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COORDINATORE Prof. Giuseppe De Luca

**INCLUSIVE CARE DESIGN:
UN SISTEMA DI SERVIZIO SANITARIO INTELLIGENTE
PER L'ASSISTENZA AGLI ANZIANI**

Settore Scientifico Disciplinare ICAR/13

Dottorando
Dott. Shuang LIANG

Tutore
Prof.ssa Francesca Tosi

Cotutore
Prof. Giuseppe Lotti

Cotutore
Prof.ssa Alessandra Rinaldi

Coordinatore
Prof. Giuseppe De Luca

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**INCLUSIVE CARE DESIGN:
SMART HEALTHCARE SERVICE SYSTEM
FOR HELPING THE ELDERLY**

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ABSTRACT

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ABSTRACT

L'invecchiamento della popolazione mondiale è diventato un problema urgente. In molte nazioni la percentuale di popolazione anziana è in aumento, la domanda e i costi dei servizi sanitari crescono in relazione all'età delle persone. Le risorse destinate ai servizi sanitari per gli anziani sono ormai inadeguate per far fronte alla complessità dei servizi. I governi stanno spingendo attivamente per lo sviluppo di sistemi di servizi sanitari in grado di alleviare questa pressione e i sistemi di servizi sanitari intelligenti stanno emergendo come un trend futuro. Nell'era digitale, molti servizi analogici sono stati trasformati in servizi online. Per gli anziani, l'interazione con la tecnologia e le piattaforme digitali è stata inevitabile. Inoltre, le misure di blocco dovute alla pandemia COVID-19 hanno accelerato lo sviluppo di servizi sanitari digitali. L'efficienza delle istituzioni mediche nella fornitura di servizi sanitari è migliorata grazie alla diffusione nell'uso di piattaforme digitali. Sebbene i servizi digitali apportino numerosi vantaggi, essi introducono nuove problematiche come il cosiddetto digital divide. Poiché gli anziani spesso non hanno competenze digitali né conoscenza di base su come utilizzare le piattaforme digitali, l'accesso ai servizi sanitari forniti da queste piattaforme è spesso difficile per loro.

Il design e la tecnologia possono aiutare le persone a colmare il divario tra le loro capacità digitali e le loro abilità fisiche. La mia ricerca di dottorato si basa sul trend di sviluppo del sistema dei servizi sanitari, a partire dall'invecchiamento della popolazione e dai servizi sanitari. Con metodi e strumenti mutuati dall'ergonomia e dal design dei servizi, indaga le sfide affrontate dagli anziani e le loro richieste di servizi sanitari, riflette sul rapporto tra invecchiamento e tecnologia digitale e propone un'ipotesi di ricerca. Attraverso indagini e casi studio, ho sviluppato una linea guida che può aiutare le piattaforme digitali di servizi sanitari a diventare più a misura di anziano in modo che le persone anziane possano beneficiare di questi servizi e della comodità fornite dalle piattaforme digitali.

La mia ricerca mira a consentire agli anziani di godere di una vita da pensionato più sicura, confortevole, sana e felice. Il risultato potrebbe aiutarli a migliorare la loro esperienza durante l'utilizzo delle piattaforme di servizi sanitari digitali. Tutti gli anziani possono avere maggiori opportunità di accedere ai servizi sanitari digitali senza discriminazioni o barriere digitali.

ABSTRACT

The world's ageing population has become a pressing issue. The percentage of elderly population in many nations is increasing and the demand and costs of healthcare services rise with age. Healthcare service resources for the elderly in many countries are now inadequate to deal with the services' complexity. Governments are actively pushing the development of healthcare service systems to alleviate this pressure, and smart healthcare service systems are emerging as a future trend. In the digital age, many offline services have been transformed into online services. For the elderly, interaction with digital technology and platforms has been unavoidable. Moreover, the lockdown measures due to the COVID-19 pandemic have accelerated the development of digital healthcare services. Medical institutions' efficiency in providing healthcare services has improved due to the widespread usage of digital platforms. Although digital services bring numerous advantages, they also introduce new issues, such as the digital divide. Because the elderly often lack digital skills and understanding of how to use digital platforms, accessing healthcare services provided by these platforms is frequently difficult for them.

Design and technology can help people bridge the gap between their digital capability and physical ability. My doctoral research is based on the development trend of the healthcare service system, starting from population ageing and healthcare services. With methods and tools provided by ergonomics and service design, it investigates the challenges faced by the elderly and their healthcare service demands, reflects on the relationship between ageing and digital technology, and proposes a research hypothesis. Through investigation and case studies, I developed a design guideline that can help digital healthcare service platforms to become more age-friendly so that older people can benefit from the services and convenience that digital platforms provide.

My research aims to enable the elderly to enjoy a safer, more comfortable, healthier and happier retirement life. The output could help them improve their experience while using digital healthcare service platforms. All elderly people can have more opportunities to access digital healthcare services without discrimination or digital barriers.

摘要

人口老龄化已成为全球最重要的挑战之一。许多国家的老年人口比例正在增加，医疗保健服务的需求和成本随着年龄的增长而上升。许多国家的老年人医疗保健服务目前不足以应对老年患者的复杂性。为了缓解这种压力，各国政府正在积极推动医疗服务体系的发展和建设。智能健康关心服务系统已经成为未来的趋势。在数字时代，许多线下服务已经转变为在线服务。对于老年人来说，这已经是不可避免的去与数字化技术和平台进行交互。此外，由于 COVID-19 新冠病毒造成的封锁措施加速了数字化健康关心服务的发展。数字平台的大规模使用提高了医疗机构服务的效率。数字服务虽然带来了许多好处，但也引起了新的问题，比如数字鸿沟的问题。老年人由于缺乏数字技能，不知道如何使用数字平台，以至于他们很难获得数字平台提供的医疗保健服务。

设计和技术可以帮助弥合人们数字技能和身体能力之间的差距。我的研究就是基于医疗服务体系的发展趋势，从人口老龄化和医疗保健服务入手。借助人体工程学和服务设计提供的方法和工具，定义了老年人面临的问题及其健康关心服务需求，反思了老龄化与数字技术的关系，并提出了研究假设。通过调查和案例研究，我制定了一个让数字健康关心服务平台变得更加老年友好的设计指南，让老年人可以享受由数字平台带来的服务和便利。

我的研究旨在让老年人享受更安全、更舒适、更健康、更幸福的退休生活。研究产出可以帮助老年人改善在使用数字平台时的用户体验。老年人可以在没有歧视和数字障碍的情况下，有更多的机会获得数字健康关心服务。

PREMESSA

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PREMESSA

L'invecchiamento della popolazione è diventata una delle sfide più importanti. Il numero e la percentuale di anziani in molti paesi del mondo sono in crescita. Secondo i dati dell'Organizzazione Mondiale della Sanità (OMS), dal 2015 al 2050, a livello globale, il numero di persone di età superiore ai 60 anni aumenterà da 900 milioni a 2 miliardi e dal 12% della popolazione al 22%. A causa di questa tendenza demografica e del maggior rischio di malattia e disabilità in età avanzata, si è verificata un'impennata nella domanda di servizi sanitari. Inoltre, a causa di una aspettativa di vita più lunga, le persone anziane dovranno ripensare i loro piani di carriera e pensionamento e avranno nuove esigenze di servizi e tecnologie. Le persone anziane vivono nel mondo reale, ma anche in una società digitale.

Le innovazioni digitali stanno rimodellando la nostra società e le relazioni tra le persone. Queste tecnologie aprono possibilità inimmaginabili in una varietà di aree, incluso il settore sanitario. Il sistema dei servizi sanitari deve adattarsi a questa transizione. La pandemia di COVID-19 ha promosso lo sviluppo di piattaforme di servizi sanitari digitali. La mancanza di competenze digitali significa che le persone anziane potrebbero dover gestire i problemi posti dal divario digitale e avere difficoltà a usufruire dei servizi sanitari forniti dalle piattaforme digitali. Il design e la tecnologia possono aiutarli a colmare le lacune nelle loro capacità digitali.

Questa tesi inizia con domande scientifiche, quindi studia i sistemi dei servizi sanitari esistenti in Cina, Italia e Giappone; analizza le esigenze delle persone anziane; considera il rapporto tra invecchiamento e tecnologia digitale; e propone un'ipotesi di ricerca. Attraverso la ricerca sperimentale si definiscono le condizioni di realizzazione e lo scopo dell'ipotesi. Vengono sviluppati una linea guida di progettazione che include i criteri di progettazione, metodi e strumenti e un meccanismo di valutazione, con l'obiettivo di coinvolgere le piattaforme di servizi sanitari digitali per diventare più a misura di anziano.

La ricerca si articola in quattro parti: introduzione, ricerca scientifica, ricerca sperimentale e ricerca progettuale. La prima parte (Capitolo 1: Introduzione) delinea la ricerca di dottorato

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e definisce le macroaree di ricerca, gli obiettivi generali e specifici, le domande e la metodologia della ricerca. Inoltre, questa parte descrive i risultati attesi, l'innovazione e rilevanza scientifica e i risultati della ricerca.

La seconda parte (Ricerca scientifica) studia importanti teorie e concetti attraverso ricerca bibliografica. Il capitolo 2 introduce politiche e piani sull'assistenza sanitaria e sull'invecchiamento sviluppati dall'OMS, dalle Nazioni Unite e dalla Commissione europea. Questi evidenziano l'importanza della ricerca sanitaria. La ricerca sui trend di transizione demografica riporta un serio problema di invecchiamento della popolazione in Giappone, Italia e Cina. Dunque, vengono studiati e confrontati i sistemi di servizi sanitari in questi tre paesi. Per una più approfondita comprensione dei servizi sanitari, vengono riassunti i modelli di servizio sanitario esistenti ed esplorati i fattori che gli influenzano. I vantaggi, le sfide e le opportunità dei servizi sanitari in Cina vengono analizzati perché intendo applicare la mia ricerca al sistema sanitario cinese. Il capitolo 3 si concentra sulla ricerca degli utenti. In questo capitolo, la ricerca sulle definizioni e classificazioni degli anziani aiuta ad analizzare le caratteristiche e i bisogni dei diversi tipi di persone anziane. Questi studi possono aiutare a definire i servizi sanitari di cui le persone anziane hanno bisogno. Il capitolo 4 discute la relazione tra invecchiamento e tecnologia digitale, nonché il significato di accessibilità e inclusione digitali. Viene proposta un'ipotesi di ricerca per aiutare a colmare il divario digitale per gli anziani.

La parte 3 (Ricerca sperimentale) descrive uno studio pilota, un'indagine, un caso di studio e le opinioni di esperti per verificare l'ipotesi e trovare una soluzione fattibile.

L'indagine 1 è uno studio pilota per valutare la fattibilità di una piattaforma digitale per aiutare gli anziani a superare la solitudine organizzando le parti interessate per fornire attività di assistenza sociale a breve termine e valutare l'architettura del sistema (Capitolo 5).

L'indagine n. 2 appartiene alla ricerca sugli utenti. Attraverso l'uso di questionari, personas, test sull'usabilità, sondaggi culturali ed altri metodi di ricerca, è possibile sintetizzare i reali bisogni delle persone anziane. L'indagine aiuta a definire i problemi che gli utenti più anziani riscontrano durante l'utilizzo della piattaforma di servizi sanitari digitali (Capitolo 6). Il caso di studio nel capitolo 7 illustra la metodologia tramite la quale un ospedale cinese fornisce servizi sanitari, definendo i vantaggi

e gli svantaggi della piattaforma di servizi sanitari digitali esistente. Le interviste agli esperti sono un metodo qualitativo, che mira a definire le condizioni per la realizzazione dell'ipotesi e pone le basi per una soluzione fattibile (Capitolo 8).

Sulla base dell'analisi teorica (Parte 2) e della ricerca sperimentale (Parte 3), la Parte 4 (Ricerca progettuale) propone dunque una linea guida di progettazione per piattaforme di servizi sanitari digitali per le persone anziane. I progettisti e/o gli sviluppatori di piattaforme possono utilizzarla come riferimento quando devono creare o migliorare una piattaforma di servizi sanitari digitali. La linea guida contiene anche strumenti ed una lista di controllo che possono aiutare a valutare se una piattaforma sanitaria digitale è o no a misura di anziano (Capitolo 9). La ricerca empirica aiuta a convalidare l'efficacia dei metodi di progettazione e degli strumenti di valutazione. Nella parte finale (Conclusioni), si discutono i limiti della ricerca e le direzioni future.

Nel complesso, la ricerca include diverse discipline (ergonomia, medicina e informatica) e sottolinea il valore della ricerca interdisciplinare. L'obiettivo del risultato è promuovere le piattaforme digitali affinché diventino più a misura di anziano in modo che le persone anziane possano beneficiare dei servizi sanitari digitali senza affrontare discriminazioni o barriere digitali.

FOREWORD

Population ageing has become one of the most important challenges. The number and the proportion of elderly people in many countries around the world are growing. According to data from the World Health Organization (WHO), from 2015 to 2050, the number of people aged over 60 globally will increase from 900 million to 2 billion and from 12% of the population to 22%. Due to this demographic trend and the higher risk of illness and disability in old age, a surge has occurred in the demand for healthcare services. Furthermore, due to a longer lifespan, older people will need to rethink their career and retirement plans, and they will have new needs for services and technologies. Older people now live not only in the real world but also in a digital society.

Digital innovations are reshaping our society and the relationships between people. These technologies open previously unimagined possibilities in a variety of areas, including the healthcare industry. The healthcare service system needs to adapt to this transition. The COVID-19 pandemic has promoted the development of digital healthcare service platforms. A lack of digital skills means that elderly people may have to manage the problems posed by the digital divide and have difficulties in receiving healthcare services provided by digital platforms. They need to go digital. Design and technology can help them bridge the gaps in their digital capability.

This thesis begins with scientific questions, then studies the existing healthcare service systems in China, Italy and Japan; analyses the demands of elderly people; considers the relationship between ageing and digital technology; and proposes a research hypothesis. Through the experimental research, the realization conditions and the scope for the hypothesis are defined. A design guideline including design criteria, methods, tools and an evaluation mechanism is developed, aiming to engage digital healthcare service platforms to become more age-friendly.

The research is divided into four parts: introduction, scientific research, experimental research and project research.

Part 1 (Chapter 1: Introduction) outlines my PhD research and defines macro research areas, general and specific objectives, and the research questions and methodology. In addition, this part describes the expected results, innovation and scientific relevance, and research output.

Part 2 (Scientific Research) studies important theories and concepts through literature research. Within this, Chapter 2 introduces policies and plans about healthcare and ageing developed by the WHO, the United Nations and the European Commission. These highlight the importance of healthcare research. Research on demographic transition trends shows that the problem of ageing populations is serious in Japan, Italy and China. Thus, the healthcare service systems in these three countries are studied and compared. For a deeper understanding of healthcare services, the existing healthcare service models are summarized, and the factors affecting healthcare services are explored. The advantages, challenges and opportunities of healthcare services in China are analysed because I intend to apply my research to the Chinese healthcare service system. Chapter 3 focuses on user research. In this chapter, research on the definitions and classifications of the elderly can help analyse the characteristics and needs of different types of elderly people. These studies can help define the healthcare services that older people need. Chapter 4 discusses the relationship between ageing and digital technology, as well as the meaning of digital accessibility and inclusion. A research hypothesis is proposed to help bridge the digital divide for the elderly.

Part 3 (Experimental Research) describes a pilot study, an investigation, a case study and expert opinions to verify the hypothesis and find a feasible solution.

Investigation 1 is a pilot study to evaluate the feasibility of a digital platform to help the elderly overcome loneliness by organizing stakeholders to provide short-term social care activities and evaluate the system's architecture (Chapter 5).

Investigation 2 belongs to user research. Through using questionnaires, personas, usability testing, cultural probes, and other research methods, the real needs of the elderly can be summarized. The investigation helps to find the problems that older users meet during using a digital healthcare service platform (Chapter 6). The case study in Chapter 7 illustrates how a Chinese hospital provides healthcare services and helps find the advantages and disadvantages of the digital healthcare service platform. Expert interviews are a qualitative method, aiming to define the conditions for the hypothesis to be realized and laying a foundation for a feasible solution (Chapter 8).

Based on the theoretical analysis (Part 2) and experimental research (Part 3), Part 4 (Project Research) proposes a design guideline for digital healthcare service platforms for the elderly. Designers or platform operators can use it as a reference standard when they need to create or improve a digital healthcare service platform. The guideline also contains tools and a checklist that can help evaluate whether a digital healthcare platform is age-friendly (Chapter 9). Empirical research helps validate the effectiveness of design methods and evaluation tools. In the final part (Conclusions), the research's limitations and future directions are discussed.

Overall, the research involves multiple disciplines (ergonomics, medicine and computer science) and emphasizes the value of interdisciplinary research. The goal of the output is to promote digital platforms to become more age-friendly so that elderly people can benefit from digital healthcare services without facing discrimination or digital barriers.

前言

人口老龄化已成为全球最重要的挑战之一。世界上许多国家老年人的数量和比例都在增长。根据世界卫生组织（WHO）的数据，从2015年到2050年，全球60岁以上人口将从9亿增加到20亿，从总人口比例的12%增加到22%。由于这种人口趋势以及老年人有更高的疾病和致残的风险，医疗健康关心服务的需求将会激增。此外，由于寿命更长，老年人将需要重新考虑他们的职业和退休计划，因此他们将对健康服务和数字技术产生了新的需求。老年人现在不仅生活在现实世界中，而且也生活在数字社会中。

数字创新正在重塑我们的社会和人与人之间的关系。这些技术为包括医疗健康在内的各个行业提供了以前无法想象的可能性。医疗服务体系需要适应这种转变。COVID-19 新冠病毒大流行已经促进了数字医疗服务平台的发展。缺乏数字技能意味着老年人可不知道如何接受数字平台提供的医疗保健服务，这导致他们不得不对数字鸿沟带来的问题。他们需要成为数字化老人。设计和技术可以帮助他们弥合数字能力的差距。

本论文从科学问题入手，研究了中国、意大利和日本现有的医疗卫生服务体系；分析了老年人的需求；考虑了老龄化与数字技术之间的关系；并提出了研究假设。通过实验研究，定义了假设的实现条件和范围。制定了包括设计标准、方法、工具和评估机制在内的设计指南，旨在使数字医疗服务平台更加适合老年人。

研究分为引言、科学研究、实验研究和项目研究四个部分。

第一部分（第1章：介绍）概述了我的博士研究并定义了宏观研究领域、一般和特定目标以及研究问题和方法。此外，这部分描述了预期结果、创新和科学相关性以及研究成果。

第二部分（科学研究）通过文献研究，研究了重要的理论和概念。其中，第2章介绍了由世界卫生组织、联合国和欧盟委员会制定的有关医疗保健和老龄化的政策和计划。这些突出了医疗保健研究的重要性。对人口转变趋势的研究表明，日本、意大利和中国的人口老龄化问题十分严重。因此，对这三个国家的医疗健康关心服务体系进行了研究和比较。为了更深入地了解医疗健康服务，我总结了现有的医疗健康服务模式，并探讨了影响医疗健康服务的因素。因

为我计划将我的研究应用于中国的健康服务体系，因此我分析了中国健康关心服务的优势、挑战和机遇。第3章侧重于用户研究。这一章对老年人的定义和分类进行研究，有助于分析不同类型老年人的特点和需求。这些研究可以帮助确定老年人需要的健康关心服务。第4章讨论了老龄化与数字技术之间的关系，以及数字可访问性和包容性的含义。提出了一项研究假设，以帮助弥合老年人的数字鸿沟。

第3部分（实验研究）描述了试点研究、调查、案例研究和专家的意见，以验证假设并找到可行的解决方案。调查1是一项试点研究，旨在评估数字平台通过组织利益相关者提供短期社会关怀活动来帮助老年人克服孤独感的可行性，并评估系统架构（第5章）。调查2属于用户研究。通过使用问卷、人物角色、可用性测试，文化探针等研究方法清楚了解了老年人的真实需求。调查验证了老年人在使用数字健康关心服务平台时遇到的问题（第6章）。第7章的案例研究详细描述了中国的医院是如何提供数字健康关心服务的，这可以帮助发现数字健康关心服务平台的优缺点。专家访谈是一种定性方法，旨在确定假设得以实现的条件，并为可行的解决方案奠定基础（第8章）。

在理论分析（第二部分）和实验研究（第三部分）的基础上，第四部分（项目研究）提出了老年数字医疗服务平台的设计指南。设计人员或平台开发人员可以将其作为创建和改善老年友好型数字医疗服务平台时的参考标准。该指南也包含一些用来评估数字健康关心服务平台是否老年友好的方法和工具（第9章）。实证研究验证了此指南中设计方法和评估工具的有效性。在最后一部分（结论）中，讨论了我研究的局限性和未来的发展方向。

总体而言，该研究涉及多个学科（人体工程学、社会学，医学和计算机科学），并强调了跨学科研究的价值。输出的目标是为了促进数字平台变得更加适合老年人的使用，以便老年人可以从数字医疗服务中受益，而不会面临歧视或数字障碍。

PART I
INTRODUCTION

1. Introduction

PART II
SCIENTIFIC
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2. Healthcare services 3. User research 4. Ageing and digital technology

PART III
EXPERIMENTAL
RESEARCH

5. Investigation 1 6. Investigation 2
7. Investigation 3 8. Expert Interviews

Research hypothesis:
Smart healthcare service
system based on AIoMT

PART IV
PROJECT
RESEARCH

Output

9. Design guidelines of digital healthcare service platforms for the elderly

PART I

INTRODUCTION

CHAPTER 1

INTRODUCTION



CHAPTER 1

INTRODUCTION

- 1.1 Macro research areas
- 1.2 General objectives and specific objectives
- 1.3 Research questions
- 1.4 Research methodology
- 1.5 Expected results
- 1.6 Innovativeness and scientific relevance
- 1.7 Research output

References

1.1 Macro research areas

From macro research, my research belongs to the third goal of the United Nations Sustainable Development Goals 2030 (Fig.1.1), which is good health and well-being. Its goal is to ensure healthy lives and promote well-being at all ages. My research has related to the well-being of the elderly. By registering with in a smart healthcare service system, older people can get help to solve some daily life problems and then do not feel helpless and lonely. I hope that my research can help improve people's access to healthcare and medical care services.



Fig.1.1
United nations SDG.
From: United Nations
(2021)

My research is also part of the EU research & innovation programs (2021-2027), Horizon Europe (Fig.1.2). It is included in the Health Item. In this item, healthcare systems are one of these research areas. Some social studies will be required as part of my research. Before beginning the research, I need to consider several social factors, such as the acceptance of digital technology by the elderly, family members' attitudes toward a smart healthcare service system, and so on. Research on the healthcare service system in Italy and China is also necessary.

In the fourth consumer era, people's values and behaviors are more inclined to establish a connection with others as a kind of happiness. According to the requirements of the United Nations on "Healthy Aging", it is critical to promote the happiness and social participation of the elderly..

