterly 29: 446–54.

Lillrank, P., Groop, J., & Venesmaa, J. (2011). Processes, episodes and events in health service supply chains. Supply Chain Management: An International Journal, 16(3), 194–201. http://doi.org/10.1108/13598541111127182

Lovelock, C. H. (1983). Classifying Services to Gain Strategic Marketing Insights. Journal of Marketing, 47(3), 9–20. http://doi.org/10.1177/002224298304700303

Lucas, H. C. J., Agarwal, R., Clemons, E. K., El Sawy, O. A., & Weber, B. W. (2013). Impactful research on transformational information technology: An opportunity to inform new audiences. MIS Quarterly, 37(2), 371–382.

Luo, J. (G., Wong, I. K. A., King, B., Liu, M. T., & Huang, G. Q. (2019). Co-creation and co-destruction of service quality through customer-to-customer interactions. International Journal of Contemporary Hospitality Management, 31(3), 1309–1329. http://doi.org/10.1108/ijchm-12-2017-0792

Mainka, A., Castelnovo, W., Miettinen, V., Bech-Petersen, S., Hartmann, S., &Stock, W. G. (2016). Open innovation in smart cities: Civic participation and co- creation of public services. Proceedings of the Association for Information Science and Technology, 53(1), 1–5. https://doi.org/10.1002/pra2.2016.14505301006.

Maull, R., Geraldi, J. and Johnston, R. (2012), “Service supply chains: a customer perspective”, Journal of Supply Chain Management, Vol. 48 No. 4, pp. 72-86.

Marshall, M.N. (1996) Sampling for qualitative research. Family practice, 13: (6): 522-526.

Mathur, B., Gupta, S., Meena, M. L., & Dangayach, G. (2018). Healthcare supply chain management: literature review and some issues. Journal of Advances in Management Research, 15(3), 265–287. http://doi.org/10.1108/jamr-09-2017-0090

Markarian, J., 2019. Embracing the digital factory for Bio/Pharma manufacturing: new technologies enhance quality, efficiency, and flexibility. Pharml Technol. 43 (3), 16–21.

Ma, M., Li, Y., Gao, L., Xie, Y., Zhang, Y., Wang, Y., … Li, Y. (2023). Correction: The need for digital health education among next-generation health workers in China: A cross-sectional survey on digital health education. BMC Medical Education, 23(1). doi:10.1186/s12909-023-04613-6

McMullin, C., and C. Needham. 2018. “Co-Production in Healthcare.” In Co-Production and Co-Creation: Engaging Citizens in Public Services, edited by T. Brandsen, B. Verschuere, and T. Steen, 150–160. London: Routledge.

Mena, J., & Chabowski, B. (2015). The role of organizational learning in stakeholder marketing. Journal of the Academy of Marketing Science, 43(4), 429–452.

Mersha, T. (1990). Enhancing the customer contact model. Journal of Operations Management, 9(3), 391–405. http://doi.org/10.1016/0272-6963(90)90162-7

Miles, I. (2001). “Services Innovation: A Reconfiguration of Innovation Studies,” PREST Discussion Paper Series (No. 01-05), University of Manchester.

Miles, M.B., Huberman, A.M. and Saldana, J. (2014) Qualitative data analysis: A methods sourcebook. 3.California: Sage.

Miscione, G. 2007. “Telemedicine in the Upper Amazon: Inter- play with Local Health Care Practices,” MIS Quarterly (31:2), pp. 403-425.

Miles, I. 2008. “Patterns of Innovation in Service Industries,” IBM Systems Journal (47:1), pp. 115-128.

Miles I., Belousova V., Chichkanov N. (2017) Innovation Configurations in Knowledge-Intensive Business Services? Foresight and STI Governance, vol. 11, no 3, pp. 94–102. DOI: 10.17323/2500-2597.2017.3.94.102

Ministry of Health and Social Affairs: Patientlagen [the patient law] (2015) https://www.regeringen.se/rattsliga-dokument/lagradsremiss/2 014/01/patientlag/.

Moreau, C. P., & Herd, K. B. (2010). To each his own? how comparisons with others influence consumers' evaluations of their self-designed products. Journal of Consumer Research, 36(5), 806–819. http://doi.org/10.1086/644612

Morenza-Cinos, M., Casamayor-Pujol, V., Pous, R., 2019. Stock visibility for retail using an RFID robot. Int. J. Phys. Distribution Logistics Manage. 49 (10), 1020–1042. https://doi.org/10.1108/IJPDLM-03-2018-0151.