Clusters in 'Global Challenges and Industrial Competitiveness'

Clusters	Areas of intervention	
Health	<ul style="list-style-type: none"> * Health throughout the life course * Non-communicable and rare diseases * Tools, technologies and digital solutions for health and care 	<ul style="list-style-type: none"> * Environmental and social health determinants * Infectious diseases * Health care systems
Inclusive and Secure Societies	<ul style="list-style-type: none"> * Democracy * Social and economic transformations * Protection and Security 	<ul style="list-style-type: none"> * Cultural heritage * Disaster-resilient societies * Cybersecurity
Digital and Industry	<ul style="list-style-type: none"> * Manufacturing technologies * Advanced materials * Next generation internet * Circular industries * Space 	<ul style="list-style-type: none"> * Key digital technologies * Artificial intelligence and robotics * Advanced computing and Big Data * Low carbon and clean industry
Climate, Energy and Mobility	<ul style="list-style-type: none"> * Climate science and solutions * Energy systems and grids * Communities and cities * Industrial competitiveness in transport * Smart mobility 	<ul style="list-style-type: none"> * Energy supply * Buildings and industrial facilities in energy transition * Clean transport and mobility * Energy storage
Food and Natural Resources	<ul style="list-style-type: none"> * Environmental observation * Agriculture, forestry and rural areas * Food systems * Circular systems 	<ul style="list-style-type: none"> * Biodiversity and natural capital * Sea and oceans * Bio-based innovation systems

v. 25 June 2018



Fig.1.2
Horizon Europe.
From: European
Commission
(2018)

1.2 General objectives and specific objectives

From a humanistic perspective, design is a reflection on technology. The general objective of my research is to use design and digital technology to help the elderly have a safer, more comfortable, healthier, and happier retirement life. All seniors can have more opportunity to engage fully in society. without discrimination, environmental, and service barriers. We need to create a culture where people can naturally connect with one another, as opposed to a society that is excessively personal and isolated.

The specific objectives are as follows:

OS.1 Confirm the research status of healthcare service systems in Italy, China and Japan, analyze existing elderly care service models, and investigate the factors that influence healthcare services for the elderly (chapter 2);

OS.2 Explore the advantages and challenges of healthcare services for the elderly in China, and analyze the development trend of China's healthcare service system in the future (chapter 2);

OS.3 Define the needs of elderly people, according to the classification of the elderly (chapter 3);

OS.4 Evaluate the relationship between aging and digital technology, and explore possible solutions for digital technology to help meet the needs of the elderly (chapter 4);

OS.5 Test the digital platform's feasibility in assisting the elderly in overcoming loneliness by offering care service activities (chapter 5);

OS.6 Define the existing healthcare problems faced by the elderly in China and explore how Chinese hospitals use digital platforms to provide healthcare services (chapter 6-7);

OS.7 Through discussions and research with the expert team, develop solutions that can help the elderly improve the digital user experience of the healthcare service platform and help them bridge the digital divide to a certain extent (chapter 8);

OS.8 Develop a design guideline of digital healthcare service platform to help designers or platform developers to build an age-friendly digital platform (chapter 9);

OS.9 Provide an evaluation mechanism to help designers or platform operators to evaluate and improve their digital healthcare service platform and make their platform much age-friendly (chapter 9);

OS.1-9 are through the contribution of design.

1.3 Research questions

Each part of the thesis has some research questions, and I give an answer to each one.

PARTE II—THE SCIENTIFIC RESEARCH

RQ1 What is the differences between Italy, China, and Japan's healthcare service systems?

RQ2 What is the Chinese medical insurance system, and how does it work?

RQ3 What types of healthcare service models are currently available?

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RQ4 What age is considered elderly in China, Italy and Japan?

RQ5 What are the needs of the elderly?

RQ6 How to help the elderly bridge the digital divide?

PARTE III—THE EXPERIMENTAL RESEARCH

RQ7 In the current technical conditions and social environment, can smart healthcare service system be an effective solution?

RQ8 What are the most pressing issues that older persons confront when it comes to the digital divide?

RQ9 How are Chinese medical institutions assisting the elderly by a digital healthcare service platform?

RQ10 What types of solutions are feasible for a researcher to address the digital divide?

PARTE IV—THE PROJECT RESEARCH

RQ11 How should a digital healthcare service platform for the elderly be designed?

RQ12 How to evaluate whether a digital platform is age-friendly?

1.4 Research methodology

My doctoral research is based on the development trend of healthcare services. The first phase is basic research. Qualitative and quantitative research methodologies are used to analyse and evaluate investigation and user research. Applied research and output are used to test the hypothesis. My research follows the following stages:

Phase 1. Deductive

- Definition of scientific problems and research objectives
- Research background and basic research
- Formulation of research hypothesis

This step begins with a review of the research background and literature. I study international organizations' policies on healthcare and ageing, and then analyse the demographic transition trend and healthcare service system for older people in China, Italy, Japan. The existing healthcare service models and factors influencing healthcare services can be acquired and summarised through a meta-analysis. In addition, I analyse China's medical insurance system. Based on these studies, I summarize the advantages, challenges, and opportunities of healthcare

services for the elderly in China (chapter 2). Using Maslow's hierarchy of needs, the characteristics and needs of the elderly can be analysed (chapter 3). Technology is promoting the development of the healthcare industry, but at the same time, it has also caused a digital divide. I study digital accessibility and digital inclusion. After describing the theoretical foundation, a research hypothesis (Smart healthcare service system based on AIoMT) was proposed (chapter 4).

Phase 2. Strategic and analytical

- Analysis of research projects and case studies according to the hypotheses
- Developing and defining research strategies

In order to verify this hypothesis and propose feasible solutions, I conduct two investigations, a case study and expert interviews which constructs the practical basis for research output. Qualitative and quantitative research methodologies, such as direct observations, focus groups, workshops, questionnaires to older people, and semi-structured interviews, are used in this phase. With a pilot study, I examine the feasibility of a digital platform to help the elderly overcome loneliness by providing short-term social care activities (chapter 5). In the second investigation, through questionnaire, direct observation, personas, user journey map, cultural probes, and service design methods, pain points and healthcare service needs of the elderly can be collected, and some problems faced by them can be analysed and summarised (chapter 6). A case study from a Chinese hospital can help deepen the understanding of the current medical services (chapter 7). Semi-structured interviews with experts and hospital directors can help better understanding of the situation and think about feasible solutions (chapter 8).

Phase 3. Inductive

- Evaluation and interpretation of output

The above research and analysis make it possible to apply this hypothesis in a real case and develop outputs. In the smart healthcare service system, the digital platform is a core and links the elderly with service providers. It is critical to consider how to design the digital platform. My research provides a design guideline to engage digital platforms to become more age-friendly, so that elderly people can enjoy the services and the convenience brought by digital platforms. The evaluation mechanism can help designers or platform operators evaluate and

improve their platform.

1.5 Expected results

Based on these studies, the expected results are:

- To provide a guide of digital healthcare service platforms for designers or policymakers who are interested in building or improving their digital platform.
- To define a reference model for hospitals that want to apply a smart healthcare service system in medical services
- To help the elderly bridge the digital divide to a certain extent, provide them more opportunities to use digital healthcare service platforms.
- To engage digital healthcare service platforms to become more age-friendly through the contribution of my research.

1.6 Innovativeness and scientific relevance

I consider the future development trend of healthcare services for the elderly in China by researching and comparing healthcare service systems in China, Italy, and Japan, and existing elderly care service models. I also summarize the advantages, challenges, and opportunities of healthcare services for the elderly in China. These studies provide guidance and directions for the future development of China's healthcare service system. By integrating and coordinating social and medical resources to support and help elderly people, the proposed model for a smart healthcare service system could realize the dynamic and refined management of the elderly.

The General Office of the State Council of China issued a national policy 'Implementation Plan for Practically Solving Difficulties of the Older People in Using Intelligent Technology in 2020. The purpose of this policy is to solve the problems faced by the elderly when using smart technology. One of the key items in this policy is to optimize the online healthcare service platform for the elderly and improve the health management service system for the elderly (State Council General Office, 2020). The design guidelines and evaluation mechanisms of a digital healthcare service platform can help designers or platform operators make their platform more age-friendly, which is important and helpful for elderly people to access healthcare services on digital platforms. The guide is valuable and practical and fills a gap in scientific research.

1.7 Research output

My research provides a design guideline including criteria, methods, tools, and an evaluation mechanism.

- This guide describes the challenges that elderly people face when using digital platforms. In each part, I provide some design criteria and methods that can be directly used to design and construct a digital platform. The guideline can be used as a reference standard to assist designers or platform developers in developing a digital healthcare service platform for the elderly.

- The evaluation mechanism consists of some design tools and a checklist. The stakeholder map can help understand how older people are connected to other key stakeholders. Wireframes can be used to evaluate if the platform's structure is user-friendly for the elderly. User journey map and system map can help evaluate the service process, and all the actors and components involved in service delivery. Evaluation matrix can help evaluate the time consuming and interaction complexity among healthcare services. The checklist can help designers or platform operators find shortcomings in their platform and then make improvements to make their platform more age-friendly.

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PART II

SCIENTIFIC RESEARCH

**CHAPTER 2
HEALTHCARE SERVICES**

**CHAPTER 3
USER RESEARCH**

**CHAPTER 4
AGEING AND DIGITALTECHNOLOGY**

Part II — Research questions

RQ1 What is the differences between Italy, China, and Japan's healthcare service systems?

RQ2 What is the Chinese medical insurance system, and how does it work?

RQ3 What types of healthcare service models are currently available?

RQ4 What age is considered elderly in China, Italy and Japan?

RQ5 What are the needs of the elderly?

RQ6 How to help the elderly bridge the digital divide?

This chapter begins with a review of the healthcare service system for the elderly. Three countries (Italy, China and Japan) are the main research objects in studying demographic transition trends. The proportion of the elderly population is larger than the global average in these three countries. China has the largest number of older adults in the world. In Europe, Italy is facing more severe problems caused by ageing than the rest of Europe. Japan entered an ageing society earlier than China did, and studying the Japanese healthcare system can serve as a reference for future Chinese policymaking. The in-depth study of the medical insurance system in China provides a reference solution for other countries to address the problem of rising medical expenses due to an ageing population. Therefore, these studies answer RQ1 and RQ2. For RQ3. The literature review helps understand the existing healthcare service models. By classifying these models, the elderly can choose their preferred care service models based on where they live. Case studies help gain a deeper understanding of the healthcare service systems. Based on these studies, the advantages, challenges and opportunities of healthcare services for the elderly in China are summarized.

Questo capitolo inizia con una revisione del sistema dei servizi sanitari per gli anziani. Tre paesi (Italia, Cina e Giappone) sono i principali oggetti di ricerca nello studio dei trend di transizione demografica. La proporzione della popolazione anziana è maggiore della media globale in questi tre paesi. La Cina ha il maggior numero di anziani al mondo. In Europa, l'Italia sta affrontando gravi problemi causati dall'invecchiamento rispetto al resto d'Europa. Il Giappone ha subito un invecchiamento della società prima della Cina e lo studio del sistema sanitario giapponese può servire come riferimento per le future politiche cinesi. Lo studio approfondito del sistema di assicurazione medica in Cina fornisce un riferimento per affrontare il problema dell'aumento delle spese mediche a causa dell'invecchiamento della popolazione. Pertanto, questi studi rispondono a RQ1 e RQ2. Per RQ3 la revisione della letteratura aiuta a comprendere i modelli esistenti di servizi sanitari. Classificando questi modelli, gli anziani possono scegliere i modelli di servizio di assistenza preferito in base a dove vivono. I casi studio aiutano ad acquisire una comprensione più profonda dei sistemi di servizi sanitari. Sulla base di questi studi vengono riassunti i vantaggi, le sfide e le opportunità dei servizi sanitari per gli anziani in Cina.



CHAPTER 2

HEALTHCARE

SERVICES

- 2.1 Background
- 2.2 The demographic transition
- 2.3 Healthcare Service System for older people. (China, Italy, Japan)
- 2.4 Healthcare service models
- 2.5 Influencing factors of healthcare services for the elderly
- 2.6 Case studies about healthcare services
- 2.7 The advantages, challenges and opportunities of healthcare services for the elderly in China

References

2.1 Background

Global health spending increased steadily between 2000 and 2018, reaching US \$ 8.3 trillion, or 10% of global GDP, according to the 2020 Report from "Global Health Spending: Weathering the Storm." The data also show that in low and lower-middle-income nations, out-of-pocket spending remained high in 2018, accounting for more than 40% of total health spending (Health Systems Governance and Financing UHL, 2020). The United Nations General Assembly declared the decade of healthy ageing 2021-2030 in December 2020. Healthy ageing becomes the focus of WHO's work on ageing, highlights the importance of taking action across different sectors and allows older individuals to continue to be a resource to their families, communities, and economies (WHO, 2015). Population ageing has become one of the most significant social transformations of the twenty-first century, affecting nearly every aspect of society, including labour and financial markets, demand for goods and services like housing, transportation, social protection, and family structures intergenerational ties. Older people are increasingly viewed as contributors to development, and their skills to act to improve themselves and their societies should be woven into all policies and programs. In the coming decades, many countries are likely to face fiscal and political pressures with public systems of healthcare, pensions and social protection due to a growing older population (United Nations, 2019).

Active and health ageing

To address population ageing, WHO put forward the concept of healthy ageing at the World Health Assembly in 1987. In 2002, the WHO put forward a policy framework of "active ageing". Active ageing is the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age (WHO, 2002). Healthy ageing is the focus of WHO's work on ageing between 2015 – 2030. Healthy ageing replaces the policy of active ageing, a policy framework developed in 2002. It is about creating the environments and opportunities that enable people to be and do what they value throughout their lives. WHO defines Healthy Ageing as the process of developing and maintaining the functional ability that enables wellbeing in older age. Functional ability is about having the capabilities that enable all people to be and do what they have reason to value. This includes a person's ability to: meet their basic needs; to learn, grow and

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make decisions; to be mobile; to build and maintain relationships; and to contribute to society (WHO, 2019). It needs to consider which activities can help older people improve their wellbeing and participation in society.

The 2030 Agenda for Sustainable Development and the SDGs

Transforming World: the 2030 Agenda for Sustainable Development (including its 17 Sustainable Development Goals (SDGs) and 169 targets) was adopted on 25 September 2015 by Heads of State and Government at a special UN summit (European commission, 2021). The Sustainable Development Goals (SDGs) are the blueprint for achieving a better and more sustainable future for all. In Goal 3: Good health and well-being, ensuring healthy lives and promoting the well-being for all ages is essential to sustainable development (United Nations, 2021a). WHO's work is aligned with SDG target 3.8, which focuses on achieving universal health coverage (UHC), including financial risk protection, access to quality essential healthcare services and access to safe, effective, quality and affordable essential medicines and vaccines for all. WHO defines universal Health Coverage (UHC) as ensuring that all people and communities receive the quality services they need and are protected from health threats without financial hardship. The essence of UHC is universal access to a solid and resilient people-centred health system with primary care as its foundation. Community-based services, health promotion, disease prevention and immunization are key components that constitute a robust platform for primary care upon which UHC needs to be built (WHO, 2021a). Equity is at the heart of the 2030 Agenda for Sustainable Development. It is of particular importance that paragraph 26 of the 2030 Agenda states: "To promote physical and mental health and well-being, and to extend life expectancy for all, we must achieve universal health coverage and access to quality health care. No one must be left behind", thus highlighting the role of the health sector in addressing the needs of the most disadvantaged and vulnerable (WHO, 2021b).

At the World Health Assembly in May 2016, 194 countries agreed that every country should have a long-term care system. However, not so many countries have a system that can adequately meet their populations' care and support needs. Long-term-care systems that are sustainable and equitable can take different forms depending on the cultural and economic context. Older people continue to have aspirations

to well-being and respect regardless of declines in physical and mental capacity. Long-term-care systems enable older people, who experience significant declines in capacity, to receive the care and support of others consistent with their basic rights, fundamental freedoms and human dignity (WHO, 2016).

Horizon Europe is the Commission proposal for a € 100 billion research and innovation funding program for seven years (2021-2027). In Pillar 2: global challenges & industrial competitiveness, the budget for health is 7.7 billion. The research areas include health throughout the life course, environmental and social health determinants, non-communicable and rare diseases, tools, technologies and digital solutions for health and care, environmental and social health determinants, infectious diseases, and the health care system. The healthcare system is a significant part of my research content.

2.2 The demographic transition

According to the classification criteria established by the United Nations — The Ageing of Populations and its Economic and Social Implications in 1956 (United Nations, 1956) — the aging society is defined as the country or region in which the population aged 65 years or over accounts

Rank	Country	% 65+ (of total population)	65+ (in millions)	total population (in millions)
1	Japan	28.2	35.58	126.18
2	Italy	22.8	13.76	60.34
3	Finland	21.9	1.21	5.52
4	Portugal	21.8	2.24	10.27
5	Greece	21.8	2.33	10.70
6	Germany	21.4	17.78	83.10
7	Bulgaria	21.3	1.49	6.98
8	Croatia	20.4	0.83	4.05
9	France	20.3	13.16	64.83
10	Latvia	20.3	0.39	1.91

Tab.2.1
The percentage of people aged 65 years or over

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for more than 7% of the whole population. According to the report of World Population Prospects 2019 (United Nations: department of economic and social affairs, 2019), the problem of an ageing population is most serious in Japan, Italy and Finland (Tab.2.1).

Japan has the highest percentage of older adults, with 28.2% of its population being 65 or older. Next on this list is Italy, with 22.8% of its population aged 65 years or over. Elderly population in this country has remained at around 20% between 2005 and 2010 but has steadily risen in the few years since.

Rank	Country	65+ (in millions)	% 65+ (of total population)	total population (in millions)
1	China	166.37	11.9	1398.03
2	India	84.90	6.1	1391.89
3	United States	52.76	16.0	329.15
4	Japan	35.58	28.2	126.18
5	Russian Federation	21.42	14.6	146.73
6	Brazil	17.79	8.5	209.33
7	Germany	17.78	21.4	83.10
8	Indonesia	15.16	5.6	268.42
9	Italy	13.76	22.8	60.34
10	France	13.16	20.3	64.83

Tab.2.2
The number of
people aged 65
years or over

China, India and United States have the largest number of older adults (Tab.2.2). China is the country with the most elderly population around the world, and it is also one of the countries with the fastest increase in population ageing. The number of people aged 65+ in Japan is also bigger, about 35.58 million. In Europe, Italy has the second-highest number of older people, behind Germany.

The size and age composition of a population are determined jointly by three factors: fertility, mortality and migration. All regions have experienced substantial increases in life expectancy since 1950. Decreasing fertility and increasing life expectancy are the key drivers of population ageing. In some countries and regions, international migration is also an important factor (United Nations, 2021b). The demographic transition describes changes throughout socio-economic modernization.

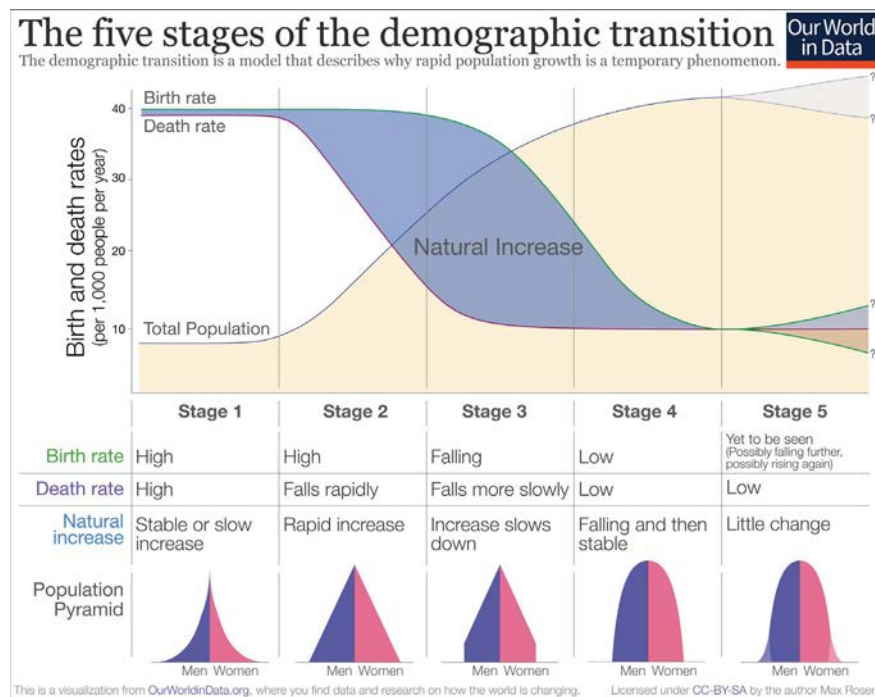


Fig.2.1
The five stages of the demographic transition. From:Max Roser, Hannah Ritchie & Esteban Ortiz-Ospina (2013)

Birth rates and death rates determine the population growth rate. Low birth rate and low death rate may cause an ageing population. There are five stages in the demographic transition (Fig.2.1) (Max Roser, Hannah Ritchie & Esteban Ortiz-Ospina, 2013):

(1) High mortality rates, high birth rates and low population growth rates
Due to high mortality and birth rates, the population pyramid is broad at the bottom and significantly narrower at the top.

(2) Mortality falls, but birth rates are still high, and rapid population growth

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Because the population's health has improved, mortality rates have decreased, while the birth rate remains as high as before. The number of the population has an increasing trend.

(3) With low death rates, the birth rate falls, and population growth slows.

The fertility starts to decline, and consequentially, the increase of population also slows down.

(4) Low mortality rates, low birth rates and stable population growth rates

The mortality rate and the birth rate are both low. The population will steadily shrink if the birth rate is lower than the mortality rate. This is the current condition in several countries throughout the world.

(5) Low mortality and signs of increased fertility

When countries or societies have a very high level of development, the demographic transition will reach this stage. The death rate is low. The birth rate can impact whether the population grows or shrinks.

2.2.1 China

Figure 2.2 shows China's birth rate, death rate and the rate of natural increase from 1949 to 2019 (National Bureau of Statistics in China, 2020). From the figure, we can see that the first peak occurred from 1952 to 1954. After World War II, the Chinese government implemented policies to convince people to have babies. This was the first baby boom in China. From 1959 to 1961, China experienced the worst natural disasters, and a large number of people died of hunger, which led to a rapid population decline. The second peak was in 1963. Many couples postponed parenthood due to natural disasters. After the socio-economic conditions improved, many children were born. This is referred to as the second baby boom. After the One-child policy was enforced in 1982, the number of births dropped sharply. In the 1980s, those born in the second baby boom reached childbearing age, and the huge population base brought about a third baby boom. In 2019, the birth rate was 10.48‰, the death rate was 7.14‰, and the natural population growth rate was 3.34‰. According to statistics released by the National Health Commission of the People's Republic of China, the average life expectancy of Chinese citizens had reached about 77.3 years in 2019. In 2020, the old-age

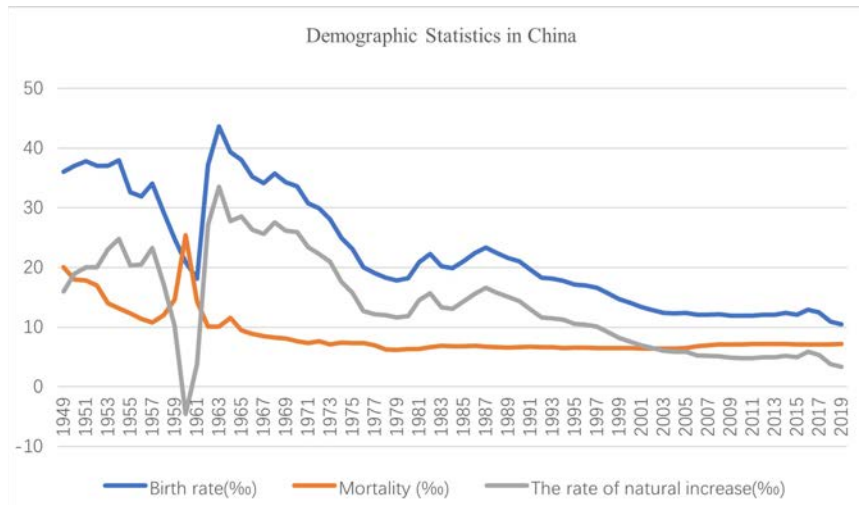


Fig.2.2 Demographic Statistics in China. From: The world bank (2019a)

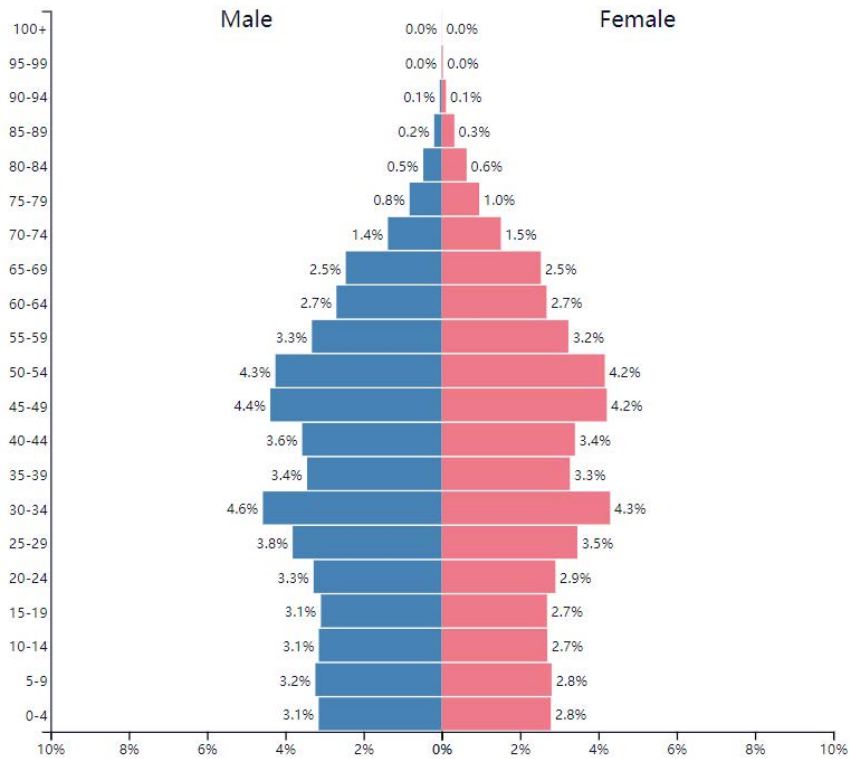


Fig.2.3 Population Pyramids of China in 2019. From: <https://www.populationpyramid.net/china/2019/>

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dependency ratio for China was 17%. The old-age dependency ratio is the ratio of older people aged 65 and over to the working-age population aged between 15 and 64 (Statista, 2021a). China is currently in the fourth stage of the demographic transition.

China's population is ageing because of the long-term low birth rate and the increasing life expectancy. This is reflected in the shape of the population pyramid, where the bottom bars are narrow and the middle bars are wider (Fig.2.3).

2.2.2 Italy

Since the baby boom of the 1960s, Italy's birth rate decreased gradually (Fig.2.4). The natural increase was also negative and decreased from 1993, which means that the number of deaths exceeded the number of births. This is why the elderly account for an increasing proportion of the population (Statista Research Department, 2021). For solving this problem, the Italian government has tried to take measures to encourage a baby boom. In fact, many young couples want to have children, but considering the financial burden, they have to postpone parenthood. In order to change the situation, the Italian government introduced a "Bonus Bebè" to help low and middle-income families, offering them a monthly allowance ranging from €80 to €192. The old-age population

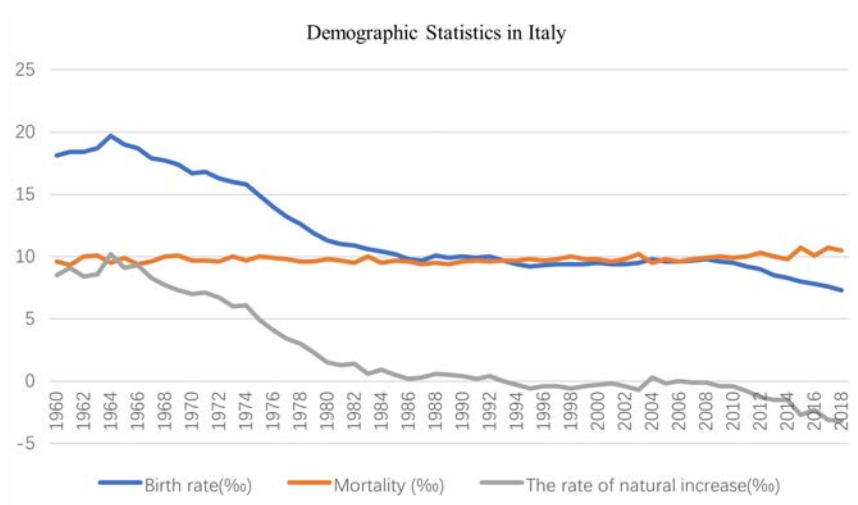


Fig.2.4
Demographic
Statistics in
Italy. From:
The world
bank (2019b)

dependency ratio in Italy was huge worldwide, with 36.2 older people every 100 individuals in working age, just behind Japan (Statista, 2021b). The public pension burden on the government is heavy.

The life expectancy for Europe is the highest around the world, and Italy is one of the countries with the highest life expectancy, reaching 83.57 years in 2020 (Eurostat, 2020). However, due to the COVID-19, it decreases to 82 during this year (L'Economia, 2021). Italy is in the fourth stage. The shape of Italy's population pyramid is typical of a developed country (Fig.2.5). It is narrow at the base and broader in the middle. The percentage of people aged between 45 and 55 is the largest. In the next 10 to 20 years, the ageing population problem will become more severe in Italy.

2.2.3 Japan

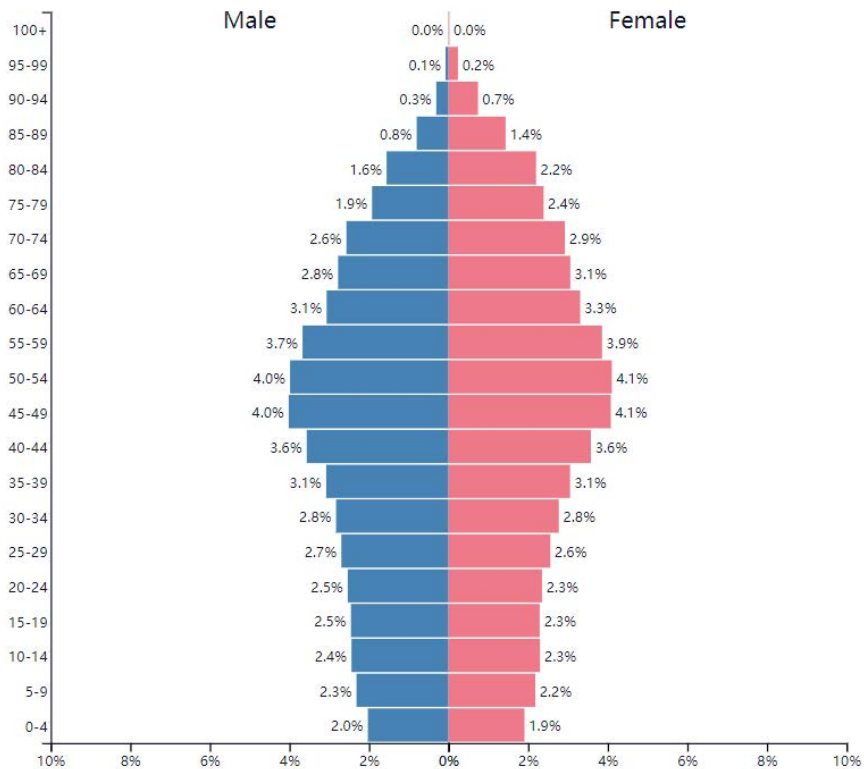


Fig.2.5
Population
Pyramids of Italy
in 2019. From:
[https://www.
populationpyramid.
net/italy/2019/](https://www.populationpyramid.net/italy/2019/)

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Between 1947 and 1949, Japan had the first baby boom (a post-war baby boom). It should be noted that in 1966, the birth rate had a sharp decline (Fig.2.6). This is because 1966 is considered as the year of the 'Fire Horse'. The Japanese use modified Chinese astrology. They believe that girls born in 1966 were dangerous and bad luck for their future husbands. These girls may be discriminated against. In this year, a baby's sex had not been detected before birth. There was a significant increase in induced abortions and a sharp decline in the birth rate. From 1971 to 1974, more than 2 million children were born pre year, and this is referred to the second baby boom in Japan. Since the second baby boom, Japan's birth rate and natural increase rate have been declining for decades, resulting in Japan's ageing population. Since 2005, the population has shown a trend of negative growth. Japan has the highest old-age dependency ratio, reaching 48% in 2020. This proportion is projected to rise to 79% in 2050 (OECD, 2018). The public pension burden on the government of Japan is becoming heavier.

The shape of Japan's population pyramid is similar to that of Italy (Fig.2.7). In 2019, the life expectancy in Japan was the highest, reaching 84.55 years. Japan has the highest proportion of older people around the world. The decreasing birth rate and high life expectancy are expected to continue in Japan (Armstrong, 2016).

With the similar demographic trend, the socio-economic environment in the three countries also has similarities. According to the population pyramids of the three countries, we can find that the problems of the ageing population will become more severe in the next 10-20 years. They all need to deal with the challenges of an ageing population. The research on sustainable health service systems is inherently relevant to these countries.

2.3 Healthcare Service System for older people. (China, Italy, Japan)

A health system consists of all organizations, people and actions whose primary intent is to promote, restore or maintain health. This includes efforts to influence determinants of health as well as more direct health-improving activities. A health system is therefore more than the pyramid of publicly owned facilities that deliver personal health services." (World

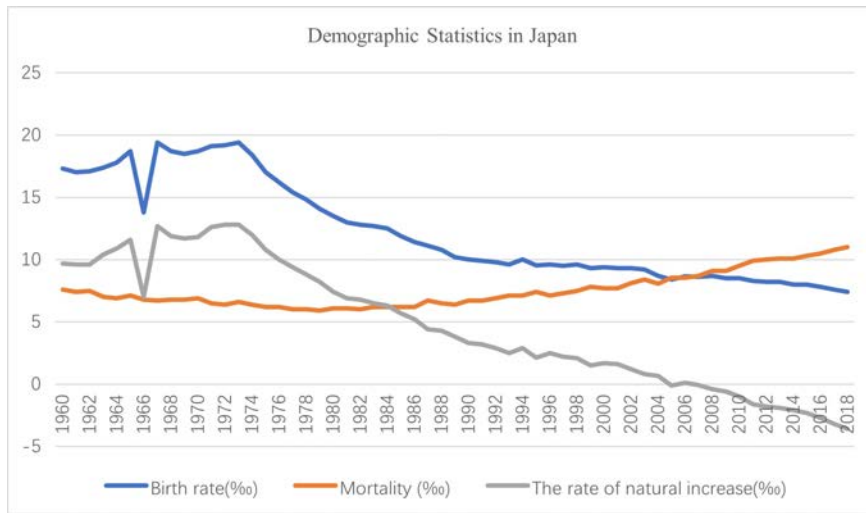


Fig.2.6
Demographic
Statistics in Japan.
From: The world
bank (2019c)

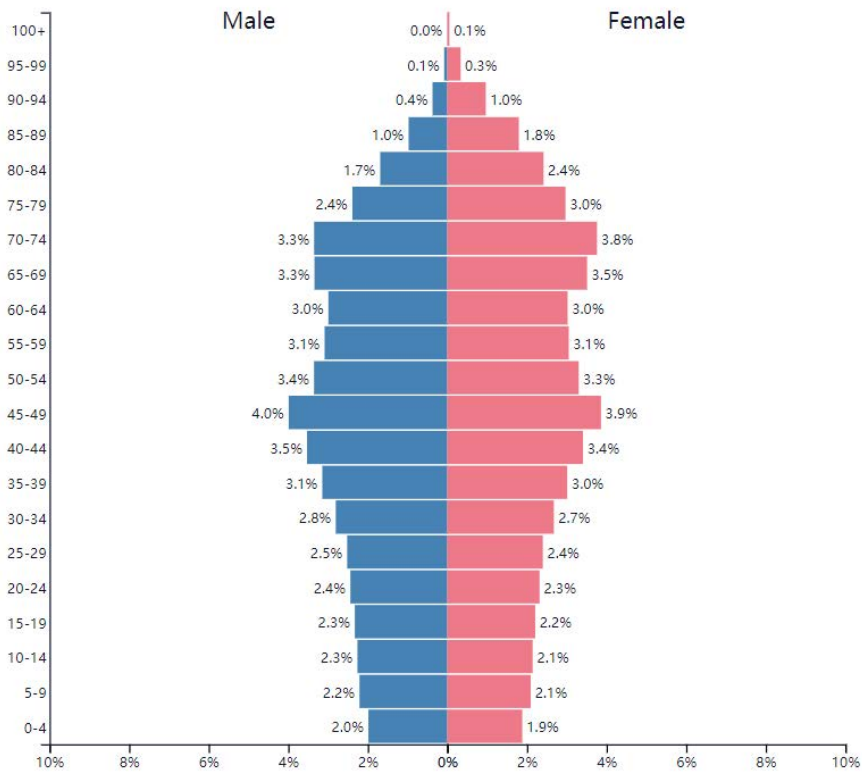


Fig.2.7
Population
Pyramids of Japan
in 2019. From:
[https://www.
populationpyramid.
net/japan/2019/](https://www.populationpyramid.net/japan/2019/)

Health Organization, 2007)

According to the definition provided by the World Bank from 1994 *Averting the Old Age Crisis*, the three pillars of a pension system consist of two mandatory pillars (publicly managed pillar and privately managed pillar) and a voluntary pillar. Backed by the government's power of taxation, the public pillar (a flat, subsistence pension) would help alleviate old-age poverty and co-insure against a multitude of risks. The privately managed pillar (earnings-related pensions) could take two alternative forms: personal saving accounts or occupational plans. Voluntary occupational or personal saving plans (voluntary retirement savings) would be the third pillar, providing additional protection for older people who want more income and insurance (World Bank, 1994).

2.3.1 Healthcare service system for older people in China

In the past decade, the healthcare service system for older people in China has developed rapidly. Policies on protecting the rights and interests of the elderly and in the healthcare service industry have been further improved. The coverage of primary healthcare services and basic medical security has been continuously expanded. The social participation of the elderly has further improved. The spiritual and cultural life is increasingly rich, and their sense of wellbeing has increased significantly. China has formed a multi-level healthcare service system based on home care, community care as the support, institutional care as a supplement and a combination of medical care (State Council of the People's Republic of China, 2017).

In China, some communities have had daycare centres that can provide resting places and cheap meals for the elderly. The government paid for these social services. Family doctors in the community are required to sign contracts with the elderly to provide door to door services. Older people over 60 years old can have free physical examination once a year and participate in many public health lectures organized by public sectors. When older people have minor illnesses, they can be treated in the community, and for serious illnesses, they will be transferred to hospitals for treatment.

This healthcare service system in China can cover a large number of

older people. The Chinese government now encourages social funds to participate in the healthcare service industry, and the government will provide subsidies if these institutions meet evaluation criteria. Many nursing homes are located near large hospitals or invested by large hospitals. Nursing homes combined with healthcare and medical care can provide services for all the elderly.

2.3.1.1 The development of the healthcare service system

In China, the development of the healthcare service system can be divided into three stages (Tab.2.3). The first stage is the initial stage (1949-1979). The main feature was family-led care for the elderly, and limited social service resources can help elderly orphans. The second

The development stage	Features	Related policies
The initial stage (1949-1979)	Family-led care model, supplemented by national welfare	There is no an official ageing policy
The exploratory stage (1980-2010)	the enhancement of social services, the development of the nursing home and the community care	<i>The Eighth National Civil Affairs Conference (1983)</i> <i>Decision of the CPC Central Committee and State Council on Strengthening Work on Aging (2000)</i> Opinions on <i>Comprehensively Promoting Home Care Services (2008)</i>
The rapid development stage (2011-Now)	Industrialization of healthcare services, a diversified, hierarchical, and systematic healthcare service system	Construction Plan of social healthcare service system 2011-2015 (2011) Several opinions on accelerating the development of the healthcare service industry (2013) “Healthy China 2030” Planning Outline (2016).

Tab.2.3
The development stage of healthcare service system in China

stage is the exploratory stage (1980-2010). In this stage, institutional and community healthcare services began to develop. The third stage is the rapid development stage (2011 to present). During the period, a primary healthcare service system has formed. A diversified, hierarchical and systematic healthcare service system is developing rapidly (Zhang, 2016).

2.3.1.2 The composition of the healthcare service system for elderly

China's elderly care service system is mainly composed of three parts: home care, community care and institutional care for the elderly (General Office of the State Council of the People's Republic of China, 2011).

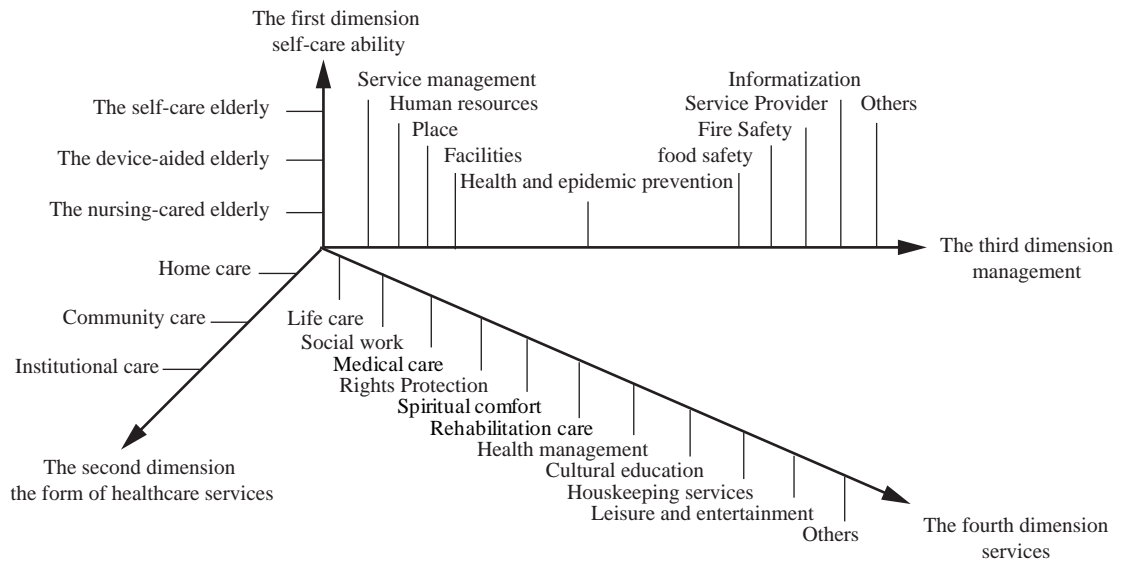
Home care services cover life care, housekeeping services, rehabilitation care, medical care, spiritual comfort, etc., with door-to-door services as the main form. For the elderly who are in the good physical condition and can take care of themselves, social service organizations can provide canteens, legal aid and other services. For older people who cannot take care of themselves, social service organizations provide domestic services, medical care, meal delivery services, emergency calls and other services.

Community care services are essential supports for home care services, with two functions: community day care and home support service. Institutional care for the elderly includes nursing homes and other healthcare institutions. These institutions mainly provide specialized services for disabled and semi-disabled seniors. These services are mainly to meet the needs of the elderly in daily life.

2.3.1.3 The standards of healthcare services

Based on the current status and trends of the development of healthcare services, the Chinese government has established standards for healthcare services in four dimensions: self-care ability, the form of healthcare services, service and management (Ministry of Civil Affairs & National Standards Committee, 2017).

The first dimension is self-care ability. Older people with different self-care abilities need different services. Older people are divided into



three categories: The self-care elderly, The device-aided elderly and the nursing-cared elderly. The second dimension: the form of healthcare services. It is divided into three types: home care, community care and institutional care. The third dimension: services. Various service items and types that healthcare services involve. The fourth dimension is management, personnel, places, facilities, safety and other management elements (Fig.2.8).

Fig.2.8
The standards of healthcare services. From: Ministry of Civil Affairs & National Standards Committee (2017)

2.3.1.4 Retirement age and pension

(1) Retirement age

According to the Law on *the Protection of the Rights and Interests of the Elderly*, 60 years are defined as the fixed threshold at which old age begins. Chinese law stipulates that if the staff of departments, agencies, public bodies and other organizations meet one of the following conditions, they should retire.

- Males are at least 60 years old; females are at least 50 years old; The overall length of service is more than ten years.
- Males are at least 55 years old; females are at least 45 years old; The overall length of service is more than ten years, and those perform exceptionally strenuous physical labour or other work that is harmful to their health.

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- Males are at least 50 years old; females are at least 45 years old; The overall length of service is more than ten years, and a person who is certified by a hospital and confirmed by the Labour Accreditation Board to be incapacitated shall retire.

(2) The Chinese pension system

China's pension system is currently centred around three primary pillars (Tab.2.4): state-endorsed public pension, enterprise annuities and personal pension (Dong, Wang, & Zhang, 2020; Melody, 2019). The first two pillars currently serve as the bedrock of China's pension regime.

Pillars	Categories	Forms	Target group	Participation method	Payment method	Pension
State-endorsed public pension	BOAIS for urban enterprise employees	social pools and individual accounts	urban enterprise employees	compulsory	employer and individual	Basic pension and individual account
	BOAIS for government employees	social pools and individual accounts	government employees	compulsory	employer and individual	Basic pension and individual account
	BOAIS for urban and rural residents	social pools and individual accounts	urban and rural residents	Policy incentives	Individual, group grants and government subsidies	Basic pension and individual account
Enterprise annuities	enterprise annuities	individual accounts	urban enterprise employees	free choice	employer and individual	individual account
	occupational annuities	individual accounts	government employee	compulsory	employer and individual	individual account
Personal pension	the Tax Deferred Pension Insurance and commercial pension insurance	individual accounts	Individuals	free choice	individual and tax incentives	individual account

Tab.2.4
The Chinese pension system

The state-endorsed public pension includes the Basic Old-Age Insurance System (BOAIS) for urban enterprise employees, BOAIS for government employees and BOAIS for urban and rural residents. The second pillar includes enterprise annuities and occupational annuities. The last pillar is the Tax-Deferred Pension Insurance and commercial pension insurance.

2.3.1.5 The country's medical insurance system in China

(1) Introduction

China's Social Security System consists of 5 mandatory insurance schemes (pension fund, medical insurance, industrial injury insurance, unemployment insurance, and maternity insurance) and a housing fund (only applicable to Chinese employees) (Fig.2.9) (Hrone,2021).

Medical insurance is a significant part of the social security system. Healthcare in China consists of public and private medical institutions and insurance programs. The country's health insurance includes medical social insurance and commercial health insurance. In China, commercial health insurance is provided and administered by nongovernmental entities and insurance companies. The increase of commercial health insurance has slowed due to the central government's push for universal medical insurance coverage. My research mainly focuses on social medical insurance. Social medical insurance is obligatory and enforced



Fig.2.9
China's social security system. From: Hrone (2021)

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by the country through legislation. Employers (or government) and individuals pay insurance premiums in a certain proportion. By the end of 2020, 1.36 billion people (about 95% of the population) were covered by social medical insurance. China's social health insurance card is similar to the Italian health insurance card (Tessera sanitaria). The government has issued electronic cards (Fig.2.10 a), and the functions are the same as physical cards (Fig.2.10 b). All insured persons can apply it through the official APP, WeChat, and Alipay.