National Health Service: The Principles and values of the NHS in England (2011). https://www.hee.nhs.uk/about/our-values/nhs-constitutional-values- hub-0.

Nie, W., & Kellogg, D. L. (2009). How professors of operations management view service operations? Production and Operations Management, 8(3), 339–355. http://doi.org/10.1111/j.1937-5956.1999.tb00312.x

Niemöller, C., Metzger, D., Thomas, O. (2017). Design and evaluation of a smart-glasses-based service support system. 13th International Conference on Wirtschaftsinformatik, 2017, St. Gallen, Switzerland.

Noveck, B. S. 2015. Smart Citizens, Smarter State. The Technologies of Expertise and the Future of Governing. Cambridge, MA: Harvard University Press.

Nutbeam, D. and Lloyd, J.E. (2021), "Understanding and responding to health literacy as a social determinant of health", Annual Review of Public Health, Vol. 42 No. 1, pp. 159-173.

Nyende, Hawa, "The role of technology in value co-creation of maternal healthcare: A service-dominant logic perspective" (2018). Research Papers. 145.
https://aisel.aisnet.org/ecis2018_rp/145

O'Brien, Daniel Tumminelli, Dietmar Offenhuber, Jessica Baldwin-Philippi, Melissa Sands, and Eric Gordon. 2016. Uncharted Territoriality in Coproduction: The Motivations for 311 Reporting. Journal of Public Administration Research and Theory 27: 320–35.

Öberg, U., Orre, C. J., Isaksson, U., Schimmer, R., Larsson, H., & Hörnsten, Å. (2018). Swedish primary healthcare nurses' perceptions of using digital eHealth services in support of patient self-management. Scandinavian Journal of Caring Sciences, 32(2), 961–970. http://doi.org/10.1111/scs.12534

O'Connor, T., & Wong, H. Y. (2002). Emergent properties. Retrieved from https://plato.stanford.edu/archives/sum2015/entries/properties-emergent/

O'Driscoll, A., Daugelaite, J., & Sleator, R. D. (2013). 'Big data', Hadoop and cloud computing in genomics. Journal of Biomedical Informatics, 46(5), 774–781.

Olsson, E.M. (2016), "Interpersonal complaints regarding cancer care through a gender lens", International Journal of Health Care Quality Assurance, Vol. 29 No. 6, pp. 687-702.

Orlikowski, W. J., and Scott S. V. 2015. "The Algorithm and the Crowd: Considering the Materiality of Service Innovation," MIS Quarterly (39:1), pp. 201-216.

Park, I., Sarnikar, S. and Cho, J. (2020), "Disentangling the effects of efficacy-facilitating informational support on health resilience in online health communities based on phrase-level text analysis", Information & Management, Vol. 57 No. 8, p. 103372.

Papanicolas, I., Woskie, L.R. and Jha, A.K. (2018), "Health care spending in the United States and other high-income countries", JAMA - Journal of the American Medical Association, Vol. 319 No. 10, pp. 1024-1039.

Patrício, L., Sangiorgi, D., Mahr, D., Čaić, M., Kalantari, S., & Sundar, S. (2020). Leveraging service design for healthcare transformation: toward people-centered, integrated, and technology-enabled healthcare systems. Journal of Service Management, 31(5), 889–909. http://doi.org/10.1108/josm-11-2019-0332

Payne, Adrian F. ; Storbacka, Kaj ; Frow, Pennie (2008), "Managing the co-creation of value", Journal of the Academy of Marketing Science, 2008, Vol.36 (1), p.83-97

Petri, J. and Jacob, F. (2016), "The customer as enabler of value (co)-creation in the solution business", Industrial Marketing Management, Vol. 56 No. 1, pp. 63-72.

Pestoff, V. 2018. "Co-Production at the Crossroads of Public Administration Regimes." In Co-Production and Co-Creation: Engaging Citizens in Public Services, edited by T. Brandsen, B. Verschuere, and T. Steen, 27–36. London: Routledge.

Pham, T.-A. N., Le, H. N., Nguyen, D. T., & Pham, T. N. (2022). Customer service co-creation literacy for Better Service Value: Evidence from the health-care sector. Journal of Services Marketing, 36(7), 940–951. http://doi.org/10.1108/jsm-09-2021-0323

Plé, L. (2016), "Studying customers' resource integration by service employees in interactional value co-creation", Journal of Services Marketing, Vol. 30 No. 2, pp. 152-164.