Fig.2.10 a
The social health insurance card in China—electronic card



Fig.2.10 b
The social health insurance card in China—physical card

The country's medical insurance mainly includes three parts, Urban Employee Basic Medical Insurance (UEBMI), Urban Resident Basic Medical Insurance (URBMI), and the New Rural Cooperative Medical Scheme (NRCMS) (Dong et al., 2021). Each targets a different population. The target population of Urban Employee Basic Medical Insurance (UEBMI) is urban employees. The Urban Resident Basic Medical Insurance targets the urban unemployed, elderly, students and children.

Rural residents are the target population of The New Rural Cooperative Medical Scheme (NRCMS). In brief, the first employee insurance is for those who have a job. The other two insurances are for residents who do not have a job.

China largely achieved universal insurance coverage in 2011 through the three public insurance programs (Yu, 2015). The health system is very complicated and is guided by the principle that every citizen is entitled to receive basic healthcare services. Local governments — provinces, prefectures, cities, counties, and towns — are responsible for organizing and providing these services (Fig.2.11) (Fang, 2020).

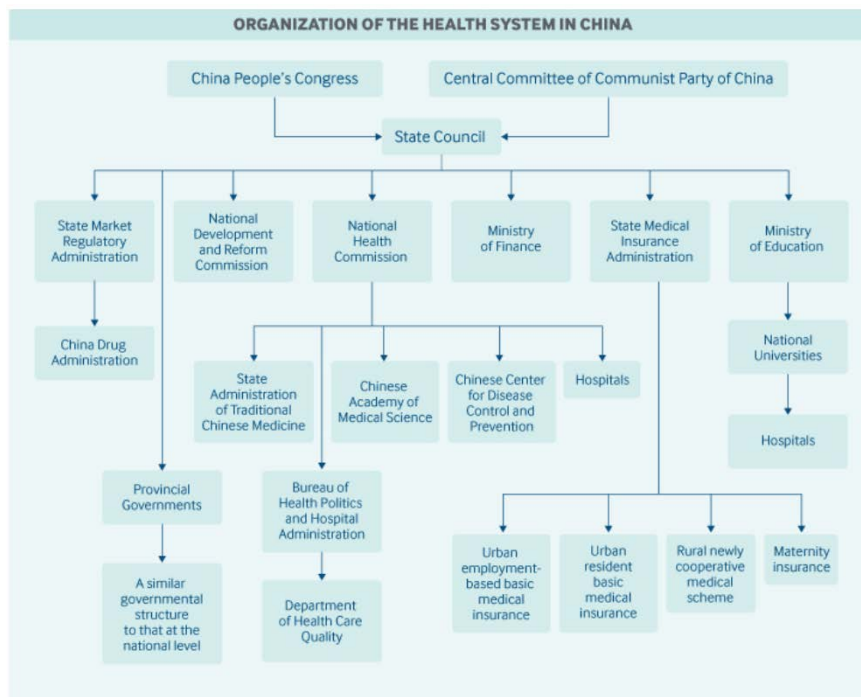


Fig.2.11 Organization of the health system in China. From: Fang (2020)

(2) Insurance premiums

Medical insurance is required to be paid by the employer and the employees every month, and insurance premiums are directly deducted from employees' wages (Tab.2.5). Residents who do not have a job pay their insurance premiums once a year. There are two accounts in employee medical insurance, a pooled basic medical insurance fund account and an individual account, while the resident medical insurance

Features of Each Scheme	Urban Employee Basic Medical Insurance (UEBMI)	Urban Resident Basic Medical Insurance (URBMI) New Rural Cooperative Medical Scheme (NRCMS)
Payment method	monthly	Annually
Pooled basic medical insurance fund account	Yes	Yes
Individual account	Yes	No
Personal payment	Approximately 120-2000 Euros per year	Approximately 40 Euros per year
Financing	Employer (6–8% of salary) Individual (2–3% of salary)	Government subsidy about 80% Individual about 20%

Tab.2.5
Characteristics of
the three social
health insurance
schemes in China

has only the first account and does not have the individual account. The pooled basic medical insurance fund account is mainly used to reimburse medical expenses, such as hospitalization, chronic disease, or special disease. The individual account is mainly used for minor expenses other than medical reimbursements, such as buying medicines, outpatient visits, and personal out-of-pocket expenses after reimbursement. The basic medical insurance premiums shall be paid jointly by the employer and the employees concerned. The payment rate for the employer shall be controlled at about 6% of the total amount of the employees' wages, while that for each employee shall be 2% of his wage income. With the economic development, the payment rates for employers and employees may be adjusted accordingly (State Council, 1998).

The personal payment of Urban Employee Basic Medical Insurance (UEBMI) is significantly higher than the other two schemes, so the proportion and amount of reimbursement of UEBMI are much higher than that of the other two schemes. Employees who have paid for the medical insurance for the specified number of years (men: over 25 years, women: over 20 years) can enjoy medical insurance for free after retirement, while residents need to pay for medical insurance every year.

(3) Reimbursement

The reimbursement scope of medical insurance mainly includes medicines, items of diagnosis and treatment, and facilities of medical service (Tab.2.6). The prerequisite for reimbursement is that the insured people must go to the prescribed medical institutions to receive treatment and the prescribed pharmacy to purchase medicines. At present, there are a large number of medical institutions and pharmacies that insured people can choose from.

Scope	Content	Ratio
Medicines	Class A	Almost 100%
	Class B	Prescribed ratio
Items of diagnosis and treat	Such as medical expenses, inspection fees, surgical costs, and other expenses	Prescribed ratio
Facilities of medical service	Such as hospital beds	General ward: 100%
		Special wards: pay yourself

Tab.2.6
The reimbursement scope of medical insurance

●Medicines

Medicines are divided into class A and class B. Class A refers to those that are widely used and lower in price. The costs of class A can be reimbursed at almost 100%. Class B refer to those medicines with higher prices. In class B, the reimbursement ratio of each medicine is different, so the cost of this kind of medicine needs to be reimbursed according to the prescribed ratio. Only the cost of medicines that enter the National Reimbursement Drug List (NRDL) can be reimbursed. In order to expand sales, many pharmaceutical companies hope their medicines can enter the list. Therefore, the government has the right to bargain, which can reduce the price of medicines provided by pharmaceutical companies. This allows the public to buy the medicines they need at a lower price. The Chinese government is constantly expanding the National Reimbursement Drug List (NRDL).

●Items of diagnosis and treatment

Medical expenses that are necessary for treatment, such as inspection fees, and surgical costs, can be reimbursed in a fixed proportion. Due to different policies, the reimbursement ratio needs to be determined according to local laws.

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●The facility fee

If insured people use the facilities provided by medical institutions in diagnosis, treatment and nursing, the facility fee can be reimbursed.

(4) Reimbursement ratio

In different cities or different hospitals, the reimbursement ratio is different. I take Beijing's reimbursement policy as an example. For a better understanding, I converted RMB into Euros.

Urban Employee Basic Medical Insurance (UEBMI)

In China, hospitals with lower grades have higher reimbursement rates. For example, community hospitals usually have a higher reimbursement ratio than tertiary hospitals. In this case, people can receive minor illness treatment in community hospitals, and there is no need to go to a tertiary hospital. This is a way for the government to alleviate the shortage of medical resources.

There are two restrictions on medical insurance reimbursement. The first is the amount of reimbursement. When we use medical insurance to reimburse medical expenses, there is usually an annual deductible. Expenses below the annual deductible are not reimbursed, and expenses that exceed the deductible can be reimbursed. If the medical expenses exceed the insurance cap, you will be responsible for any excess costs. The insurance cap is different from region to region.

●Outpatient care

For those with employee medical insurance, the annual deductible for their outpatient visits is about 230 euros. They go to the community hospital to see a doctor, and 90% of expenses can be reimbursed. When they go to a regional or tertiary hospital, 70% of their expenses can be reimbursed. If they have retired, their annual deductible is about 170 euros. For treatment in a community hospital, they can be reimbursed

Tab.2.7
Reimbursement
ratio for an
outpatient care

	Employment status	Annual deductible	Insurance cap	Reimbursement ratio		
				Primary hospital	Secondary hospital	Tertiary hospital
Outpatient	On-the-job	230 euros	2600 euros	90%	70%	70%
	Retirees	170 euros		90%	85%	90%

90% of their costs. They visit a regional hospital, and 85% of expenses can be reimbursed. For a visit to tertiary hospitals, they only need to pay 10% of the costs. For outpatient care, the insurance cap is 2600 euros. The excess costs need to be paid by themselves (Tab.2.7).

● Inpatient care

The annual deductible for the first inpatient care each year is 170 Euros. During this year, starting from the second hospitalization, the deductible dropped to 85 Euros. The amount of medical expenses determines the reimbursement ratio. 90% of the expenses can be reimbursed for office workers when they spend less than 4,000 euros in the primary hospital. In the secondary (regional) hospital, the reimbursement ratio is 87%, while in tertiary hospitals, the ratio is 85%. When the medical expenses increase to 13,200 Euros, the ratio also increases to 95-97%. If the medical expenses exceed 13,200 Euros and less than 66,000 Euros, only 85% of the expenses can be reimbursed. Once the medical expenses exceed 66,000 Euros, the excess expenses cannot be reimbursed.

For retired elderly people, their overall reimbursement ratio is slightly higher than that of office workers. Almost 90% of expenses can be reimbursed. Similarly, the insurance cap is also 66,000 Euros, and the excess part needs to be paid by themselves (Tab.2.8).

	Employment status	Annual deductible	Insurance cap	Reimbursement ratio		
				Primary hospital	Secondary hospital	Tertiary hospital
Inpatient care	On-the-job	170 euros for the first Inpatient visit in this year, 85 euros for the second and subsequent visits	170-4000 euros	90%	87%	85%
			4000-5300 euros	95%	92%	90%
			5300-13200 euros	97%	97%	95%
			13200-66000 euros	85%		
	Retirees		170-4000 euros	97%	96%	95%
			4000-5300 euros	98%	97%	97%
			5300-13200 euros	99%	99%	98%
			13200-66000 euros	90%		

Tab.2.8
Reimbursement ratio for an inpatient care

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Urban Resident Basic Medical Insurance (URBMI) and New Rural Cooperative Medical Scheme (NRCMS)

The reimbursement ratios of URBMI and NRCMS are similar and lower than that of employee medical insurance. When they visit the outpatient clinics of primary hospitals, they can be reimbursed for expenses exceeding 15 Euros, but only 55% of the extra expenses can be reimbursed. When going to the outpatient clinics in secondary or tertiary hospitals, the annual deductible is 70 euros, and half of the excess expenses can be reimbursed. The insurance cap is 600 euros.

For the inpatient care in the community, secondary, and tertiary hospitals, annual deductibles are 15 euros, 120 euros, and 195 euros respectively. The reimbursement ratio in the community is the highest, about 80%, and in higher-grade hospitals, the proportion is about 75-78%. The insurance cap is 33000 euros (Tab.2.9).

	Annual deductible			Reimbursement ratio			Insurance cap
	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary	
Outpatient	15 euros	70 euros		55%	50%	50%	600 euros
Inpatient care	15 euros	120 euros	195 euros	80%	78%	75-78%	33000 euros

Tab.2.9

Reimbursement ratio for outpatient care and inpatient care

The expense reimbursement policy of medical insurance in China is very complicated, and it is difficult to calculate. Therefore, when patients need to pay medical costs, the existing system has already calculated all the expenses, and they only need to pay the out-of-pocket cost.

Medical insurance for the poor

For the poor who do not have money to pay for medical insurance, the national government subsidizes them. They only need to go to the local government to determine their income status (like ISEE in Italy). They do not need to pay insurance premiums and enjoy resident basic medical insurance.

2.3.1.6 The development trend of healthcare service system

(1) Change from family support to social security

At present, most older people in China are supported by their families. In many areas with rapid economic development, social security systems that combine pensions with various commercial insurances have been established and introduced. The financial resources of the elderly are transitioning from family support to social support.

(2) Transition from family care to social services

Many years ago, most older people lived with their children, and their children could take care of them. In recent years, an increasing number of young people have worked and lived in big cities. They do not have the time to take care of their parents living in their hometown. They cannot help parents solve problems in their daily life problems. This has caused some older people to seek help from social services.

(3) Integration of healthcare services with other industries

With the strong support of national policies for the healthcare service industry, many industries have begun to integrate with the healthcare industry, thus forming a variety of healthcare service models. The development of the elderly care service industry in a market-oriented manner can drive the development direction of the entire industry.

(4) Integration of healthcare services and medical services

This trend is to integrate professional medical technology and advanced equipment with the daily lives of the elderly. The integration of medical services and healthcare services is a development priority for the healthcare industry in China.

2.3.2 Healthcare service system for older people in Italy

2.3.2.1 Age and requirements for the pension

Since 2019, the retirement age has been set at 67 for all categories of workers (Tab.2.10) In the ministerial decree of 5.11.2019, the age of 67 was confirmed also for 2021-2022 (“Età e requisiti per la pensione 2021”, 2021).

According to the Amato law (legislative decree 30 December 1992, no. 503; INPS circular no. 16/2013), some exceptions are still valid for some categories of workers who have paid contributions for 15 years. There is also a pension with only 5 years of contributions after 1995 and 70 years of age (Tab.2.11). If workers who do not pay contributions before 1996 want to retire at 67, the amount of the pension is at least equal to 2.8 times the monthly amount of the welfare-based social allowance (EUR 460.28 in 2021) (“Età e requisiti per la pensione 2021,” 2021) .

2.3.2.2 The age of early old pension

It is accessed at any age and reserved for workers registered with INPS management. It requires:

- paid a minimum of 42 years and 10 months of contributions for male
- paid a minimum of 41 years and 10 months of contributions for female

Tab.2.10
Requirement
of the ordinary
retirement age

	public employees	private employees	self-employed	private sector workers	self-employed workers	contribution requirement
2018	66 years and 7 months	66 years and 7 months	66 years and 7 months	66 years and 7 months	66 years and 7 months	20 years
2019-2022	67	67	67	67	67	20 years

Tab.2.11
Personal
requirements
for pension

	Male	Female	Contribution requirement (only paid contributions after 1995)
2018	70 years and 7 months	70 years and 7 months	5 years
2019	71 years old	71 years old	5 years
2020	71 years old	71 years old	5 years
2021	71 years and 3 months	71 years and 3 months	5 years

(1) Social APE

The SOCIAL APE is an allowance guaranteed by the state and paid by the INPS to workers in a state of difficulty who ask to retire at the age of 63. The allowance is available for the so-called weak categories (the unemployed, the disabled, those who need to help their relatives with disabilities, and those with burdensome jobs). The other requirements are that applicants need to reach 63 years old, with 30-36 years of contributions. Applicants will receive an INPS allowance up to 3 times the social allowance until they receive pension (“Età e requisiti per la pensione 2021”, 2021).

(2) Early retirement for “precoci” workers (with at least 1 year of contributions before the age of 19):

People with 41 years of contributions can apply early retirement at any age, but they must meet one of the following conditions:

- unemployment
- disability ascertained by Medical Competent Authorities
- living with a disabled family member together
- burdensome jobs (for at least seven years in the last 10 years, or at least six years in the last seven years).

(3) Early retirement of workers with burdensome jobs

For workers with burdensome jobs, the quota system is still available (Tab.2.12). These requirements remain valid until 31.12.2026 (“Età e requisiti per la pensione 2021”, 2021).

(4) Early retirement with the Woman Option and Quota 100

It is introduced by law 243 2004 on an experimental basis. It is reserved for female workers (Tab.2.13). These women with 35 years of contributions can retire, but they need to meet one of the following conditions:

- 57 years old for employees
- 58 years old for self-employed women

Furthermore, the starting date of the allowance was postponed by 12 months for employees and 18 months for self-employed women. The 2020 budget law (Law 160 2019) also extended the duration of the benefit. The time window is 12/18 months before the disbursement of the pension check is confirmed (“Età e requisiti per la pensione 2021,” 2021).

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Tab.2.12
Early retirement
of workers with
burdensome jobs

	Employees	Self-employed. (o con versamenti in entrambe le gestioni)
workers in particularly strenuous tasks for at least 78 days / nights in a year	quota 97,6 e	quota 98,6
	minimum age 61 years and 7 months	minimum age 62 years and 7 months
night-shift workers, with the number of working days from 72 to 77 per year	quota 98,6 e	quota 99,6
	minimum age 62 years and 7 months	minimum age 63 years and 7 months
Night shift workers with the number of working days from 64 to 71 per year	quota 99,6 e	quota 100,6
	minimum age 63 years and 7 months	minimum age 64 years and 7 months
In any case, 35 years of paid contributions are required. These requirements remain valid until 31.12.2026		

Tab.2.13
Woman's options

	Employees	Self-employed women
age requirement to be reached by 31.12.2019	58 years old	59 years old
the time window	12 months	18 months
contribution requirement	35 years	

QUOTA 100

It is the experimental measure only for a three-year period 2019-2021, introduced by the Law Decree 4 2019. It provides for early retirement upon reaching quota 100 as a sum of 62 years old and 38 years of contributions. It is reserved for members of the INPS management of both the public and private sectors ("Età e requisiti per la pensione 2021," 2021).

2.3.2.3 The healthcare system in Italy

Since 1979, Italy has had the national health service. Servizio Sanitario Nazionale (SSN) provides universal coverage. Italian healthcare system is a regional service system based on the national health service. The main source of financing is national and regional taxes, supplemented by co-payments for pharmaceuticals and outpatient care (World Health Organization, 2014).

Italy's national health service (SSN) has three fundamental principles: universality (the coverage of healthcare services to the whole population), equality (access to healthcare without any discrimination) and equity (equal access to health needs) (Pagella, 2020). The Italian health system has been ranked the second-best in the world by the World Health Organization, with only the French system ranked higher. The Ministry of Health is responsible for administering the health service, but much of the control has been passed to the regional and the local health authorities known as ASL (Azienda Sanitaria Locale). The whole system includes 21 regional health authorities and about 200 local authorities. Local health units (ASL) are responsible for managing all health services in their region. Private providers can also operate within the SSN. The coverage and quality of services in North Italy are better than that in the South and Islands. For the long-term care services, different regions have diverse models (Boldrini, 2018).

Healthcare services for the elderly can be distinguished according to the services locations, the type of services, and the nature of the provider.

- health services:

This category includes hospitals and district healthcare, and district healthcare can be divided into primary, specialist and outpatient care.

- territorial services:

- home care services, with health content - provided by Aziende Sanitarie Locali (ASL) - or of a social-assistance nature, provided by local bodies (mainly municipal government)

- semi-residential care, provided for example through adult day care.

- monetary transfers to local application, provided by local government (municipalities, provinces and regions) in the form of allowances.

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- residential services:

These consist in the provision of long-term care in non-hospital residential structures (therefore excluding acute interventions provided by hospitals and similar health institutions), such as residential nursing homes (RSA), nursing homes or community housing.

- national monetary transfers:

They consist of pensions (disability pensions, accompanying allowances, etc.). Under a certain condition of invalidity, the pension can be provided by national institutions (such as INPS, INPDAP etc.) (Lamura, et al.,2005).

The 1998 Guidelines for Rehabilitation Care issued by the Ministry of Health established general rules for the organization and delivery of services, concerning inpatient, outpatient, and home- and community-based rehabilitation. As for the specific rules and laws addressing the needs of the elderly persons, in 1992, a national plan for senior citizens was issued with the name “Objective: Ageing Persons” aimed at better coordination of medical and social services, which can be integrated within a person’s home care service system.

Rehabilitation care for the elderly is also provided in long-term hospitals, outpatient ambulatory settings, nursing homes, and residential and semi-residential homes. The residential settings for the elderly are usually classified as residential or semi-residential facilities (residenza sanitarie assistenziali—RSA) or community nursing homes. RSAs generally care for patients who require healthcare resources in nursing and medical consultations, whereas more “stable” patients are directed toward community nursing homes. As for home-based rehabilitation, service delivery is usually based on the home care model (assistenza domiciliare integrata—ADI), part of the LEAs (Boldrini, 2018).

According to this conceptual framework (Fig.2.12), the analysis starts from a request for help that results from the onset of diseases or disabilities, from a part of older people. The request can be satisfied through formal or informal assistance. The formal assistance can be distinguished on the basis of the nature of the provider. (public or private), the content of the service (mainly health services or social services), as well as the response methods ("direct" in the case of goods and services, "indirect" in the case of monetary transfers) It can also be further subdivided based on the degree of urgency (emergency services

vs aftercare services) and the place where the services are provided (family, residence, outpatient) (Lamura, et al.,2005). The informal assistance can be divided into family members, volunteers, friends and neighbours (Boldrini, 2018).

In Italy, there is still much emphasis on family support. Looking after the older family members is regarded as a responsibility or a “social duty,” especially by the women, and this also includes taking care of extended family. Many family members provide informal healthcare without receiving any kind of subsidy from the government and professional support. A relatively new phenomenon is that the healthcare services for the elderly or the disabled is provided by immigrants or women on very low incomes. Some cash benefits for disabled people (including the elderly) to support home care, are delivered by the social care authorities or local municipalities (Boldrini, 2018).

2.3.3 Healthcare service system for older people in Japan

Asia and Europe are home to some of the world’s oldest populations, those ages 65 and above. At the top is Japan at 28 percent, followed by Italy at 23 percent (Population reference bureau, 2020). Japan is aging fast. Its 'super-aged' society is the oldest in the world. Japan's experience in the healthcare industry is of great value and can be learned and applied by other countries in the world.

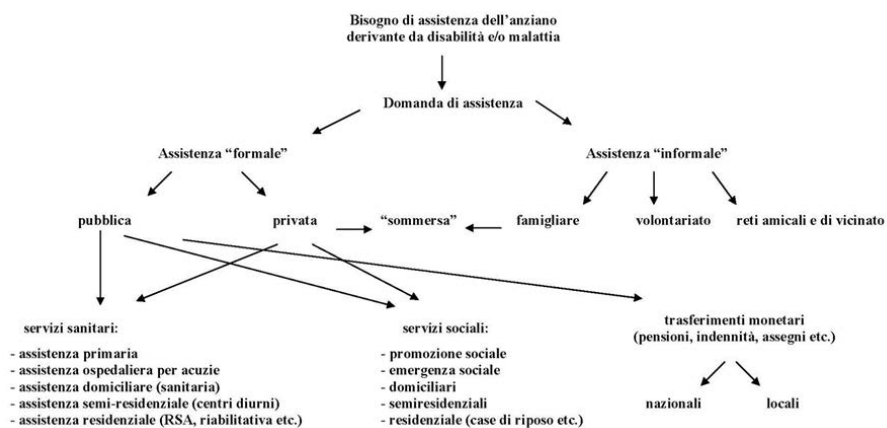


Fig.2.12
Needs for
elderly care.
From: Lamura,
et al. (2005).

2.3.3.1 Insurance system

Asia and Europe are home to some of the world's oldest populations (those aged 65 and above). Japan is at the top, 28 per cent, followed by Italy at 23 per cent (Population reference bureau, 2020). Japan is ageing fast. Its 'super-aged' society is the oldest in the world. Japan's experience in the healthcare industry is of great value and can be learned and applied by other countries in the world.