Porter, M.E. and Lee, T.H. (2013), "The strategy that will fix health care", Harvard Business Review, Vol. 91 No. 10, pp. 50-70.

Porter M.E., What is value in health care?, N. Engl. J. Med. 363 (2010) 2477–2481. doi:10.1056/NEJMc1101108#SA1.

Phelan, A., McCormack, B., Dewing, J., Brown, D., Cardiff, S., Cook, N., … van Lieshout, F. (2020). Review of developments in person-centred healthcare. International Practice Development Journal, 10(Suppl2), 1–29. http://doi.org/10.19043/ipdj.10suppl2.003

Prajogo, D. and Olhager, J. (2012), "Supply chain integration and performance: the effects of long-term relationships, information technology and sharing, and logistics integration", International Journal of Production Economics, Vol. 135 No. 1, pp. 514-522.

Prahalad, C.K. and Ramaswamy, V. (2000), "Co-opting customer competence", Harvard Business Review, Vol. 78 No. 1, pp. 79-90.

Prahalad, C.K. and Ramaswamy, V. (2004), "Co-creation experiences: the next practice in value creation", Journal of Interactive Marketing, Vol. 18 No. 3, pp. 5-14.

Ranjan, K. R., & Read, S. (2014). Value co-creation: Concept and measurement. Journal of the Academy of Marketing Science, 44(3), 290–315. http://doi.org/10.1007/s11747-014-0397-2

Roehrs A, da Costa CA, Righi RD, de Oliveira KS. Personal health records: a systematic literature review. J Med Internet Res 2017 Jan 6;19(1):e13 [FREE Full text] [doi: 10.2196/jmir.5876] [Medline: 28062391]

Rodriguez Müller, A. P., Casiano Flores, C., Albrecht, V., Steen, T., & Crompvoets, J. (2021). A scoping review of empirical evidence on (Digital) public services co-creation. Administrative Sciences, 11(4), 130. http://doi.org/10.3390/admsci11040130

Rubbio, I., Bruccoleri, M., Pietrosi, A., Ragonese, B., 2019. Digital health technology enhances resilient behaviour: evidence from the ward. Int. J. Operations Production Manage. 40 (1), 34–67. https://doi.org/10.1108/IJOPM-02-2018-0057.

Rust, R.T., Lemon, K.N. and Zeithaml, V.A. (2004), "Return on marketing: using customer equity to focus marketing strategy", Journal of Marketing, Vol. 68, pp. 109-27.

Sawhney, M., Wolcott, R. C., and Arroniz, I. 2006. "The 12 Diff- erent Ways for Companies to Innovate," MIT Sloan Management Review (47:3), pp. 75-81

Sako, M. (2010). "Outsourcing Versus Shared Services," Communications of the ACM (53:7), pp. 27-29.

Sampson, S. E., & Spring, M. (2012). Customer Roles in Service Supply Chains and Opportunities for Innovation. Journal of Supply Chain Management, 48(4), 30–50. http://doi.org/10.1111/j.1745-493x.2012.03282.x

Sampson, S. E. (2012). Visualizing Service Operations. Journal of Service Research, 15(2), 182–198. http://doi.org/10.1177/1094670511435541

Sampson, S. E., Schmidt, G., Gardner, J. W., & Van Orden, J. (2015). Process Coordination Within a Health Care Service Supply Network. Journal of Business Logistics, 36(4), 355–373. http://doi.org/10.1111/jbl.12106

Sampson, S. E., & Chase, R. B. (2020). Customer contact in a Digital World. Journal of Service Management, 31(6), 1061–1069. http://doi.org/10.1108/josm-12-2019-0357

Santana MJ, Manalili K, Jolley RJ, Zelinsky S, Quan H, Lu M. How to practice person-centred care: a conceptual framework. Health Expect. 2018;21(2):429–40.

Saldaña, J. (2012) The coding manual for qualitative researchers. Sage.

Saunders, M., Lewis, P. and Thornhill, A. (2012) Research Methods For Business Students, 6/e. Harlow, England: Pearson Education.

Saha, V., Mani, V., & Goyal, P. (2020). Emerging trends in the literature of value co-creation: A Bibliometric analysis. Benchmarking: An International Journal, 27(3), 981–1002. http://doi.org/10.1108/bij-07-2019-0342

Sandhu, M.A., Al Ameri, T.Z. and Wikstr€om, K. (2019), “Benchmarking the strategic roles of the project management office (PMO) when developing business ecosystems”, Benchmarking: An International Journal, Vol. 26 No. 2, pp. 452-469.

Schneller, E.S., 2018. 2018 healthcare supply chain trends/issues. Healthcare Purchasing News 42 (8), 56–59.

Saunila, M., Ukko, J., & Rantala, T. (2019). What determines customers’ engagement in the digital service process? Journal of Manufacturing Technology Management, 30(8), 1216–1229. http://doi.org/10.1108/jmtm-01-2018-0006

Schorsch, T., Wallenburg, C.M. and Wieland, A. (2017), “The human factor in SCM: introducing a meta-theory of behavioral supply chain management”, International Journal of Physical Distribution & Logistics Management, Vol. 47 No. 4, pp. 238-262.

Scholz, B., Bocking, J. and Happell, B. (2016), “How do consumer leaders co-create value in mental health organisations?”, Australian Health Review, Vol. 41 No. 5, pp. 505-510.

Sepucha K, Uzogarra B, O'Connor M. Developing instruments to measure the quality of decisions: early results for a set of symptom-driven decisions. Patient Educ Counsel 2008;73(3):504-510.

Seidman, I (1998). Technique isn't everything, but it is a lot. In Interviewing as qualitative research: A guide for researchers in education and the social sciences. New York, NY: Teachers College Press.

Sharma, A. and Mehta, V. (2004), "Serivce quality perceptions in financial services – a case study of banking services", Journal of Services Research, Vol. 4, pp. 205-22.

Singh, M., Rice, J. and Riquier, D. (2006), Transforming the Global Health Care Supply Chain, MIT Center for Transportation and Logistics, Cambridge, MA.

Sichtmann, C., Selasinsky, M. and Diamantopoulos, A. (2011), "Service quality and export performance of business-to-business service providers: the role of service employee-and customer-oriented quality control initiatives", Journal of International Marketing, Vol. 19 No. 1, pp. 1-22.

Sinaiko, A.D., Szumigalski, K., Eastman, D. Alyna, T. and Chien (2019), "Delivery of patient centered care in the US health care system: what is standing in its way?", Robert Wood Johnson Foundation Optimizing Value in Health Care Program: Academy Health, available at: https://www.academyhealth.org/sites/default/files/deliverypatientcenteredcare_august2019.pdf .

Sienkiewicz-Małyjurek, K., & Szymczak, M. (2023). Understanding Public Service Supply Chain Management: A systematic literature review. Management Review Quarterly. doi:10.1007/s11301-023-00350-8

Solaimani, S., & van der Veen, J. (2021). Open Supply Chain Innovation: An extended view on supply chain collaboration. Supply Chain Management: An International Journal, 27(5), 597–610. doi:10.1108/scm-09-2020-0433

Spring, M., Faulconbridge, J., & Sarwar, A. (2022). How information technology automates and augments processes: Insights from artificial−intelligence−based systems in Professional Service Operations. Journal of Operations Management, 68(6–7), 592–618. doi:10.1002/joom.1215

State Council. (2016). (rep.). "Healthy China 2030" Planning Outline. Beijing, China: State Council.

Stewart M. Towards a global definition of patient centred care: the patient should be the judge of patient centred care. BMJ. 2001;322:444.

Taulli, T. (2019). SmileDirectClub: Lessons For Entrepreneurs. Retrieved June 28, 2020, from https://www.forbes.com/sites/tomtaulli/2019/09/14/smiledirectclub--lessons-for-entrepreneurs/

Tan, J. D., & Saragih, H. S. (2018). Co-innovation: A review and conceptual framework. International Journal of Business Innovation and Research, 17(3), 361. https://doi.org/ 10.1504/ijbir.2018.10016527.

Tana, G., & Chai, J. (2023). Digital Transformation: Moderating supply chain concentration and competitive advantage in the service-oriented manufacturing industry. Systems, 11(10), 486. doi: 10.3390/systems11100486

Tekic, A., & Willoughby, K. (2019). Co-creation–child, sibling or adopted cousin of open innovation? Innovation: Organization and Management, 21(2), 274–297. https://doi. org/ 10.1080/14479338.2018.1530565.

Tilson, D., Lyytinen, K., and Sørensen, C. 2010. "Research Commentary—Digital Infrastructures: The Missing IS Research Agenda," Information Systems Research (21:4), pp. 748-759.