Since 1961, Japan has provided a universal National Health Insurance (NHI) system for medical care to all citizens (Tab.2.14). In 2000, the LTC insurance was established, as a mandatory social system for all citizens above the age of 40. It aims to cope with the ageing society and help reduce family members' burden. The medical insurance covers hospitalization, rehabilitation, medication, medical treatment, surgery, and visiting nursing services. The insurance is necessary for medical treatment due to illness, injury, preparation for hospitalization, surgery, outpatient visits, and medication treatment. The LTC insurance service covers in-home care and community-based care, such as residential facilities and facility care. When older people require nursing care. They can apply the LTC insurance. Insured people who are over the age of 65 are eligible for the two insurance services. If the insured person needs acute medical care, he/she will be admitted to a hospital and will receive medical treatment. After being discharged, the person can use in-home care services, including housekeeping, nursing care, and rehabilitation services, all of which are provided by the LTC insurance (Akiyama et al., 2018).

In this insurance system, the relationship between service provisions and burdens is that 50% comes from insurance premiums, and the rest is shared equally by national and local governments; premiums and out-of-pocket payments are fixed by the government (30% of service cost till the age 70; 10 to 20% between age 70 to 74; and 10% for people aged 75 and above; higher-income elderly pays a maximum of 30 %) (Itoko, 2017).

2.3.3.2 Pension

The Japanese pension system is mainly composed of national pension insurance and employees' pension insurance.

(1) National pension system (Tokyo International Communication Committee, 2021a)

The national pension system aims to provide a common "basic pension" to all residents in Japan. There are three types: basic pension for the

	Insurance plan	Insured person	Insurer
Medical insurance	Health insurance	Employees of applicable business establishments. (workers of private business corporations)	Japan Health Insurance Association, health insurance associations
		Part-time/seasonal workers of applicable business establishments. (excluding those who are employed for over a certain period)	Japan Health Insurance Association
	Seamen's insurance	Sailors employed by ship owners	Japan Health Insurance Association
	Mutual aid association insurance. (short-term payment)	National public employees, local public employees, faculties of private schools	Mutual aid associations
	National health insurance	General citizens other than employees insured by the above health insurance/seamen's insurance/ mutual aid association insurance	Municipal authorities. (ward / city / town / village)
Retiree healthcare system	National health insurance	Citizens under 65 years of age who were enrolled in employees' pension plans for a certain period and are receiving old age or retirement pension payments	Municipal authorities. (ward / city / town / village)
Elderly healthcare system	Latter-stage elderly healthcare system	Citizens who are 75 years of age or older; citizens who are between 65 and 74 years of age whose disability level has been officially assessed and recognized	Extended association. (handled by municipal governments)

Tab.2.14
Public medical insurance plans in Japan (Tokyo International Communication Committee, 2021b)

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disabled, basic pension for the bereaved and basic pension for the elderly. The first basic pension is paid under certain conditions when a pensioner becomes disabled due to illness or injury. The second pension is paid to a pensioner's dependents with children or their children under certain conditions when a pensioner die. The basic pension for the elderly is payable in principle to a pensioner at the age of 65.

For the basic pension for the elderly: Those who are enrolled in the national pension plan and have paid premiums for 10 years or longer are eligible for the elderly basic pension. If people pay premiums for at least 10 years, they can receive the pension payment whether or not they live in Japan at the age of 65. People need to make a claim to start receiving pension payments after you turn 65 years of age. Submit a claim for determination of eligibility for old-age pension payment under national pension and employees' pension insurances to a local pension office to confirm your eligibility. In addition, a non-Japanese national who lived in Japan and paid the national pension premiums may be eligible to receive a lump-sum withdrawal payment if he/she permanently leaves Japan.

The enrolment procedures of the national pension are handled at the municipal office in the ward (or city, town or village) where older adults live. If older adults join the employees' pension plan or the mutual aid association at work, they are automatically enrolled and do not have to apply.

(2) Employees' pension insurance (Tokyo International Communication Committee, 2021a)

Employee pensions are mainly for those employed by private businesses. Employees who contribute to the retirement account are entitled to future pension payments and access to a variety of welfare benefits. When employees engage in their company's pension plan, they are automatically enrolled in the national pension plan; they pay additional premiums on top of the national pension premiums. As a result, people required to pay employee pension premiums will get increased pension payments in the future.

Like the national pension, non-Japanese nationals enrolled in the employees' pension for a certain period are eligible for the lump-sum withdrawal payment when they permanently leave Japan. Up to 36 months' worth of pension contributions is receivable. When a company

hires workers, they are automatically enrolled in the employer's pension plan. Generally, the premiums are deducted from their salary.

In principle, older individuals in Japan can begin receiving pensions at 65, but the government allows them to begin at 70 in order to encourage them to work longer. If the starting age is extended by five years from the current limit, the monthly payment will increase by 84 per cent (Nikkei, 2020). In Japan, the average pension is approximately \$1,350.01 per month (Tetsushi, 2019).

2.3.3.3 Mandatory retirement

Japanese law permits but does not require employers to set a mandatory retirement age. Traditionally, employers institute mandatory requirement age of 60. The national retirement age is now being raised to 65, and the Older Person's Employment Stabilization Law allows employers to retain their mandatory retirement age of 60 but requires any employer that does so to "re-employ" workers aged 60 and older until age 65. Employers typically do so on fixed-term contracts (Bonnie, 2019).

2.3.3.4 The current issues

Japan's elderly healthcare system has been facing the following critical issues (Itoko, 2017).

- (1) Government overburdened with rapidly increasing elderly people
The medical costs are very high in Japan. In 2016, 30% of total costs (42 trillion yen) were spent on older people. It is estimated to increase to 18 trillion yen by 2025.
- (2) Rapid increase of people aged 75 and above and people aged 90 and above living alone at home. In Japan, the people aged 65 and over account for 26 % of the whole population and those ages 75 and above make up about 13 % of the population. About a quarter of the elderly live alone at home.
- (3) Lack of care workers and their low salaries
There are not enough care workers to take care of older people. It is difficult for care workers to have a high salary.
- (4) Few and low-quality nursing homes

The number of nursing homes cannot meet the demands of the elderly. The nursing care facilities are poor in both quantity and quality.

2.4 Healthcare service models

Ovretveit (1992, p. 4) defines quality care as the “Provision of care that exceeds patient expectations and achieves the highest possible clinical outcomes with the resources available”. Mosadeghrad (2013) defined quality healthcare as “consistently delighting the patient by providing efficacious, effective and efficient healthcare services according to the latest clinical guidelines and standards, which meet the patients’ needs and satisfies providers”.

"Health care services" defined by Oregon State Legislature (U.S.) (2007) means:

“the furnishing of medicine, medical or surgical treatment, nursing, hospital service, dental service, optometrically service, complementary health services or any or all of the enumerated services or any other necessary services of like character, whether or not contingent upon sickness or personal injury, as well as the furnishing to any person of any and all other services and goods for the purpose of preventing, alleviating, curing or healing human illness, physical disability or injury.”

These definitions all illustrate the role of healthcare services, and its goal is to combine various resources to meet users' needs by providing services. With economic development, the healthcare service models have significantly developed. However, many older people do not know which healthcare services are available. Due to the different physical conditions of the elderly, the traditional healthcare service models are no longer able to meet the needs of the elderly. By summarizing the existing healthcare service models, older people can have more choices.

2.4.1 Literature review

Using the meta-analysis method to summarize the existing healthcare service models. Sources for literature reviews include: (1) relevant academic books, policies and government websites; (2) journal articles from Chinese literature databases (CNKI), Web of Science and other databases; (3) Google Scholar and Baidu Scholar. In databases, advanced search is used and the search condition is (TI=(older people or elderly

people or the elderly or old people or seniors)) AND TI=(healthcare or healthcare services or healthcare service system or elderly care or healthcare service models). Time span is form 1985-2022. The query languages are English or Chinese. I search 5974 results from Web of Science Core Collection and 5254 results from Chinese literature databases in total. By using CiteSpace (version: 5.8.R3), these publications can be analyzed to get the density view of keyword (Chen, 2017). Fig.2.13 shows keywords related to healthcare service in these literatures. In the Fig.2.14, the larger circle means the more articles related to this research area were published during this period. This diagram shows how the focus of researchers around the world changes with time and Which research areas have received high attention. It is clear that informal care for the elderly has the highest degree of attention.

Based on the data, I select the earliest literature of each elderly care service model as its source. However, when it first appeared, the definition or concept of the healthcare service model may be a little



Fig.2.13
Density view of
keyword

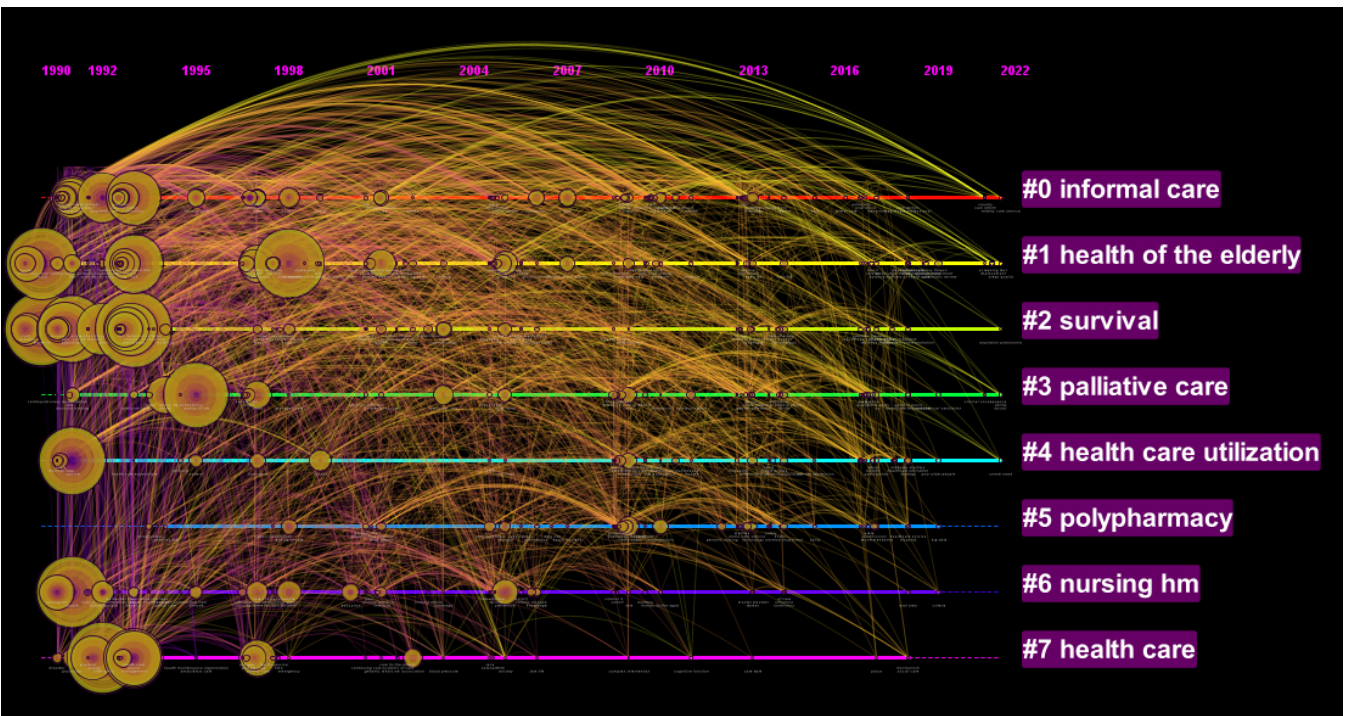


Fig.2.14
Timeline view

vague, so I adopt more precise interpretations from other research materials. Table 2.15 shows the results of the research. These healthcare service models complement each other, and older people can receive a variety of healthcare services simultaneously.

According to the above research, the healthcare service presents a diversified development situation, and a series of new healthcare service models have emerged, such as Healthcare Town and “Internet+ healthcare”. The healthcare service industry has also emerged a new trend of integration and development with the medical and health industry, tourism industry, science and technology industry, and financial industry. With the development of the Internet, some new healthcare service model can gradually be accepted by the elderly. Smart healthcare services will be an important development trend. There are still fewer services models related to products for the elderly, and there is more room for development.

2.4.2 Classification of healthcare service models

2.4.2.1 The classification of aged care industry in China

According to the research results, 34 healthcare service models and concepts are available. Based on the Industrial Classification of Economic Activities, the National Bureau of Statistics of China released the

Time	Name	Content	Source
1949	Community home care	Older people who live in their home can receive a series of healthcare service from the community (Li, 1999).	Cherkasky (1949)
1960	Retirement community	a master-planned retirement community built specifically for active adults (Sun City, n.d.).	Sun City, America
1965	Long-term-care systems	enable older people, who experience significant declines in capacity, to receive the care and support of others consistent with their basic rights, fundamental freedoms and human dignity. (World Health Organization, n.d.)	<i>The Older Americans Act</i>
1973	Social healthcare services	Various healthcare services for taking care of the elderly (Yang & Ren, 1993).	Brody (1973)
1984	Adult day care	Adult day care is a community-based group program designed to meet the needs of functionally impaired adults through an individual plan of care.	National Institute on Adult Daycare (U.S.) (1990) Haight, Kittredge Duchsnau & Gibson (2005)
1985	Legacy-support agreement	A legacy-support agreement means an agreement made by the donator and the legatee in which the legatee is obligated to assumes the duty to support the former in his or her lifetime and attends to his or her interment after death, in return for the right to legacy (English and Foreign Languages University, n.d.).	Liu & Zhang (1985)
1990	Healthy ageing	the process of developing and maintaining the functional ability that enables wellbeing in older age.	World Health Organization (1990)

Tab.2.15
The healthcare service models and related concepts

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Time	Name	Content	Source
1990	A self-invested personal pension	A self-invested personal pension. (SIPP) is the name given to the type of UK government-approved personal pension scheme, which allows individuals to make their own investment decisions from the full range of investments approved by HM Revenue and Customs. (HMRC)	Self-invested personal pension (2021)
1992	Family care	Pensions come from the family and are provided by family members (adult children).	Yuan (1992)
1992	Social pension	Pensions are provided by the society in the form of pensions or relief funds.	
1995	Active ageing	the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age (World Health Organization, 2002).	Guan (1995)
1998	Savings for old age	the special savings made by individuals for future pensions when they are young.	
1998	Social welfare department and care home	living in social welfare institutions or nursing homes in their old age	Wang (1998)
1998	Continuity of care	Continuity of care is defined as continuous and consistent supply of medical services by healthcare manpower to meet patients' medical needs or the concept of a "continuous caring relationship" between doctor and patient.	Citro et al. (1998) Gulliford et al. (2006)
2002	Retirement migration, Snowbird model	Retirement migration involves short- or long-term relocation, typically to destinations with favorable climates, by retired persons. (Pickering & Crooks. 2019)	Gustafson (2002)
2003	Ecological aging	Promoting an ecological perspective to aged care suggests that there is no need to manage older people in isolation, as is common practice, but as integral to the way society lives, works, and plays.	Harris, Grootjans, & Wenham (2008)
2004	House-for-pension program	house-for-pension scheme reverse mortgage loan	Chai (2004)

Tab.2.15
The healthcare service models and related concepts

Time	Name	Content	Source
2004	Aging in place	remaining living in the community, with some level of independence, rather than in residential care.	Davey, de Joux, Nana, & Arcus (2004)
2005	Integrated elderly care and medical services	Integration of elderly care and medical services refers to the organic integration of medical and elderly care resources that draw together daily care and rehabilitation. (Deloitte, 2018)	Guo et al. (2005)
2006	Monetized healthcare	The government pays for services to ensure the basic livelihood of low-income elderly	Li & Gao (2006)
2006	Home share	Based on the idea of exchange, the Householder offers a bedroom and the use of their home's facilities to the Sharer. (the person who lives with them) in return for around 10 hours a week of practical help and support, usually including cooking, light cleaning, shopping, gardening and other small DIY jobs.	Share and care (2006)
2006	Elder care agencies	nursing homes, hospice care, adult day care and other aged care agencies in which old people can live	Zhan, Liu, Guan, & Bai (2006)
2009	The urban-rural health insurance integration	The urban-rural health insurance integration is intended to unify the management, funds, policies, and administrative bodies of the URBMI and NCMS, and to form an integrated and residential-based social health insurance program. (i.e., URRBMI)	Huang & Wu. (2020)
2009	Group housing	Some old people with similar interests rent a/an house/apartment to live together and help each other.	He & Xu (2010)
2009	"9064" model	90% home care, 6% community services, and 4% institutional care	Beijing municipal government, China

Tab.2.15
The healthcare service models and related concepts

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Time	Name	Content	Source
2009	Smart ageing	all individuals and the societies are maturing intellectually while effectively dealing with the changes associated with ageing	Hiroyuki (2015)
2011	“9073” model	90% home care, 7% community services, and 3% institutional care	The 12th Five-Year Plan - Ministry of Civil Affairs
2012	Time bank	Young people can start to save time from taking care of the seniors when they are young, and then using it when they get old, sick, or need someone to take care of them.	SWI (2012)
2016	“Internet +” model	Provide comprehensive, fast, flexible, timely and low-cost home care services for the elderly by Information and Communication Technology (ICT).	Sui & Peng (2016)
2016	Healthcare town	With the health industry as the core, Healthcare Town integrates diversified functions such as health, health preservation, elderly care, leisure, tourism, etc., to develop a characteristic town with a better ecological environment.	Sichuan Provincial Government (2016)
2016	Shared service model	Based on home care, with the help of internet technology, old people can share all social service resources.	He (2016)
2016	Precision Aged Care	It is a service model that provides differentiated services for the elderly in different situations on the basis of their demands	Wang & Zhu (2016)
2020	Community embedded elderly Care	The embedded elderly care model is based on the community as the carrier, with the concept of resource embedding, functional embedding and multiple operation modes embedding, and embedding a market-oriented elderly care service organization in the community through a competitive mechanism to integrate peripheral elderly care service resources and realize elderly care The organic integration of institutions and communities provides professional, personalized and convenient services for the elderly to provide for the elderly.	Feng (2020)

Tab.2.15
The healthcare service models and related concepts

Statistical Classification of Elderly Care Industry (2020), which divided the elderly care industry into three levels, 12 major categories, 51 medium categories, and 79 sub-categories. Based on the Chinese classification standards and combined with the needs of the elderly, the healthcare service models can be classified as follows (Tab.2.16).

As shown above, the healthcare service models and concepts are divided into three layers. The first layer is the theory, the place where the services are provided, attributes, and industry segmentation. The healthcare theory is related to the healthcare system, finance, services, and Internet services. Older people can receive healthcare services at home, institutions, and other places. The attribute of healthcare service providers can be split into individual, government, market, and mixing attributes. The third layer is the healthcare service models and concepts.

Layer 1	Layer 2	Layer 3
Theories	System	Long-term-care systems, Healthy ageing, Active ageing, “9064” Model, “9073” Model, The urban–rural health insurance integration, Aging in place
	Finance	Family care, Social pension, Savings for old age
	Services	Community Home Care, Time Bank
	Internet	Smart ageing, “Internet +” Model, Precision aged care
The place where old people receive services	Home	Community home care, Social healthcare services, Legacy-support agreement, Social healthcare services, House-for-pension program, Continuity of care, Savings for old age, Integrated elderly care and medical services, Monetized healthcare, Virtual nursing homes, Community embedded elderly care, Shared service model, The urban–rural health insurance integration, Home share
	Agencies	Social healthcare services, Social welfare department and care home, Ecological aging, Integrated elderly care and medical services, Adult day care, Elder care agencies, Community embedded elderly care, Healthcare town, Shared service model, Group housing, Retirement community
	Other places	Legacy-support agreement, Social healthcare services, House-for-pension program, Retirement migration, Ecological aging, Home share, Healthcare Town, “Internet +” Model, Monetized healthcare, Group housing

Tab.2.16
The classification of healthcare service model

PART II : SCIENTIFIC RESEARCH

Layer 1	Layer 2	Layer 3
Attribute	Individual	Community home care, Legacy-support agreement, House-for-pension program, Retirement migration, Savings for old age, Aging in place, Home share, Shared service model, Family care, Group Housing
	Government	Continuity of care, The urban–rural health insurance integration, Monetized healthcare, Social pension
	Market	Retirement community, Social healthcare services, Continuity of care, Ecological aging, Integrated elderly care and medical services, Home Share, Community Home Care, Elder Care Agencies, Healthcare Town, Home share, Time Bank, House-for-pension program
	Mixing	Adult day care, Social welfare department and care home, Virtual nursing homes, Community Embedded Elderly Care, “Internet +” Model
Industry Segmentation	Elderly care services	Legacy-support agreement, Retirement migration, Community Home care, Adult day care, Community embedded elderly care, Healthcare town, Elder care agencies, Shared service model
	Medical and health services	Integrated elderly care and medical services
	health promotion and social participation	Social healthcare services, Ecological aging, Aging in place, Home share, Time bank, Group housing
	Social security	Long-term-care systems, Healthy ageing, Active ageing, Social welfare department and care home, Continuity of care, The urban–rural health insurance integration, “9064” Model, “9073” Model, Precision aged care
	financial services	Family care, Social pension, Savings for old age, House-for-pension program, Monetized healthcare
	Technology and smart elderly care services	Virtual nursing homes, Smart ageing, “Internet +” model
	public management	Retirement community

Tab.2.16
The classification of healthcare service model

The two-dimensional correlation analysis of the places and attributes can help the elderly find healthcare service models that suit them. They can choose the healthcare services provided by different service providers according to the place they live (Fig.2.15).

2.4.2.2 The Australian National Aged Care Classification (Eagar et al, 2019)

The Australian National Aged Care Classification is a hierarchical classification system that can organise aged care residents into homogeneous resource groups depending on their characteristics. Three distinct branches exist, each determined by the resident's mobility (Fig.2.16).

The independent branch is divided into two kinds based on compounding factors in the resident. The compounding factors include the activities of daily living, Australian modified functional independence measure (AM- FIM) cognition, Australia-modified Karnofsky Performance Status (AKPS), daily injections and behaviour. The aided mobility branch is divided into five categories, based on cognition and whether the resident has compounding factors (Eagar et al., 2019). The Braden activity score, activities of daily living, AM- FIM motor, AM- FIM social cognition, AM- FIM communication, AKPS, Rockwood score, disruptiveness, falls in the last 12 months, daily injections, and complex wound management are all contributing variables in compounding factors (Eagar et al., 2019).

The immobile branch is divided into five classifications based on function and risk of pressure sores, and compounding factors for the lower branches. The Braden total, AM-FIM eat, AM-FIM transfer, disruptiveness, falls in the last 12 months, obesity flag, daily injections, and complex wound management are all compounding factors in the not mobile branch (Eagar et al., 2019). Australia classifies aged care based on the inhabitants' level of mobility. These compounding factors are derived using various regression models that account for a number of independent variables. This classification is more suited to data analysis by government agencies.

While the healthcare industry is growing fast, it also confronts numerous challenges. It is a sunrise industry, but the fact is that there is an insufficient investment. Numerous elder care agencies struggle to make ends meet, and the difficulty in making a profit prevents them from recruiting more employees. Due to a shortage of care workers, older adults cannot receive timely and effective assistance. This forms a vicious circle.



Fig.2.15
The two-dimensional correlation analysis

Older persons can receive healthcare services at home, at a nursing home, or elsewhere, depending on where they live. There are four different categories of service providers in each location. The term “market services” refers to services given by private businesses. Government services are those services provided by public health service agencies. Individual services are those offered by individuals (carers, caregivers, etc.). Older people can choose who provides services for them in various locations.