Torfing, Jacob, Eva Sørensen, and Asbjørn Røiseland. 2019. Transforming the Public Sector Into an Arena for Co-Creation: Barriers, Drivers, Benefits, and Ways Forward. Administration & Society 51: 795–825.

Toulmin, S. E., Rieke, R., & Janik, A. (1979). An Introduction to Reasoning. New York: Macmillan.

Townsend A, Adam P, Li LC, McDonald M, Backman CL.(2013) Exploring eHealth ethics and multi-morbid- ity: protocol for an interview and focus group study of patient and health care provider views and experiences of using digital media for health purposes.

Tronvoll, B., Brown, S.W., Gremler, D.D., et al. (2011) Paradigms in service research. Journal of Service Management, 22: (5): 560-585.

Tukker, A., U. Tischner. New Business for Old Europe: Product-Service Development, Competitiveness and Sustainability, Greenleaf Publishing, Sheffield, 2006.

Turhan, S. and Vayvay, O. (2009), "Modeling of VMI implementation via SOA in a healthcare supply chain", 6th European and Mediterranean Conference on Information Systems.

Uusipaavalniemi, S. and Juga, J. (2008), "Information integration in maintenance services", International Journal of Productivity and Performance Management, Vol. 58 No. 1, pp. 92-110.

Vargo, S. L., and Lusch, R. F. 2004. "Evolving to a New Dominant Logic for Marketing," Journal of Marketing (68:1), pp. 1-17.

Vargo, S. L., and Lusch, R. F. 2008a. "Service-Dominant Logic: Continuing the Evolution," Journal of the Academy of Marketing Science (36:1), pp. 1-10

Vargo, S. L., and Lusch, R. F. 2008b. "A Service Logic for Service Science," in Service Science, Management and Engineering Education for the 21st Century, B. Hefley and W. Murphy (eds.), Berlin: Springer, pp. 83-88.

Vargo, S. L., & Lusch, R. F. (2016). Institutions and axioms: An extension and update of service-dominant logic. Journal of the Academy of Marketing Science, 44(1), 5–23.

Vanleene, D., J. Voets, and B. Verschuere. 2017. “The Co-Production of a Community : Engaging Citizens in Derelict Neighbourhoods.” VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations 29 (1): 201–221.

Voss, C., Tsikriktsis, N. and Frohlich, M. (2002) Case research in operations management. International journal of operations & production management, 22: (2): 195-219.

von Nordenflycht, A. 2010. “What Is a Professional Service Firm? Towards a Theory and Taxonomy of Knowledge-Intensive Firms,” Academy of management Review (35:1), pp. 155-174.

Wagner EH (1998). ‘Chronic disease management: what will it take to improve care for chronic illness?’ Effective Clinical Practice, vol 1, no 1, pp 2–4.

Wass, S. and Vimarlund, V. (2016), “Healthcare in the age of open innovation–a literature review”, Health Information Management Journal, Vol. 45 No. 3, pp. 121-133.

Ward, A., Eng, C., McCue, V., Stewart, R., Strain, K., McCormack, B., Dukhu, S., Thomas, J. and Bulley, C. (2018) What matters versus what’s the matter – exploring perceptions of person-centred practice in nursing and physiotherapy social media communities: a qualitative study. International Practice Development Journal. Vol. 8. No. 2. Art. 3. https://doi.org/10.19043/ipdj.82.003.

Wang, B., Kang, Y., Childerhouse, P., & Huo, B. (2018). Service supply chain integration: the role of interpersonal relationships. Industrial Management & Data Systems, 118(4), 828–849. http://doi.org/10.1108/imds-02-2017-0062

Wainaina, G. M. (2022). Insights from architectural elements of a service transformation process—a literature review. Journal of Service Science and Management, 15(03), 256–287. http://doi.org/10.4236/jssm.2022.153015

WHO(2005) Resolution WHA58. 28. eHealth., Fifty-eighth World Health Assembly, Ginebra,16–25. http:// apps..int/gb/ebwha/pdf_files/WH A58-REC1/english/A58_2005_REC1- en.pdf

Witell, L., Kristensson, P., Gustafsson, A., & Löfgren, M. (2011). Idea generation: Customer co‐creation versus traditional market research techniques. Journal of Service Management, 22(2), 140–159. http://doi.org/10.1108/09564231111124190

"White Paper on the Development of China's Digital Economy", compiled by Huajing Industry Research Institute, 2022.

World Health Organization (2016) Framework on Integrated, People-centred Health Services. Report by the Secretariat: Sixty-ninth World Health Assembly. Retrieved from: tinyurl.com/WHO-people.

Wong E, Lam G. Can e-health support programme improve self-management for diabetes patients in the community? J Community Health Nurs 2016; 2: e111.

Yazdanparast, A., Manuj, I., & Swartz, S. M. (2010). Co−Creating Logistics Value: A service−dominant logic perspective. The International Journal of Logistics Management, 21(3), 375–403. doi:10.1108/09574091011089808

Yang, C.W., Fang, S.C. and Hsu, W.Y. (2016), "Value Co-Creation in the hospital-patient collaborative network: a conceptual framework", Academy of Management Proceedings, Vol. 2016 No. 1, pp. 11359.

Yao, T., Zheng, Q. and Fan, X. (2015), "The impact of online social support on patients' quality of life and the moderating role of social exclusion", Journal of Service Research, Vol. 18 No. 3, pp. 369-383.

Yardley, Lucy. (2009). Demonstrating validity in qualitative psychology. In J. A. Smith (Ed.), Qualitative psychology: A practical guide to research methods. Los Angeles: Sage.

Yin, R. K. (2016). Qualitative research from start to finish. New York: The Guilford Press.

Yin, R. K., & Campbell, D. T. (2018). Case study research and applications: design and methods. Thousand Oaks, CA: SAGE Publications, Inc.

Yoo, Y., Boland Jr., R. J., Lyytinen, K., and Majchrzak, A. 2012. "Organizing for Innovation in the Digitized World," Organi- zation Science (23:5), pp. 1398-1408.

Zaman, S. I., Khan, S. A., Qabool, S., & Gupta, H. (2022). How digitalization in banking improve service supply chain resilience of e-commerce sector? A technological adoption model approach. Operations Management Research, 16(2), 904–930. doi:10.1007/s12063-022-00341-0

Zhang, H., Lu, Y., Wang, B. and Wu, S. (2015), "The impacts of technological environments and co-creation experiences on customer participation", Information & Management, Vol. 52 No. 4, pp. 468-482.

Zhang, L., Tong, H., Demirel, H. O., Duffy, V. G., Yih, Y., & Bidassie, B. (2015). A practical model of value co-creation in Healthcare Service. Procedia Manufacturing, 3, 200–207. http://doi.org/10.1016/j.promfg.2015.07.129

Zhou, L., DeAlmeida, D., & Parmanto, B. (2019). Applying a User-Centered Approach to Building a Mobile Personal Health Record App: Development and Usability Study. JMIR MHealth and UHealth, 7(7). http://doi.org/10.2196/13194

ZIRI (Zhongyan Industrial Research Institute.) (2023). (rep.). Analysis Report on Current Situation and Future Development Trends of Supply Chain Logistics Industry from 2024 to 2029. Beijing, China: ZIRI.

APPENDICES

APPENDIX A: PARTICIPANT INFORMATION

Participant Information sheet

Study title: Customer engagement in healthcare service supply chains and digital transformation

Name of Lead Researchers: Dr Xiaoqian Xu

We would like to invite you to take part in our research study to see how organizations engage customer in their service supply chain (service producing and service delivering). And how the digital technologies transform it? Before you decide whether you would like to take part it is important for you to understand why the research is being done and what it would involve for you.

What is the purpose of the study?
The purpose of this study is to explore the customer engagement effect of healthcare service supply chain under digital environment. It is specifically about if the participation of customer in healthcare service supply have a positive or a negative influence and how the customer contribute to healthcare service supply with the help of digital technologies, including the benefits and challenges of this king of customer engagement.

Who can take part?
You have been invited to take part in this research if you meet as least one of the following conditions

1. You are the doctor/consultant in hospital or medical company
2. You work/worked in hospital or medical company
3. You teach healthcare relative content in hospital/university
4. You are the supplier of a hospital or a medical company

Please note that in order to take part in the research, you need to be 18 years or older.

Do I have to take part?
No. It is up to you to decide if you want to take part. If you do decide to take part you will be free to withdraw from the study at any time, without giving a reason. If you do take part, you can withdraw at any time prior to or during completion of the form. However, as we only record *pseudoanonymised* data (i.e. *an assigned ID code or number will be used instead of the participant's name and a key will kept allowing the researcher to identify a participant's data*) you cannot withdraw your data once submitted. In addition, The dataset will be available to others after the study while all the data will be anonymized in the research output.