Additionally, how to improve the work performance of employees is also critical. In some countries, care workers lack professional training. They do not have the opportunity to develop professional skills and hence are unable to give professional services to the elderly, which has a negative influence on the quality of healthcare services. Without academic qualifications or vocational credentials, it is difficult for these care workers to earn high incomes. In comparison, the babysitter and housemaid are more respected by society and employers, and they have higher wages, so they are more willing to improve their professional

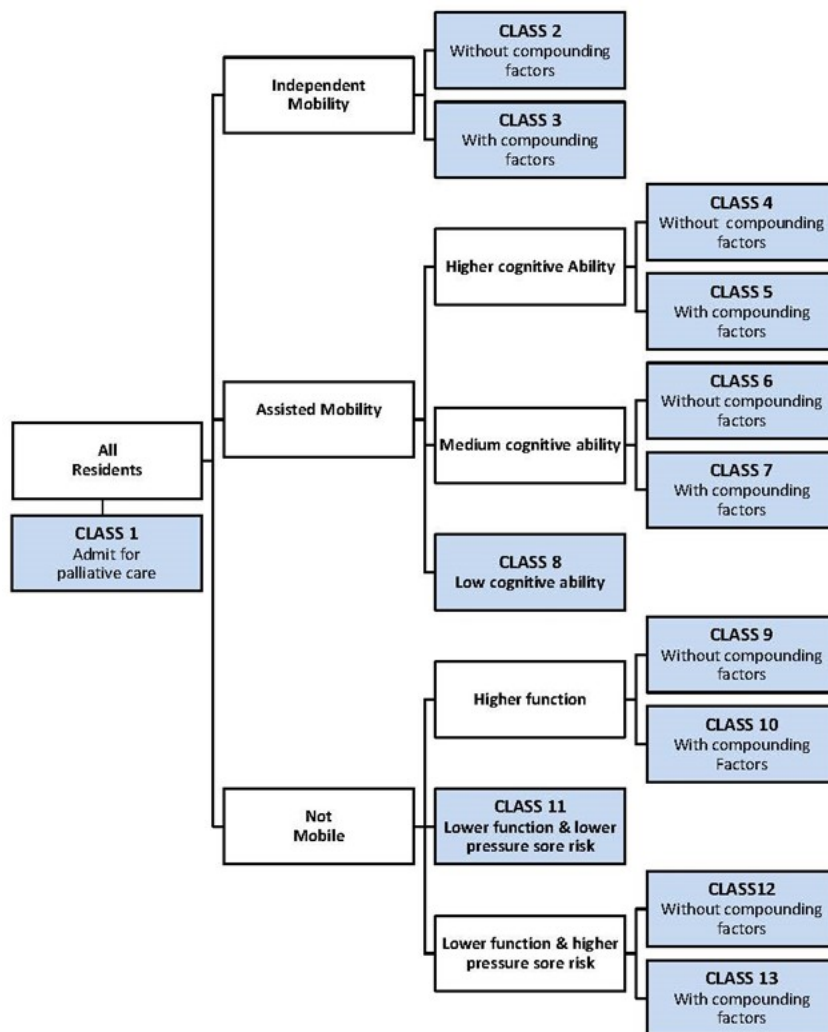


Fig.2.16
The Australian
National Aged Care
Classification. From:
Eagar et al. (2019).

skills, which create a virtuous circle. In the traditional customs, sending parents to nursing homes is unfilial. However, young people have to work and do not have time to take care of the elderly who need 24-hour care, so that elderly care institutions may become the only alternative. From the perspective of the elderly, due to several negative news, older people believe that living in a nursing home is isolating and helpless. They are reluctant to go there. Secondly, many nursing homes lack humanistic care, and older people cannot gain a sense of well-being.

In general, basic healthcare services can only meet the survival needs of the elderly. Emotional communication and spiritual needs can only be met by some nursing homes with higher costs. Therefore, it is necessary to develop a new healthcare service system that can combine with the existing healthcare service models to meet the basic and spiritual needs of the elderly (Eagar et al, 2019).

2.5 Influencing factors of healthcare services for the elderly

In order to meet the diverse needs of the elderly, healthcare services from service providers are necessary. We also need to discuss the factors influencing healthcare services to improve the healthcare service quality and ensure that the elderly have access to healthcare services.

2.5.1 Influencing factors of healthcare services that can meet basic needs of the elderly

- Economic factors

Financial status of older people may affect the quality of healthcare services. Older people with good financial conditions do not have to worry about the cost of health services. They are willing to pay more to receive better services. In contrast, some older people may not afford the costs associated with healthcare services and treatment, and have to cancel the services and choose other solutions (Mosadeghrad, 2014).

- Physical conditions

The disabled elderly need more healthcare services, and these services are not necessary for those older people who can take care of themselves.

- Number of adult children

Older adults with fewer children require additional healthcare services since their adult children lack the time necessary to care for them. They have to rely on healthcare services when they require assistance.

- Service quality

The quality of healthcare services is determined by the service provider's experience, the customer's experience, and the customer's relationship with the provider (Mosadeghrad, 2012). The quality of service has a direct impact on the elderly's attitude toward healthcare services. High service quality indicates that elderly people are content and willing to pay for services.

- Resources and facilities

Sufficient social healthcare service resources and medical facilities are key factors and fundamentals for delivering elderly care.

- Social culture and values

Different regions of a country are likely to have different cultures and beliefs. The local culture and customs determine that older adults have different choices for healthcare services. Some services may be considered offensive in certain cultures. When providing healthcare services, service providers should pay attention to older people's culture, customs, and etiquette and then match their way of acting and speaking to meet the particular group's needs.

2.5.2 Influencing factors of healthcare services that can meet psychological needs of the elderly

- Community support

Whether the local community regularly organizes some activities to promote communication among the elderly is an important influencing factor.

- The subjective wishes

- Service attitude and professionalism

A positive attitude and professional services are very important for the emotional needs of the elderly. Otherwise, they feel discriminated against. If the elderly and their children are more satisfied with

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healthcare services, they are more willing to accept such services.

- Leisure activities organized by healthcare institutions

If healthcare institutions can organize some leisure activities regularly, it will be easier for the elderly living in these institutions to gain a sense of happiness.

2.5.3 Influencing factors of healthcare services that can meet self-fulfillment needs of the elderly

- Social support

If society can make effective use of the old's knowledge and abilities to enable them to contribute to the development of the society/community, this will help give the elderly a sense of accomplishment and fulfilment.

- Autonomy

Elderly people are willing to realize their sense of self-fulfilment, which is most important.

2.6 Case studies about healthcare services

2.6.1 Examples of healthcare services in China

Under the guidance of Healthy China 2030, the health industry has entered a golden period of rapid development. The healthcare service industry is developing faster than other traditional medical industries. The healthcare service industry covers a wide range of research fields, and it is easily integrated with the cultural industry, tourism industry, real estate industry, insurance sector, Internet companies, and other emerging industries. Due to strong policy support and increasing demand for healthcare, investors have gradually increased their investment in the healthcare service industry. Real estate companies, government-owned enterprises, large insurance companies, and large hospitals have entered the healthcare industry. Table 2.17 shows the investment projects and features of different types of companies.

(1) Vanke - SuiYuanJiaShu Retirement Communities

The SuiYuanJiaShu project is a large-scale retirement community that

Types	Name	Features	Typical Projects
Real estate companies	Vanke	Senior Apartments + Continuing care retirement communities (CCRCs)	SuiYuanJiaShu Retirement Communities, YiYuan Senior Apartments
	China Greentown	University for Seniors + Healthcare + Vacation	Wuzhen Yayuan, YiYang Senior Apartments
	Poly Group	long-term care facilities + Community care services	Anping Retirement Communities, HeXiHui Senior Apartments
Insurance companies	Tai Kang	Endowment Insurance + Continuing care retirement communities (CCRCs)	Taikang Retirement Communities
	China Life	Luxury Retirement communities	Suzhou Jiayuan
Healthcare companies	Da Ai Cheng	Community for all ages	Xianghe DaAiCheng, Ningbo DaAiCheng
Government-owned enterprise	SDIC	Elders real estate +Healthcare services	SDIC Senior Apartments
	Shou Kai Group	Long-term care facility + Day care + Home care services	ShoukaiCuncao Healthcare project
	Government of Hainan Province	international Medical tourism + Licensed medical treatment + health management + Rehabilitation center + Medical cosmetology + anti-aging	The Hainan Boao Lecheng International Medical Tourism Pilot Zone
	Beichen Group	Comprehensive Health Services	Beichen International Health Care Complex

Tab.2.17
The investment projects and characteristics of different types of companies

provides comprehensive services (Fig.2.17). It started in 2012, covering 100 acres. It builds 58937 m² of apartments, 5381 m² of public facilities, and 4571 m² of health and leisure areas. Tourism resources include museums, resort hotels, etc. There are also basic commercial facilities, entertainment and leisure facilities, medical facilities and schools, etc., which can meet the daily needs of residents.

There are three types of apartments (75 m², 100 m² and 110 m²) with a total of 575 apartments (Fig.2.18). The price is about 1750 euro/ m².

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Fig.2.17
SuiYuanJiaShu
Retirement
Communities.
ARCHINA. From:
<http://www.archina.com/index.php?g=works&m=index&a=show&id=586>



Fig.2.18
Three types of apartments. SOHU. From: https://www.sohu.com/a/376196304_100110125

After the elderly move in, the basic service costs 300-500 euro. This project does not sell the property rights of the apartment, but the right to use it. The target group is mainly for the healthy older people who can take care of themselves.

Older people have been cared for from entering the retirement community. The slopes of the main roads in the community are all designed to be less than 5%. With external corridors around the entire area, the elderly may easily access each unit, even on rainy days (Fig.2.19).



Fig.2.19
The exterior corridor.
ARCHINA. From:
<http://www.archina.com/index.php?g=works&m=index&a=show&id=586>

In the room, there are eight product modules, including 48 elderly-centered designs. As an ageing-friendly community, barrier-free design is the most important. Along with safety handrails, the maximum width for wheelchair passage and wheelchair turns radiuses, the bathroom also uses the strip floor drain grate to eliminate the difference in height between the balcony, toilet, and shower room (Fig.2.20).

In order to meet the living habits of wheelchair users, the kitchen uses pull-down baskets and blind corner cabinets as more efficient storage methods. The direct drinking water system can avoid the risk of boiling water (Fig.2.21). The large balcony can increase natural light in the home. The drying rack on the balcony allows older people to use it without standing. Through the patio, the rooms in the middle of the building also have a better ventilation system. The central air conditioner with fresh air ventilation systems can effectively improve the air quality. Modern underfloor heating systems are able to offer maximum comfort in winter. The foot warmer under the desk is also available. For elderly couples with different living habits, there are different types of apartments (one

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Fig.2.20

The design of bathroom. ARCHINA.

From: <http://www.archina.com/index.php?g=works&m=index&a=show&id=586>



Fig.2.21

The design of kitchen.

ARCHINA. From:

<http://www.archina.com/index.php?g=works&m=index&a=show&id=586>

bedroom, two bedrooms) to choose. High-brightness LED lighting, big button mobile phone, night lights, and other design can better serve the elderly (Fig.2.22). In addition, the life alert system prevents the elderly from being at risk (Fangtianxia, 2021).

This retirement community has been operating nine years in Hangzhou, China, and has developed an integrated healthcare service system that includes active senior apartments, a nursing home (rehabilitation centre), and a community healthcare service centre. The active senior apartments are designed for elderly residents who are self-sufficient. The nursing home provides services for older people with disabilities and those who need rest and recovery after surgery. The community healthcare centre can provide services to older residents of communities (Sohu, 2019a). This retirement community currently has eight service modules with 165 services, which can meet various needs of the elderly.

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Fig.2.22
Elderly-oriented
designs. ARCHINA.
From: <http://www.archina.com/index.php?g=works&m=index&a=show&id=586>

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(2) Taikang Retirement Communities

Taikang Retirement Communities is invested and managed by Taikang Life Insurance Company Limited, which has developed into one of the well-known healthcare companies in China. This project is located in Beijing's Changping district, about 40 kilometres away from the city centre, with a total 310,000 m² and an investment of about 700 million euros (Fig.2.23). The retirement community can accommodate up to 3,000 residents. This project started operation in June 2015 and is a CCRC (Continuing Care Retirement Community) with rehabilitation hospitals and professional medical equipment.

This is a luxurious retirement community where the elderly living independently and those who need professional healthcare services can live for a long time. Taikang Life Insurance Company has established CCRC and rehabilitation hospitals in 19 core cities in China, and a healthcare service network has been formed (Fig.2.24).

This retirement community offers four different apartment sizes (65 m², 95 m², 121 m², and 181 m²) (Fig.2.25). These flats are divided into units for independent living, assisted living, and apartments for older individuals who require 24-hour care. According to their physical conditions, older people are divided into 6 categories (Active seniors, Seniors living independently, Assisted living, Skilled nursing, Memory care, and hospice care).

Independent living units provide necessary healthcare services and domestic products to senior residents who are actively independent and able to care for themselves. For the semi-self-care elderly and older people with memory loss, the assisted living units emphasize the combination of family life and nursing care. For the disabled elderly and older people who cannot take care of themselves, the apartments are designed with an integrated healthcare model, equipped with monitoring equipment, and the 24-hour home care is necessary (Fig.2.26).

This retirement community adopts a membership model. The fee is made up of three components: a basic fee, a membership fee, and a monthly service fee. The basic fee is 200,000 RMB (about 25,000 Euro), but it is fully refundable if older people move out from the community. The Membership dues vary according to apartment type, ranging from 1.2 million RMB (150,000 euros) to 1.95 million RMB (250,000



Fig.2.23
Taikang Retirement
Communities. From:
ARCHINA (2019)



Fig.2.24
The healthcare
service network of
Taikang retirement
communities. From:
Taikang (2021)

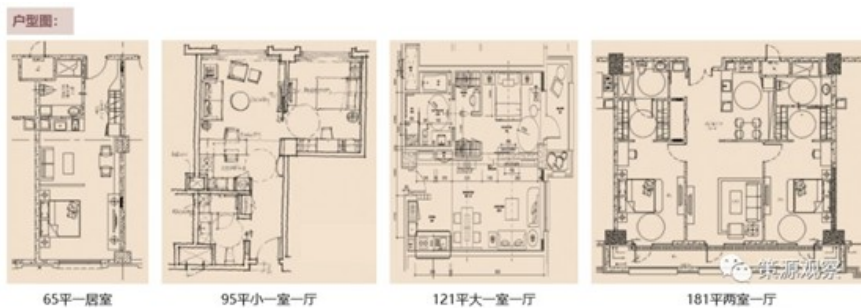


Fig.2.25
The four types of
apartments. SOHU.
From: https://www.sohu.com/a/349361397_120059752

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Fig.2.26

The independent living unit, the assisted living unit, the apartments with 24-hour homecare, from left to right. SOHU. From: https://www.sohu.com/a/349361397_120059752



euros). The membership fees can also be exempted by purchasing insurance provided by the company. The monthly service fee comprises management fees, service fees, etc. range from 6,200 RMB (780 euro) to 13,100 RMB (1650 euro).

The older residents of this community have access to all of the community's services. Community services include three parts: medical care and rehabilitation services, daily services, and cultural and leisure services. The community's distinguishing feature is its medical care and rehabilitation system, including rehabilitation hospitals and medical clinics. This community has cooperated with numerous renowned hospitals to establish private health records and provide individualized health plans for the elderly. The daily services include 9 restaurants of different styles, providing 24-hour food delivery services to fulfil the needs of the elderly and their families. This community has a 5,000 m² cultural activity centre where older residents can participate in a variety of cultural and recreational activities. Frequently, the community arranges a variety of activities ranging from culture and art to leisure and entertainment, sports and fitness, and education. In order to respect the religious beliefs of the elderly, this community also has religious facilities such as Buddhist halls and churches (Sohu, 2019c).

(3) The Village Family Service Center

There are many empty-nest elderly, elderly widows and widowers in rural areas in China. For a lengthy period of time, the development of healthcare services has been insufficient due to a lack of money. To address the issue, the Chinese government has continuously pushed for the expansion of healthcare facilities in rural areas. The local government has built service centres for the elderly in many villages. These older residents living in remote areas can access home care services at the

service centre, and they can also take care of each other.

In the Yongchun County, Quanzhou City, Fujian Province, there are 86,000 older people over 60 years old, accounting for 14.28% of the total population. Since 2012, the local government has made extensive use of public resources such as empty school buildings, farmyards, or ancestral halls to build the village family service centre, providing foods, recreational activities, cultural and leisure activities, and healthcare services. This region has established 61 village family service centres to date, including canteens, fitness centres, medical clinics, gate ball courts, and other sports facilities (Fig.2.27). In order to enrich the spiritual lives of the elderly in mountain villages, the local government gives each service centre a subsidy of 10,000 to 20,000 yuan every year to support them in organizing cultural and recreational programs. The government often invites specialists from universities and cultural departments to develop activities and provide services.

The features of the village family service centre are:

- Through government grants and charitable donations, the local government integrates diverse social resources to create the village family service centre to provide service for the elderly.
- The government prioritizes the healthcare demands of elderly widows and widowers, older people defined as financially disadvantaged, elderly widows and widowers, and older people who have made significant contributions.



Fig.2.27
Homecare service and
activity centre. From:
Xinlang (2018)

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- Seniors living in rural places can also take advantage of a variety of services available at the local family service centre, including recreational activities, free food, and fitness exercises. The service centre also provides meal delivery services for the disabled elderly who cannot eat at the service centre.
- The local government provides subsidies and purchase accident insurance for senior residents over the age of 80 who are suffering economic hardship (Guipaiwenlv, 2020).

2.6.2 Examples of healthcare services in Italy

In Italy, RSA, “case di riposo” and “case di cura” provide healthcare services for the elderly with different physical conditions. They can be managed by private companies or by a public sector. The cost of healthcare needs to be paid by the elderly or their family members, but in many cases, it is possible to have an economic contribution by Social Service Office.

- **La Residenza Sanitaria Assistenziale (RSA)**

The Residenza Sanitaria Assistenziale (RSA) is a healthcare institution aimed at older people who are unable to take care of themselves and need continuing healthcare, nursing or rehabilitation. The RSA's fundamental characteristic is that the elderly can obtain 24-hour healthcare services from doctors, nurses, or care workers. If a private company administers an RSA, the cost of healthcare needs to be paid by the elderly or their family members. In contrast, if the RSA is a public institution, the elderly can sign an agreement with the Social Service Office to have a contribution (Fondazione Onda, 2021).

- **La Casa di Riposo**

La casa di riposo is a nursing home, which can provide services for the elderly who are partially self-sufficient. The nursing home is suitable for those older people who cannot or no longer want to live alone and prefer to be surrounded by peers. In the nursing home, doctors or care workers can provide some helps in daily activities, but the staff do not accompany the elderly. Recreational activities are frequently organized, and some common areas are available where seniors can receive visits and spend time with family and friends. Like the RSA, the nursing home can be managed by private companies or the public sector (Fondazione Onda, 2021).

●La Casa di Cura

This institution can provide services for the elderly who are partially self-sufficient and suffer from acute and chronic diseases. These older people need to be taken care of by nurses or care workers. Older adults can participate in some recreational activities. In Italy, most of these institutions are operated by private companies, so the elderly need to pay by themselves or their family (Fondazione Onda, 2021).

Pio Albergo Trivulzio

In 1771, Antonio Tolomeo Trivulzio opened the Pio Albergo Trivulzio, an example of the cooperation between private charity and the government. Pio Albergo Trivulzio has had more than 250 years of history. Today the Pio Albergo Trivulzio is referred to as a “small city” in Milan (Fig.2.28). As an ageing service center, it also provides general public services (such as the outpatient clinic) for all citizens. The Trivulzio is a training centre specializing in geriatric medicine and can meet the growing need for the healthcare of elderly patients (Il Pio Albergo Trivulzio, 2021).

Trivulzio is where older adults can receive the help they need in daily life. They can meet their family and friends at any time without limitations. All departments are equipped with medical and nursing room, dining



Fig.2.28
Pio Albergo Trivulzio.
From: Smart Dental
Clinic (2021)

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room and gym. The zones dedicated to socialization, such as the library or the leisure room, are conveniently accessible. The balconies and the large internal garden also allow older adults to enjoy good weather, and the large bar can help them find moments of relaxation. There are a church and a chapel where religious services are carried out (Residenze per anziani, 2021).

In the Trivulzio, there are various services that older people can enjoy.

- Health services

This institution provides 24-hour medical and nursing services. The expert team consists of doctors, nurses, social health workers, rehabilitation therapists, and volunteers, with the mission of enhancing the elderly's well-being and health. For every older adult living here, the Trivulzio develops an Individual Assistance Plan (Piano di Assistenza Individuale, PAI) that is periodically updated to verify the results and reassess the objectives. The social health workers can help and accompany older people in their daily activities, ensuring that older people can receive help in personal needs such as personal hygiene, eating, etc. More importantly, the dignity and privacy of the elderly also need to be respected.

- Specialist services

The doctors of the Pio Albergo Trivulzio RSA can prescribe according to demand, with no additional costs for specialist visits and diagnostic tests, thanks to the collaboration of specialists and equipment in the Trivulzio's 25 speciality clinics and health facilities affiliated with the National Health Service. The doctors, psychologists, and various care workers of Trivulzio are required to fulfil the demands of the elderly.

- Rehabilitative services

The doctor will evaluate whether older people need to have a physical examination. If they need physiotherapy, doctors will assist them in maintaining and improving their physical, mental, and cognitive capacities.

- Social service

There are some social workers in the RSA who organize activities for older people and their families. These social workers can offer support, information, and advice to assist older adults in overcoming obstacles.

- Entertainment service

Recreational, cultural, and social activities are organised every day, such as board games, concerts, reading, painting, and film clubs. Seniors are encouraged to participate in activities based on their ability and availability.

- Catering

Meals are prepared in Trivulzio's internal kitchen. The menu is updated to ensure that the elderly have access to various foods and maintain a balanced diet. With the advice of nutrition and diet services, Trivulzio can assess an individual's nutritional needs and develop a customized meal plan.

- Religious support

The elderly residents of Trivulzio are promised the maximum level of self-determination, and their religious beliefs and moral ideals are respected. Older people who believe in religions other than Catholicism may contact the nurse or contact ministers of other religions. According to the Archdiocese of Milan, the Catholic church service is planned to provide spiritual assistance and support to senior citizens.

- Visits from relatives and friends

The relatives and friends of the elderly can come and visit them without any limitation. Trivulzio respects the privacy of all people and hopes the place can become a new home where the elderly can receive the help they need and maintain their family and social relationships.

- Other services

Shaving the beard, cutting, washing and drying the hair, and other services are also available, but some of them are not free (VIVERE AL TRIVULZIO, 2021).

2.6.3 Examples of healthcare services in Japan

(1) Dream Lake Day Care Center (夢のみずうみ村浦安デイサービスセンター)

This day care centre is one of Japan's most distinctive and popular healthcare service centres and can accommodate 80-100 older people. The area of this daycare centre is about 3,423 square meters. It is mainly aimed at the semi-self-care elderly who need day care and rehabilitation

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training in the surrounding communities. This centre is not trying to eliminate all the height differences on the ground like other healthcare facilities, but to preserve the various difficulties in daily life as much as possible under the premise of ensuring safety. It aims to encourage the elderly to overcome difficulties and improve their ability to live independently. The design concept is to encourage the elderly to get rid of their dependence on mobility aids and genuinely rely on their strength to spend a fulfilling day in the facility.