What will happen to me if I take part?
If you agree to take part in the study you will be invited to attend an interview (which will probably take you around 30-60 minutes). The interview questions will be forwarded to you before the interview for you preparing. A number of the questions are open ended and direct quotations from these answers may be used in our research reports, but no confidential information will be used.

What are the possible disadvantages and risks of taking part?
We do not believe that there are risks involved in taking part in the study. The disadvantage is that you will have to spend some time to attend our interview which approximately may take you

30-60 minuets. Due to the COVID-19, the interview may be hold online. If we have to meet face to face, we need to take our temperature before the interview. masks will also be prepared in interview to protect each other.

What are the possible benefits of taking part?

There are no direct benefits to you, though we hope you will find the interview and research is interesting and meaningful.

What if there is a problem or if I have concerns?

If you have a concern about any aspect of this study, you should ask to speak to the researchers who will do their best to answer your questions. In the first instance please contact Dr Xiaoqian Xu on

In the event that something does go wrong and you are harmed during the research, and this is due to someone's negligence, then you may have grounds for a legal action for compensation against the Sponsor of the study (University of Birmingham).

Will my taking part in this study be kept confidential?

You will be interviewed *pseudoanonymisedly which only assigned number will used instead of participants' name and other detailed information*. The data recorded cannot be traced back to you as an individual and we do not ask you for personal information such as your name, date of birth or address.

What will happen to the results of the research?

We intend that the results of this study will be published. If you take part and are interested in understanding how your contribution to this study has been used, you can request a participant version of the final study report by contacting Dr Xiaoqian Xu by writing to her at: University house, University of Birmingham, Birmingham, B15 2WB or via email: XXX752@student.bham.ac.uk.

Who is organising and funding the research?

The Research is being organised by Dr Xiaoqian Xu and guided by Professor Yufeng Zhang and Professor Pualina Ramirez at the University of Birmingham. The research have no fund currently.

Who has reviewed the study?

This study has been reviewed and given favourable opinion by the Ethics committee from the University of Birmingham.

Contact and Further information

If you want any further information about this particular study, you can contact Dr Xiaoqian Xu on or email Professor Zhang on email / Professor Ramirez on email / Business school of Birmingham University on

If you want any more information about business school research you can contact postgraduate research center for business school on pgrbusiness@.bham.ac.uk.

You can print this participant information sheet or keep a copy on your computer

APPENDIX B: DATA MANAGEMENT PLAN

writing a thesis: Customer engagement in service supply chain and digital transformation

A Data Management Plan created using DMPonline

Creator: Xiaoqian Xu

Affiliation: University of Birmingham

Template: UoB short template

Project abstract:

This project try to figure out the customer engagement effect in service supply chain and its digital transformation. The research will be an exploratory study based on a literature review, conceptual analysis and case studies including hospitals in Birmingham and dental company SDC(Smile Direct Club). Semi-structured interviews to customers/patients and doctors/nurses will be utilized to collect in-depth data. open-ended questions on the current technologies the company/hospital have taken to help make the health care provision process smooth and make the process structure effective to patients will ask them to get data.

Last modified: 12-07-2020

writing a thesis: Customer engagement in service supply chain and digital transformation

Data description

What types of data will be used or created?

In my research, in-depth data which is collected from interviews will be utilized. I am able to gather data from their answers to my open-ended questions and their emotions and gestures. Interview question design will also be a problem I should think of before the interviews. During the process of interview, I should be kind and mild. I could not affect the respondents' answers based on my attitude towards customer engagement and digital technologies.

How will the data be structured and documented?

I will structure these answers by word. Firstly, I should write down the key word of interviewers' answer to remind me and also record the interview process in case I miss any detail about interviewers answer. Then, I should file all these interviews by word to keep them. A new document will be created for me to structure these data by following data management guidance.

Data storage and archiving

How will your data be stored and backed up?

I will store the data in a specific document in my personal computer. And I will upload the document to google drive where the document will only be seen by me. To back up the document, I also will store the document in my USB drive to keep it. The University of Birmingham provides a Research Data Store (RDS) as well, access to the RDS is restricted to project members. Backup copies of data are taken on a daily basis and data is stored in separate buildings from the live data.

Is any of the data of (ethically or commercially) sensitive nature? If so, how do you ensure the data are protected accordingly?

It is not certain whether I will require access at all to ethically sensitive data. If some of my data could be of a sensitive nature, and I will accordingly comply with the procedures of the archive to protect that data. Meanwhile, I will introduce my research topic and research objective to interviewers to help them understand my research and keep confident about their personal data.