The elderly can make an appointment by phone, and then they will be picked up from home by car to the nearest Dream Lake Day Care Centre. After arriving, the elderly can put the items in the locker and then determine which activities they want to participate in. They can put the activities on the schedule (Fig.2.29). This daycare centre has hundreds of activities that the elderly can choose from. These activities are well-designed to help the elderly recover after surgery. These activities will be improved based on the feedback from the elderly. These activities and games pay attention to the psychological needs of the elderly. The elderly can engage in activities that they are good at to maintain their self-confidence and dignity. For example, activities that can help activate the brain's ability include cooking, bread making, language rehabilitation, mahjong, etc. Activities for improving hands-on skills include porcelain making, calligraphy, flower arrangement, carpentry, origami, weaving, etc. Physical activities include swimming, walking, rehabilitation, table tennis, karaoke, etc. Relaxation activities include bathing, watching movies, reading, sleeping, and chatting.



Fig.2.29

The schedule. 夢のみずうみ村.

From: https://www.komei.or.jp/km/tama-imai-mitsue/files/2013/05/20130508_0949041.jpg

Everyone can choose and decide how to spend their day. The elderly can earn virtual currency “YUME” by participating in activities. These currencies can be used to pay for courses, buy coffee, small products and snacks, etc. If they do not want to spend money, they can deposit it in the “YUME” bank. The “YUME” system allows the elderly to realize that they need money, so that they are motivated to participate in activities. The elderly need to pay the cost of some activities in order to improve their cognitive abilities. When the elderly withdraw money from the wallet again and again, the upper limb ability can be improved. If the elderly have enough money, they also need to consider how to use it, which also improve their thinking skills (夢のみずうみ村 , 2021).

The proportion of male users in the Dream Lake day care centre is the highest among the day care centres in Japan. Older men are delighted to enter the day care for rehabilitation exercises. The elderly hope to continue to carry out social activities in this small society. In Japan, day care centres are supported by long term care insurance. The elderly only need to spend 10% of the price, and the government pays the remaining 90% (Zhou & Xu, 2016).

(2) 鶴の苑

Located in a residential community in Machida City, Tokyo, 鶴の苑 is a representative of healthcare facilities in Japan. The healthcare service centre integrates medical clinics, rehabilitation centres, community services, day care, and nursing homes (Fig.2.30) (合掌苑 , 2021a).

The first floor is the day care centre, including clinics/infirmaries, a pharmacy, an activity area, a restaurant, and a restroom (Fig.2.31) . The second floor is reserved for elderly residents who require special care. There are 24 rooms, all of which have been carefully created for seniors with mild, moderate, or severe dementia. They can receive more professional, detailed and personalized nursing care in a space full of a family atmosphere. Considering dementia patients with BPSD (Behavioral and psychological symptoms of dementia), these rooms eschew direct light and use indirect light to create a comfortable environment, which will effectively calm patients' emotions. In order to reduce the terrible consequences caused by the accidental fall, the floor use more flexible vinyl flooring. A box is placed in front of the entrance,, and some small items that the elderly love are specially placed into the box to help the elderly confirm that this room is his home. To ensure service quality, a

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Fig.2.30
鶴の苑 . 合掌苑 .
From: <https://r-guide.jp/facility/s1763/>

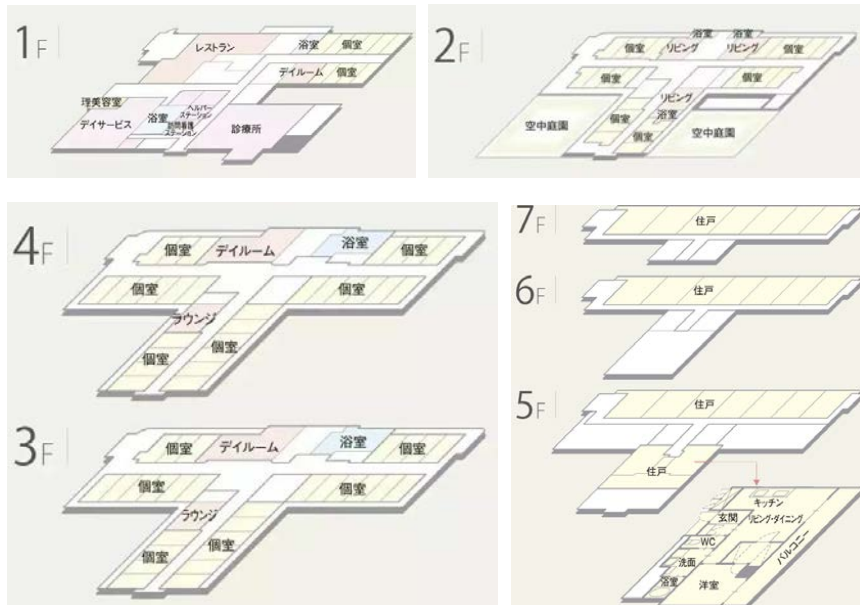


Fig.2.31
The layout. From: 合掌苑 (2021b)

care worker only needs to serve two older people with dementia. There is also a sky garden full of flowers and green plants on the second floor to help the elderly relax. With doctors and experts, the elderly can receive professional healthcare. The 3rd and 4th floors are for the elderly who need long-term care and medical services. There are 58 rooms with toilets. The care workers are available 24 hours to provide care service. For the elderly who cannot take care of themselves, the bathroom is outfitted with the latest technology, making it simple for the elderly to take a shower. The fifth, sixth and seventh floors can be used by the elderly concerned about their health and want to live independently. According to the services and physical conditions of the elderly, the costs on each floor are different (合掌苑, 2021b).

The restaurant in this building offers a wide variety of food. Barbers can help older people cut hair, dye hair, make-up, trim nails, and wash their faces. This agency also cooperates with nearby hospitals to provide emergency medical services. The elderly can also buy some prescription drugs in the pharmacy in the building. With these services, older people can live happy and healthy (合掌苑, 2021c).

2.6.4 Famous examples of healthcare services in other countries

(1) Sun city USA

In 1960, the Del Webb Development Company proposed a bold idea: a master-planned retirement community built specifically for active adults. Friendship, socializing, recreation, and fun have been the main staples of living in Sun City (Fig.2.32). This is a self-contained community where residents can meet all their needs without going to other places. As the population grows, the need for a range of services, including shopping, medical care, dining, and long-term care is also increasing. Now, residents can obtain high-quality healthcare services due to increased investment. Numerous physicians, doctors, dentists, and specialists are available, and there is a top-rated medical centre. Residents can benefit from world-renowned research, medical specialists, support services, and clinical trials. Sun City's healthcare facilities are better around the United States (Sun City, 2021a; Sun City, 2021b).



Fig.2.32

Humanitas Akropolis.
From: Humanitas
(2021)

Several types of senior housing are available, including independent living, assisted living, continuing care retirement communities (CCRCs), memory care, skilled nursing, and rehabilitative care (Sun City, 2021c). Renting an apartment is also an option for seniors, but renters must meet all requirements (including that one person in residence must be at least 55 years of age). Sun City residents have access to a variety of special-interest clubs and activities. With over 130 groups accessible and a steady stream of events and activities, each day may be filled with opportunities to keep active, creative, and entertained. Seven distinct recreation centres are located across there. Sun City's recreation centres own and run eight golf courses with five snack bars, two bowling centres with leased full-service restaurants, an open-air amphitheatre, a softball field, a 33-acre artificial lake, and an off-leash dog park. Numerous organizations and service agencies offer low- or no-cost resources and assistance to preserve an active senior lifestyle (Sun City, 2021d). These services are available to all residents.

(2) Apartments for Life (Humanitas Akropolis)

Humanitas is a Dutch non-governmental organization (NGO) formed in 1945. In 1992, Hans Becker, the NGO's previous CEO, established the first apartment for life (A4L) in Rotterdam (Fig.2.33). The apartment for life is the world's first healthcare service concept designed in the form of a hotel. Since then, the organization has expanded to include 3,000 units spread across 30 locations around the Netherlands and generates annual

revenue of £86 million (Ike, 2013). The apartment for life has achieved international fame for its innovative approach to senior living and care. The model has become the standard healthcare service model in the Netherlands. A4L's primary goal is to ensure the wellbeing of older adults by blending age groups and providing older adults with the maximum level of autonomy (ACCESS Health Sweden, 2016). The philosophy behind this approach is a belief that older adults want to remain independent and involved in society as much as possible and want to avoid the stigma and other associated issues related to relocation (Glass, 2014).

The apartment for life in Rotterdam is a residential care complex comprised of three buildings. Elderly people live in different apartments according to their physical conditions. These apartments are divided into units for independent living, assisted living, and some special units for older adults who require 24-hour care. The central building contains a nursing home for the disabled elderly and older adults with intellectual disabilities. The single and double rooms with private sanitary facilities are comfortable and convenient, and the privacy of the elderly can be guaranteed. There are professional medical teams available to provide services to the elderly (Humanitas, 2021).

The notable features of A4L are:

- In the apartment for life, the staff do not refuse the requirements of the elderly, as long as these things do not pose a threat to the health of the elderly. The elderly are encouraged to remain in charge of their own lives.



Fig.2.33
Humanitas Akropolis.
Humanitas. From:
<https://www.stichtinghumanitas.nl/home/2017/06/page/2/>

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- Hans Becker thinks that the over-provision of care is more damaging than the under-provision. The apartment for life pays more attention to improving the self-care ability of the elderly, rather than helping the elderly deal with all daily challenges.

- Hans Becker thinks that the feeling of loneliness and the fear of abandonment are the root causes of depression for many older people. The A4L fully considers the physical and psychological characteristics of the elderly from site selection to design. The A4L is based on communities and is open to residents. This model turns healthcare facilities into a social and cultural centre. Residents can freely enter the apartment, enjoy the convenient services, and can also meet or talk with the elderly. This way can give older people a sense of community, improve their social interaction, and reduce loneliness.

- Medical staff do not need to wear lab coats and wear their clothes. The elderly will not feel that they are being specially cared for.

- Most of the A4L has an atrium connected to each apartment's corridor. Many activities can be organized in the atrium, and older people have more opportunities to communicate with others.

- These apartments fully consider the physical characteristics of the elderly and adopt a barrier-free design to avoid any inconvenience for older people (Yinuoguihua, 2020).

Through the above case studies, the healthcare model can be divided into the following categories (Tab.2.18).

2.7 The advantages, challenges and opportunities of healthcare services for the elderly in China

2.7.1 Advantages

- Smart healthcare service platforms

In China, many regional and local governments have established smart healthcare service platforms to provide elderly care services for older people (Zhang, Li, & Wu, 2020).

- The complete system

China has formed a multi-level healthcare service system based on home care, community care as the support, institutional care as a supplement and a combination of medical care. These are also the three main models of China's healthcare services. This system can meet the basic needs of the elderly.

- Legal and policy support

A series of policies and regulations promulgated by the state have established basic principles for the healthcare service system. In order

Categories	Models	Features	Cases
The Composite Healthcare	Comprehensive Community	providing healthcare service for the elderly, including senior apartments, nursing homes, hospitals and other medical facilities	Vanke - SuiYuanJiaShu Retirement Communities
	All-age community	providing healthcare service for people of all ages	Sun city
Community-based Healthcare	Community-embedded	Day care	Dream Lake Day Care Center, The Village Family Service Center
Institutional care for the elderly	Senior apartments, nursing homes	long-term-care	Pio Albergo Trivulzio, 鶴の苑
Special healthcare	Medical-oriented Healthcare	In-depth involvement of medical industry	ChanggengYiyang
	Education-oriented Healthcare	In-depth involvement of education industry	Daaicheng
	Travel-oriented healthcare	In-depth involvement of tourism industry	HaiNan Free Trade Port Boao Hope City
	Interaction-oriented healthcare	In-depth involvement of social resources	The apartment for life

Tab.2.18
The categories of healthcare model

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to encourage the development of the elderly care service industry, the government has issued a series of encouraging policies, including a discount on utility bills, to promote social resources into the elderly care service industry to increase investment in elderly care services. The government encourages and supports various social entities to participate in constructing, operating, and managing community comprehensive service facilities to provide elderly care services.

- The high participation rate for medical insurance

Social medical insurance has covered about 95% of the population in China. Almost everyone can enjoy the services brought by social medical insurance.

- Internet hospital

Internet hospitals have broken the restriction that patients must go to the hospital for a consultation, allowing patients to use the Internet to consult professional doctors anytime and anywhere. Telemedicine breaks through the limitations of traditional medical care and saves medical expenses. The online registration and consultation services provided by Internet hospitals have greatly optimized the patient's consultation process and saved patients' time. Doctors can also use the fragmented time to provide online medical services. The remote technology has broken through the medical radiation radius of traditional hospitals, not only can effectively expand the hospital's outpatient volume and increase hospital income, but also help the hospital expand the scope of services and achieve more comprehensive business upgrades. Many hospitals have established Internet medical platforms to provide more convenient services to the elderly. Remote technology has helped hospitals expand the scope of traditional services, increase the number of outpatient services, and increase hospital revenue.

- Integrating medical institution and nursing homes

The elderly with minor illnesses can receive treatment in nursing homes. Older people with serious illnesses can be sent to the hospital for treatment. After older people are cured, they can return to the nursing home. This service model optimizes medical resources in hospitals and nursing homes.

2.7.2 Challenges

- Poor social perception of smart homecare service in China
A field study found that 93% of older people do not know smart homecare. However, when they have a good understanding of smart homecare services, 63% think that these smart services can help them live better (Zhang, Li, & Wu, 2020).

- High costs caused by insufficient demand
Healthcare service providers need to make profits through service supply, and these smart services tend to be expensive. Due to high costs, older adults do not want to use healthcare services. Insufficient demand brings about insufficient supply in the service market. As a result, the price of services increases.

- Lack of regulation on standard
Technical compatibility is an essential factor for smart healthcare services and products. Many countries (including China) lack unified industry technical standards for healthcare services. This limits the popularization of smart healthcare services.

In China, multiple government departments are jointly responsible for the quality supervision over smart healthcare services. Ministry of Civil Affairs and State Administration for Market Regulation are responsible separately for the quality supervision over smart daily healthcare services provided by the public institutions and services offered by the private institution; Ministry of Industry and Information Technology (MIIT) is responsible for regulating the operation of the smart healthcare service platform and the smart security service. At present, these departments and agencies do not issue a national unified industry standard and quality regulation for smart healthcare services (Zhang, Li, & Wu, 2020).

- Unbalanced distribution of medical resources
In China, the total amount of high-quality medical resources is relatively insufficient. Medical resources are concentrated in large cities, and there are not enough medical resources in some rural or remote areas.

- Lack of digital skills
By 2020, the number of Chinese Internet users will reach 904 million. Older people aged 60 and above is the smallest group of Internet users,

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accounting for 6.7% of the total. This means that a proportion of older adults do not have smartphones and cannot master advanced digital skills. They face a digital divide.

- Lack of investment attractiveness

The early-stage investment in the elderly care service industry is relatively large, and it will take about 10 years to recover the cost. According to the annual report of China's health and elderly care service industry, about 40% of the elderly care institutions are at a loss, and only 9% are profitable. This leads to social investment reluctance to invest in the healthcare service industry.

- Social inclusion

At present, the service processes of hospitals and Internet hospitals are for everyone, not specifically for the elderly. Many older people will face more problems in the process of receiving services. They do not know how to use a self-service kiosk to register, pay bills, print medical slips, etc., so they have to queue up at the hospital registration desk. These services not only waste the time of the elderly, but also add to their burden. For the elderly, social inclusion needs to be improved.

- Some services are not available

Internet hospitals are convenient, but there are not many doctors to choose from when seeking health consultation, and most doctors do not provide video consultation services. This makes some medical services unavailable.

- Adoption of smart technology among older adults

Elderly people are sensitive to the price of smart healthcare products and have high requirements for the convenience of smart devices. Thus, their self-efficacy perspective on the use of smart technologies is relatively low. A social survey showed that most older adults in China have poor knowledge of smart healthcare services, and only 27% of the elderly are familiar with smart healthcare services. It is very difficult for them to imagine the expected benefits of smart healthcare services (Lee, 2014; Gao et al, 2019; Mao & Li, 2015; Demiris et al, 2004).

2.7.3 Opportunities

- Following national development strategies

From Opinions on Comprehensively Promoting Home-based Elderly Care Services (issued by China National Working Commission on Ageing) in 2008 to Action Plan for the Development of Smart Health and Elderly Care Services (2017–2020) (issued by the Ministry of Industry and Information Technology and the Ministry of Civil Affairs) in 2017, China government has issued a series of policy to promote the development of smart healthcare services for elderly. China's smart healthcare are obviously a policy driven services rather than demand-driven services or services of technological progress. Chinese government had played a major role in developing smart healthcare services. It aims to flourish the consumption market of healthcare services. The research on smart healthcare services is valuable and meaningful.

- Internet plus

In 2015, China's prime minister put forward the "Internet plus" plan in the Report on the Work of the Government. Immediately after this, the National Development and Reform Commission (NDRC), in collaboration with other departments, issued a notice that proposes applying the "Internet plus" plan to elderly care. As the core content of internet plus, healthcare services, smart homes for older people have become the key development direction of China government (Zhang, Li, & Wu, 2020). The Chinese government is promoting the application of new-generation information technology, such as artificial intelligence, the Internet of Things, cloud computing, and big data, in the healthcare services industry. The smart healthcare service system is an important part of the national project.

- digital devices and smart technology

A caregiver cannot take care of the elderly 24 hours a day. Smart devices with IoMT can help solve this problem. For example, a GPS receiver, accelerometer, heart rate monitors, ECG, blood pressure, body temperature, and breathing sensor can be used to continuously track and monitor older people's health parameters (Beard, 2010). Based on the collected data, smart technology such as big data analysis and AI can predict health risks. Through a monitor of body sensors, when the physiological parameters exceed the normal range, the emergency alarm can be triggered, and the elderly can get timely help. This can shorten the reaction time and maximize the safety of the elderly.

- The home network information service

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Many regional governments are supporting enterprises and social institutions to use the Internet, Internet of Medical Things and other technologies to build home care service models, develop e-commerce for the elderly, create home service network platforms. These actions aim to provide emergency calls, housekeeping appointments, health consultations, purchases of goods, online payments, and other valuable services for the elderly. The community has also been supported to introduce service providers, such as social institutions, housekeeping companies, and charity organizations, to establish community service centres for the elderly.

- Cooperation between government and enterprises

In order to realize smart healthcare service system, the government and enterprises can use a public-private partnership (PPP) to cooperate. It is necessary to clarify the responsibility boundary between the government and enterprises. Enterprises are in a dominant position in service supply. The government's main responsibility is to build a smart healthcare service platform, formulate evaluation standards of healthcare services, strengthen supervision of market behaviour, guide the market to provide more effective healthcare services and promote the development of the healthcare services industry.

- Smart home and The Internet of Medical Things (IoMT)

By integrating information and communication technology (ICT) and connecting various medical devices to the IoT network, the smart home allows older people to transmit medical data from their home to their primary care provider or a hospital. The use of IoMT devices along with telehealth can also be helpful for ongoing care outside of the patient setting. For example, personal emergency response systems (PERS) can track events—such as a fall or heart attack—to automatically call for help. PERS can provide security to at-risk people, such as seniors that want to live at home without compromising their safety (Orde, 2021; Harper, 2006).

- Smart community

The smart community uses IoMT devices throughout a broader town or geographic area. In this environment, mobility devices can be used to track older people. The Chinese government stipulates that healthcare service facilities need to be constructed in new cities and new residential areas. For some old towns and communities, the local government is also

required to improve or build healthcare service facilities for the elderly. The construction of infrastructure provides opportunities for developing a smart healthcare service system.

- In-Hospital IoMT

Hospitals must manage the quality and supply of their medical assets over time, and they also need to understand how personnel and patients are moving throughout the premises. Healthcare professionals use IoMT sensors and other tracking systems to track all of these interactions so that administrators can get a comprehensive understanding of what is going on.

- Smart healthcare service system

The development of smart cities makes Smart healthcare service system possible. By connecting to the smart city network, this smart healthcare service system can know how the elderly interact with stakeholders and social institutions and monitor what is happening in their daily lives.

- Elderly-oriented design

Elderly people without an income and the disabled elderly can apply government subsidies. According to the "Standards for Accessible Design", the local government need to help them improve their living environment to meet their daily needs. These policies provide support for smart home renovations.

- International cooperation

International cooperation can also help improve healthcare services. In 1988, Italy provided free assistance to China and established several medical emergency centres. At that time, China sought help from many European countries, but only Italy provided the help (Sohu, 2020). International cooperation can help improve the quality of health care services, promote the development of smart technologies, and improve the research level of geriatrics.

- A non-profit organization

A non-profit organisation

The government encourages non-profit organisations to participate in the construction of healthcare institutions, the development of smart products, and the provision of elderly care services, so that non-profit organisations can become a vital force to promote the development of

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the healthcare service industry.

- Social inclusion

Although technology is developing rapidly in China, social inclusion for the elderly is still not enough.

- User centre

Enterprises involved in offering smart home care services should implement a customer-oriented strategy. At present, disabled and older adults have great demand for smart care services, and thus these groups could become the main target market of a smart home for elderly care. Enterprises should develop more products and services suitable for disabled and older people.



Fig.2.34
International
assistance. From:
Sohu (2020)

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CHAPTER 3

USER RESEARCH

- 3.1 Definitions and classifications of the elderly population
- 3.2 The characteristics of the elderly
- 3.3 Analysis of the needs of the elderly
- 3.4 Healthcare services

References

Part II — Research questions

RQ1 What is the differences between Italy, China, and Japan's healthcare service systems?

RQ2 What is the Chinese medical insurance system, and how does it work?

RQ3 What types of healthcare service models are currently available?

RQ4 What age is considered elderly in China, Italy and Japan?

RQ5 What are the needs of the elderly?

RQ6 How to help the elderly bridge the digital divide?

This chapter focuses on user research. What age is considered elderly must first be defined, and this varies in different countries and regions. The research can answer RQ4. The age of the elderly determines to a certain extent the healthcare services they need. Research on the psychological and physiological characteristics of the elderly can help service providers address methods of providing healthcare services, such as home delivery, age-friendly digital service platforms and staff services. In order to answer question 5, the elderly must be classified in different dimensions (stage of ageing, physical health and functional ability, demands, healthcare services, living situation). In each ageing stage, older people with different physical conditions and living situations have different needs, and their demands are very complex. Based on Maslow's hierarchy of needs, analysing their demands can help obtain the healthcare services to meet their needs. The study found that the most important needs in old age are medical.

Questo capitolo si concentra sulla ricerca utente. In primis, occorre definire quale età viene considerata come "anziana", seconda dei paesi e delle regioni. Questa ricerca può rispondere a RQ4. L'età degli anziani determina in una certa misura i servizi sanitari di cui hanno bisogno. La ricerca sulle caratteristiche psicologiche e fisiologiche degli anziani può aiutare i fornitori di servizi a definire i metodi di fornitura di servizi sanitari, come la consegna a domicilio, le piattaforme di servizi digitali a misura di anziano e i servizi per il personale. Per rispondere alla domanda 5, gli anziani devono essere classificati secondo diverse dimensioni (stadio di invecchiamento, salute fisica e capacità funzionale, esigenze, servizi sanitari, situazione di vita). In ciascuna dell'invecchiamento, persone anziane con condizioni fisiche e situazioni di vita diverse hanno esigenze diverse e le loro richieste sono molto complesse. Sulla base della gerarchia dei bisogni di Maslow, l'analisi delle loro richieste può aiutare a ottenere i servizi sanitari per soddisfare le loro esigenze. Lo studio ha rilevato che i bisogni più importanti nella vecchiaia sono di tipo medicale.