Where will your data be archived in the long term?

At the publication of a paper, a subset of the data that underpins the paper will be transferred to the UoB Research Data Archive (RDA). Once transferred the data will be set to read-only to prevent any inadvertent additions or deletions of the dataset, Any changes will result in a new dataset, which will be archived separately. The RDA solution has been created to be highly resilient and is located at two data centers in two different sites, with a backup placed in a third site. Data will be stored for 10 years, should access to the data be requested within a 10 year period, the 10 year clock is then reset from the point of last access. After the 10 year period the data will be deleted.

Data sharing

Which data will you share, and under which conditions? How will you make the data available to others?

I will share the data to public only when I finish data collection part and thesis writing part. I will share the data in the middle of my data collection to my supervisors to ask for their suggestions. After that, Data will be shared through the University of Birmingham's eData repository (https://edata.bham.ac.uk/) which makes the datasets discoverable through search engines like Google. eData uses Dublin Core as a metadata standard and the minimum metadata provided for published datasets will cover amongst others title, type of data, creators, publication date and related publications.

APPENDIX C: INTERVIEW CONSENT FORM

Interview Consent Form

Research project title: customer participation in healthcare industry and digital transformation Research investigator: Dr Xiaoqian Xu

Thank you for agreeing to be interviewed as part of the customer participation in healthcare industry and digital transformation Project. The interview will take approximately 1 hour

Ethical procedures for academic research undertaken from UK institutions require that interviewees explicitly agree to being interviewed and how the information contained in their interview will be used. This consent form is necessary for us to be sure that you understand what is going to happen, how your data will be treated and the rights you have as a participant. Would you therefore read the accompanying information sheet and then sign this form to confirm that you understand and agree.

What will happen?

- The interview will be recorded and a written transcript will be produced.
- You will be sent a copy of your transcript to review. If you want to make any changes or add anything extra then you will be able to.
- The transcript of the interview will be analysed by Xiaoqian Xu as researcher.
- Your name and any identifying information will be changed to protect your identity.
- Access to the (anonymised) interview transcript will be limited to the researcher and academic colleagues and researchers with whom she might collaborate as part of the research process.
- Any summary interview content, or direct quotations from the interview, that are made available through academic publication or other academic outlets will be anonymised so that you cannot be identified, and care will be taken to ensure that other information in the interview that could identify you is not revealed.
- The recording and transcription will be kept for ten years following completion of the interview project and then deleted (in accordance with the University of Birmingham's Code of Practice for Research). If you chose to leave the study, your transcript and data will be deleted immediately.
- Any variation of the conditions above will only occur with your further explicit approval

How will data be used?

You will have the opportunity to review the transcription of your interview and make any changes that you wish. You will also have the opportunity to discuss the researchers' initial analysis of your interview and make comments and corrections. Once this process has been completed then the final anonymised transcript may be used as follows.

All or part of the content of your interview may be used;

- In academic papers, policy papers or news articles
- In an archive of the project as noted above

Agreement
By signing this form I agree that;

1. I am voluntarily taking part in this project. I understand that I don't have to take part, and I can stop the interview at any time;
2. The researcher can make an audio recording of the interview and store the data in accordance with the UoB Code of Practice for Research (outlined above).
3. I can withdraw my involvement in the project within three months after this interview by contacting the researcher.
4. The transcribed interview or extracts from it may be used as described above;
5. I have read the Information sheet;
6. I don't expect to receive any benefit or payment for my participation;
7. I can view a copy of the transcript of my interview and make edits I feel necessary to ensure that my identity has been protected;
8. I have been able to ask any questions I might have, and I understand that I am free to contact the researcher with any questions I may have in the future.
9. The dataset will be available to others after the study which all the data will be anonymized.

Printed Name_____

Participant's Signature _____Date _____

Researcher's Signature _____Date _____

Contact Information
This research has been reviewed and approved by the University of Birmingham Research Ethics Board. If you have any further questions about this study, please contact:
Name of researcher: Xiaoqian Xu Full address: University house, Department of Business, University of Birmingham, Edgbaston, B15 2TT E-mail: [redacted]

Other contact information:

Professor Zhang on email [redacted]

Professor Ramirez on email [redacted]

Business school of Birmingham University on [redacted]

What if I have concerns about this research?
If you are worried about this research, or if you are concerned about how it is being conducted, you can contact Sue Cottam (Research Ethics Officer, University of Birmingham) at [redacted]