3.1 Definitions and classifications of the elderly population

3.1.1 Definitions

Ageing societies are becoming a global phenomenon. Conventionally, the elderly is defined as a chronological age of 65+. People aged from 65 to 74 are referred to as youngest-old, those aged between the ages of 75 and 84 as middle-age, and those aged over 85 years as oldest-old (Orimo et al., 2006). The United Nations and many researchers define older persons as those aged 60 or 65 years or over (United Nations, 2019). The WHO divides the older age group into two categories, Elderly (older persons) and Oldest-old. The Elderly refers to people aged 65+ or sometimes 60+, and people aged 80+ are considered as the Oldest-old (World Health Organization, 2008). The World Health Organization defined a new criterion that divides older people as follows: 66-79 years old (middle-aged); 80-99 years old (elderly/senior); 100+ years old (long-lived elderly) (Victoria, 2016).

According to Chinese Law "The Protection of the Rights and Interests for the Elderly", 60 years are defined as the fixed threshold at which old age begins. In Japan, like many countries, the elderly is defined as having a chronological age of 65 years or older. Many older people below 75 years old are still robust and active, and they do not want to be treated as elderly. The Joint Committee of Japan Gerontological Society and the Japan Geriatrics Society suggest redefining the elderly as aged 75 years and older, as the rapid ageing of Japan's population continues (Ouchi et al., 2017). Italy has the second oldest population in the world, just behind Japan. The national congress of the Italian Society of Gerontology and Geriatrics (SIGG) thinks that a person should be considered "old" only after their 75th birthday (Fiorentin & Monter, 2018). Based on the above definition, we can find that in those countries where the problem of ageing is severe, the age defined as "old" is relatively greater.

3.1.2 Classifications

The classification of the elderly is helpful to the study on specific groups of older people, which can more accurately understand the characteristics, behaviours and habits, and daily demands of this group.

Based on these studies, the healthcare service system can provide more direct and effective services, such as home delivery, age-friendly digital service platform, healthcare services, etc.

3.1.2.1 Five stages of aging

Some experts and researchers break down ageing in older adults into five basic stages (Mu, 2015; Lori, 2021):

Stage 1: Independence

At this stage, older adults have retired for several years and are in good health. Most of them live in their own home and can deal with some problems in daily life by themselves. Mental and physical activity may experience a minor decline, but not enough to affect their lives. They can be self-sufficient and self-reliant. They are willing to participate in some social activities. They have a high quality of life.

Stage 2: Interdependence

With increasing age, older adults gradually lose their ability to perform some daily duties, and they forget things more frequently, even if they are unaware. While certain physical activities and mental tasks may become more difficult, they can still do many things independently, but not everything. If they cannot get help from others, their quality of life may suffer.

Stage 3: Dependency

During this period, older adults require further assistance. They have trouble handling a few daily tasks by themselves as age-related changes kick into overdrive. It may be difficult for them to travel alone. Their physical characteristics make healthy ageing at home slightly more difficult, but still with a high possibility. Some of them may need more assistive devices to live independently or require moderate help from a healthcare provider. Their quality of life decreases significantly.

Stage 4: Crisis management and complex care

Older people at this stage can no longer live independently. They need more or less 24-hour healthcare. Some older people can get help and support by moving into an assisted living facility.

Stage 5: End of life

They need medical care and healthcare services almost all day. They

need to ensure quick access to health facilities and medical resources. They tend to stay in assisted living facilities, nursing homes, or even hospice care.

3.1.2.2 Physical health and functional Ability

Functional status refers to a person's ability to perform tasks required for living. The geriatric assessment begins with a review of the two primary functional ability classifications: activities of daily living (ADL) and instrumental activities of daily living (IADL) (Elsawy & Higgins, 2011).

ADLs are self-care activities that older adults conduct on a daily basis. They include self-feeding, bathing, toileting, clothing, personal hygiene and grooming, and transferring. The instrumental activities of daily living (IADL) are activities that are needed to live independently, and include using the telephone, housekeeping, shopping, food preparation, prescription management, financial management, using transportation, and doing laundry (Graf, 2008; Williams, 2014).

Disabilities are classified according to a variety of physical and mental impairments that might impede or limit an individual's capacity to perform daily activities. The disability includes mobility and physical impairments, spinal cord disability, head injuries and brain disability, vision disability, hearing disability, cognitive or learning disabilities, psychological disorders, and invisible disabilities (Disabled World, 2019). Ruaro and other researchers (2014) proposed a version of the ICF (the International Classification of Functioning, Disability and Health) core set to classify the physical health of older adults. The main components of the core set are body functions, body structures, activities and participation, and environmental factors (Tab.3.1).

The elderly can be classified into the following categories based on their physical health and functional ability:

- Self-care elderly: older adults who can take care of themselves, live independently, and not rely on others.
- The device-aided elderly (semi-self-care elderly):
Older adults who rely on handrails, crutches, wheelchairs and lifting facilities in their daily life.
- Assisted living for the elderly:
Older adults who need personal care services and medical assistance in

Components	ICF Category
Body functions	Energy level
	Quality of sleep
	Vestibular function of determination of movement
	Proprioceptive function
	Sensation of pain
	Heart rate
	Blood pressure functions
	Respiration rate
	General physical endurance
	Aerobic capacity
	Mobility of joints generalized
	Power of all muscles of the body
	Tone of all muscles of the body
	Endurance of all muscles of the body
Body structures	Heart
	Bones
	Joints
	Muscles
Activities and participation	Focusing attention
	Squatting
	Standing
	Walking
	Using transportation
	Ensuring one's physical comfort
	Managing diet and fitness
	Informal relationships with peers
Environment factors	Drugs
	General products and technology for culture, recreation, and sport
	Health services

Tab.3.1
The core set

daily living.

- The Disabled elderly:

Older adults who have difficulty with communication, self-care, mobility, learning, or behaviour (Davis, 2000). The level of disability is divided into mild disability, moderate disability, and severe disability.

- Older adults with intellectual disabilities:

There are four levels of intellectual disabilities: mild, moderate, severe, and profound (Karen, 2019).

3.1.2.3 Healthcare services

The elderly can be classified into four categories based on their healthcare service needs:

- Older people with 24-hour healthcare services
- Older people with high-intensity home care service
- Older people with medium-intensity home care service
- Older people with low-intensity home care service.

3.1.2.4 Demands

According to the demands, the elderly can be divided into the following categories.

- Demands for luxury services

The elderly with high income requires high-quality and highest-level healthcare services.

- Elastic demand

Elderly people who have actual needs for healthcare services often choose to receive care services at home or community.

- General needs

The elderly who are disabled require varying levels of healthcare services based on their physical conditions.

- Rigid demand

Older adults with intellectual disabilities need to receive a high-intensity healthcare service.

3.1.2.5 Living situation

According to the living situation, the elderly can be divided into the following categories: older adults living alone, older adults living with relatives, older adults living with children, older adults living in nursing homes and older adults living in assisted living facilities. The needs of the elderly are complex and diverse. The classification of the elderly is an effective method to provide better and more effective services for different groups of older people.

3.2 The characteristics of the elderly

In reality, many elderly adults dislike being treated differently and sometimes resist receiving healthcare services. This is decided by their psychological characteristics. Therefore, care workers need to understand the psychological and physical characteristics of the elderly. Based on these studies, care workers can provide the elderly with more acceptable services to them.

3.2.1 Psychological characteristics

- Do not want to be treated as an old person

Many older people can deal with some problems by themselves in daily living. They do not like to be treated differently.

- Dependency

Due to the degradation of bodily functions, some older people find it difficult to cope with emergencies in daily life. They are emotionally dependent on their children, relatives, family numbers, etc.

- Inferiority complex

With the development of society, the use of technology reduces the value of experience and skills. These experiences are the basis for older people to be respected in the past. Therefore, the process of modernization has led to a decline in the social status of the elderly (Xu, 2011). After the elderly retire, they also have changed from people who contribute to society to dependents who need to depend on society or family members. They may have a personal feeling of inadequacy, but they still need social recognition and respect.

- Vainglory

Many older people like to hear compliments. This is human nature. Based on their own experience, some older people like to show off their glorious experiences and brilliant achievement and express authoritative opinions. Sometimes, they are stubborn.

- Social participation

Robert J. Havighurst (1961) proposed the activity theory in 1961, which means that a continuing level of activity and social interaction is essential to well-being and healthy ageing. Some older people are unwilling to be

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abandoned by society. They want to participate in social activities that can interact with others actively. One of the significant areas of age-friendly cities is social participation, and it is also an essential component of successful ageing (Yazawa et al., 2016; Takeuchi et al., 2013). Thus, paying attention to the social participation of older adults is particularly important, and its promotion is one of the key recommendations of the World Health Organization in response to concerns about the ageing population (He et al., 2017; Dehi Aroogh & Mohammadi Shahboulaghi, 2020).

- Loneliness

Some older people have left their jobs, and their spouses, relatives and friends have passed away. They cannot communicate with their old friends or children. These older people are unwilling to interact with others and fear that they are discriminated against, so they may be depressed and lonely.

- Suspicious

Older people who are suspicious, often suspect others and always believe that others (including relatives and children) talk about them.

- Degeneration

Elderly people show naive psychology and behaviours that are inconsistent with their own age. In other words, they have the same cognitive and behavioural characteristics as children.

- Hope to get more spiritual care

Older people seek increased spiritual care as their living standards improve. However, this kind of demand involves intergenerational and interpersonal relationships, friendship and family affection and cannot be met by themselves. It needs participation and support from others. The social support theory advocated by Cobb in the 1970s believes that social support is closely related to individual mental health, and it has an important impact on alleviating individual psychological pressure, eliminating individual psychological barriers, and improving individual mental health (Cobb, 1976).

- Pay more attention to themselves

Cumming and Henry, in 1961, formulated the disengagement theory in the book "Growing Old". The theory claims that "ageing is an

inevitable, mutual withdrawal or disengagement, resulting in decreased interaction between the ageing person and others in the social system he belongs to” (Cumming & Henry, 1961). They gradually pay attention to themselves and their personal spiritual needs in the process. Sometimes, they also are various degrees of being self-centred.

- Pay more attention to life

As older people grow older, it is inevitable for them to fear death and hope to have a long and healthy life, so they pay more attention to the quality of life (Xu, 2011).

- Economic considerations

Some older people did not have high incomes when they were young. They worry about their finances, especially medical expenses.

- Nostalgia

Most older people prefer to live in a familiar environment, and it is difficult for them to adapt to a new environment.

3.2.2 Physiological characteristics

- A weak immune system

With age, the immune system of the elderly decreases gradually. They tend to be sick and suffer from chronic diseases. The self-healing ability of the body decrease make them take longer to recover from illness.

- A weak digestive system

With age, the immune system of the elderly decreases gradually. They tend to be sick and suffer from chronic diseases. The body's self-healing ability decreases, making them take longer to recover from illness.

- Decreased ability to perform physical exercise

The muscle strength of the elderly is significantly reduced. The reduced lower limb muscle strength leads to a decline in balance, which may lead to accidents such as falls.

- Loss of coordination

Reflexes and coordination start to slow with age. They become slow and inflexible.

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●Sensory deprivation

Ageing contributes to sensory deprivation, such as hearing loss, vision loss, or diminished senses of smell, touch, and taste. As people age, the degeneration in the visual system may result in a decrease in vision or even eye diseases, such as Presbyopia, Cataracts and Glaucoma. Hearing loss is widespread among the elderly. In old age, the number of taste buds decreases, which leads to an increase in the taste threshold and a decrease in sensitivity to sour, sweet, bitter, and salty. Smell disorders cause the elderly to reduce their ability to distinguish odours. Their olfactory sensitivity to irritating gases in the air is only one-tenth that of young and middle-aged people, and it becomes hard for them to smell a natural gas leak. These problems have a profound effect on a senior's life, and they need the help of auxiliary devices (Wang, 2017).

●Aging changes in the nervous system

Forgetfulness is a common symptom of aging. The frequency usually increases with age. Decline of memory function is a normal process for the old age. Changes in the structure and function of the brain are the primary cause of nervous system degeneration. The size of the brain gradually shrinks with age. The gradual deterioration of brain function also leads to the decline of sleep quality and hours of sleep. (Wang, 2017).

Personality traits and habits can affect people's life expectancy. There are seven traits that the oldest seniors all share (Michael, 2021). These traits and habits can help keep healthy and live longer.

●Productive and active lifestyle.

With a productive and purposeful life, older adults can engage in physical activities that are critical for maintaining good health.

●Positive mindset.

For older adults who have a cheerful outlook, life is perpetually hopeful.

●Resilience and adaptability

Older people who can adapt to changes are more likely to be longevity and have happy lives.

●Maintain a healthy weight and eat a balanced diet in general

A balanced diet and healthy eating habits can help lower the risk of disease and promote a good mindset.

- Ability to manage stress

The ability to balance and handle stress has significant effect on mental health and physical health. The oldest seniors have the ability to prioritize passion and stress.

- Good self-esteem and stubbornness

Older adults with high self-esteem are not easily swayed by others' opinions and have a good decision-making skill.

- Close bonds and social relationships

Positive social ties and interactions with others can aid in the fight against depression and loneliness, which can have a positive effect on physical and mental health.

3.3 Analysis of the needs of the elderly

Due to this demographic trend and the higher risk in old age to get ill or have a disability, there is a significant surge in demand for elderly care. Home care has always been the mainstream mode under the intergenerational relationship of "feedback mode". With the traditional concept of family, taking care of older people is considered a family responsibility for Italian, but many adult children are likely to have to work and live in other cities. Therefore, what we can do for older adults and how to take care of them has become a social problem. With the coming of elderly economics, home care for older adults has been an important field of service design (Yu, Gong, Gu, 2017).

Most older people prefer to live in their homes (Eurostat, 2015). Many older people have deep emotional attachments to their homes that they have lived in for many years. They prefer to live with old friends nearby, and they are reluctant to leave the environment where they originally lived. When they become older and cannot do much of the work, they hope someone can help them. There are still some realistic problems. They do not want a servant always to be around. Another reality is that the number of beds in nursing homes cannot meet the huge demand of the increasing number of older people. The number of Italian nursing homes is insufficient, and government and society will only intervene when the empty-nest elderly need it. Many older people have difficulties in domestic life and personal care. They have to solve some problems by themselves. Getting older can bring on health problems. These older

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people who live alone could be a risk for their safety (Cavallo et al., 2018). They begin to need various help. It is also important for them to participate in some social activities to tackle isolation and depression.

Based on Maslow's hierarchy of needs (Fig.3.1) (McLeod, 2020), the needs of the elderly can also be classified as basic needs, psychological needs and self-fulfillment needs (Maslow, 1943). The basic needs include physiological needs and safety needs. Belongingness and love, and esteem needs belong to psychological needs. Self-fulfillment needs mean self-actualization.

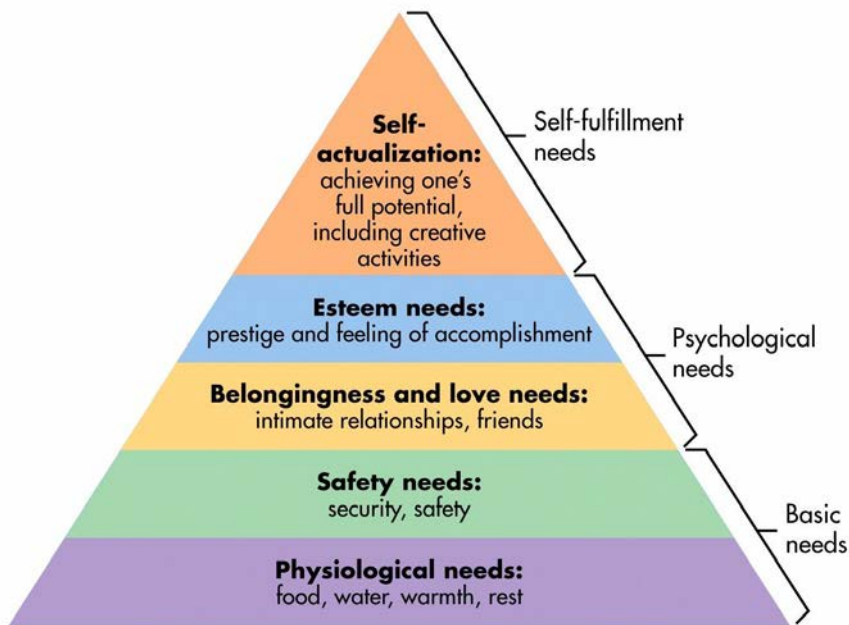


Fig.3.1
Maslow's
hierarchy of
needs. From:
McLeod (2020)

3.3.1 Basic needs

3.3.1.1 Physiological needs

- Daily needs

The "early elderly" are in better physical conditions and have a faster metabolic rate than the "late elderly". The "early elderly" does not need

much help from others in daily life. For the disabled elderly and older adults with intellectual disabilities, most of their daily needs cannot be met by themselves, and they need various healthcare services, such as eating, bathing, personal cleaning (washing and brushing teeth, etc.), haircut, dressing, going to the toilet, bed-wheelchair transfer, going up and downstairs, dental check-up, care for a pressure sore, turning over in bed, rehabilitation training, etc. For the semi-self-care elderly, the elderly with different physical conditions have different service needs. Generally, day care, housekeeping services (laundry, cooking, cleaning), meal assistance, haircuts, bathing, home maintenance services, and other services are most popular for them (Yang, 2019).

- Activities

Older people need to have daily activities and do exercises. Physical activities can help improve their health, prevent chronic diseases, and enhance happiness. Seniors who live at home have more options for physical activity. In contrast, many older people in nursing homes lack opportunities to exercise, and their physical functions are poor. The potential needs and urgency of physical activity for the elderly in nursing homes are greater than that of living at home (Han, 2013).

- Transportation needs

Transportation systems are built to serve communities by providing accessibility and mobility. However, older people living in these communities may face different challenges. They have special transportation needs due to limitations in mobility and the decline of accessibility levels where they live. The disabled elderly cannot fulfil all their transportation needs without help from others or society (Wasfi, Levinson, & El-Geneidy, 2012).

3.3.1.2 Safety needs

- Medical needs

Medical needs are the most important for the elderly and are also an important factor affecting their quality of life. The disabled elderly may need to receive medical services in hospitals or nursing homes where professional doctors and nurses provide these services. For the self-care elderly, their medical needs can be met at home or in the community.

Medical needs include professional healthcare services, medical escort

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service, emergency medical services, medication guides, physical examinations and re-examinations, onsite medical care, blood pressure measurement, blood sugar measurement, long-term care for chronic diseases, etc. Community medical centres and emergency support services are most needed by the elderly living at home. The disabled elderly have unique healthcare needs. They need rehabilitation equipment and training to help them recover in daily life.

In order to live a healthy life, the elderly also need some advice on diet, exercise, lifestyle, and safety education. Health and safety education can help the elderly understand their health status, prevent common diseases, and promote physical recovery. Health education is necessary and helpful for the elderly, especially the oldest-old people. They often have some chronic diseases. If they have an in-depth understanding of their diseases, they can prevent the disease from getting worse and receive treatment as soon as possible. The middle-old and oldest-old people have a more urgent need for health education, but youngest-old people are more likely to receive health education (Sun et al., 2018). At present, in China, elderly people have the most urgent needs for medical care services and onsite services (Yang, 2019).

- The residential environment

For the elderly, the bed should be placed parallel to the window to avoid glare. The TV should be placed parallel or below the line of sight, within 3m from the seat. For the disabled elderly, we need to consider the wheelchair turning space and install handrails to prevent falls. Some assisted living products are necessary, such as a wheelchair, walking frames, walking sticks, crutches, and beds with bed rails, etc.

According to different scales, adult day care centres can be different in the structure of functional space. Functional spaces should include kitchen, canteen, shower room, toilet, medical care room, rehabilitation training room. If there is enough space, it should also include a hairdressing room, reading room, recreation room, etc. The dining area should adopt a 6-person dining table, which should be placed perpendicular to the window (Lin, Tang, & Zhang, 2015).

- The legal needs of older people

Seniors are designated as a social and economic disadvantage group, and they are likely to experience additional difficulties when it comes to

getting legal services. This is why it is critical to handle older adults' legal issues (Ellison et al., 2004).

- Demand for Insurance Services

Health insurance can help cover some expenses of healthcare. For all the elderly, this is beneficial to reduce the burden on the family.

- Demand for financial services

Older people may face a range of financial and consumer issues. They lack experiences in handling financial affairs, so for them, they need this kind of services.

3.3.2 Psychological needs

3.3.2.1 Belongingness and love needs

Interactions and emotional exchanges from family, friends, and neighbours contribute to the improvement of happiness in life. If these needs cannot be met, the elderly may be depressed and feel lonely. Most older people need spiritual care services, psychological counselling services, and chat services, especially for the elderly living at a nursing home (Liu, 2011). After the elderly retire, they have much time to participate in different cultural and physical activities, according to their physical conditions. These older people living in their own homes have many opportunities to participate in social activities. Through social participation, some needs of them can be met, so they have higher levels of wellbeing, and their need for spiritual care services is less urgent than the elderly living at a nursing home. In the home-based care model, older people have a good memory, a wide range of hobbies, and regular physical exercise. Their performance in self-recognition, cognition and intelligence, interpersonal relationships, and adaptability is significantly better than institutional care. Visits from children, relatives or friends can enhance the wellbeing of older people living in a healthcare institution. If they can find a friend who can talk to each other in the institution, they can also feel happiness. If they can go home on some important festivals, the sense of wellbeing will be improved. Generally, home care is still the best choice for the elderly (Wang et al., 2015).

3.3.2.2 Esteem needs

Esteem needs are an important aspect for the elderly. They often correlate respect with freedom. As their freedom and abilities decrease, they sometimes feel less respected. Those with a higher education level are more likely to want to be respected by others. In some cases, if the elderly can participate in the decision-making process, they will feel respected.

3.3.3 Self-actualization

Self-actualization of the elderly can come from many aspects. Older people look forward to participating in society by playing a specific social role. If they can do something useful to the lives of others, they feel delighted. Some simple activities, such as growing flowers, tidying up the room, etc., can also give the elderly a sense of accomplishment. For the elderly living in nursing homes, if they can help to do something within their capacity, it will also help realize self-actualization.

3.3.4 Explicit and implicit Demand

The needs of the elderly can be divided into explicit demands and implicit demands. Explicit demands mean that older people can directly and clearly express what they want. Implicit demands mean some care services that older people need, but they do not directly express due to the urgency and lack of understanding. According to the above analysis, explicit demands include daily needs, needs for activities, transportation needs, safety needs, medical needs and needs for the residential environment. The legal needs of older people, demand for insurance and financial services, psychological needs, love and belongingness needs, esteem needs and self-actualization belong to implicit demands.

3.4 Healthcare services

The Oregon State Legislature (United States) defines "healthcare services as "any medical or remedial care or service, including supplies delivered in connection with the care or service" (Oregon Revised Statutes, 2007). Health services consist of medical professionals, organizations, and ancillary healthcare workers who provide medical care to those in need.

Health services cover an emergency, preventative, rehabilitative, long-term, hospital, diagnostic, primary, palliative, and home care ("Health Services: Definition, Types & Providers", 2018).

WHO has identified three approaches that will better serve the needs of older populations (WHO, 2015):

- Develop and ensure access to services that provide older-person-centred and integrated care.
- Orient systems around intrinsic capacity.
- Ensure there is a sustainable and appropriately trained health workforce.

To support these approaches, WHO develops and shares evidence-based guidance on how to provide integrated care to older populations, especially those in less-resourced settings, provides technical assistance and support to countries to develop evidence-based policies, and promotes approaches to improve health workers' knowledge and competencies on Healthy Ageing.

According to the above research, healthcare services can be divided into three types to cover basic needs, psychological needs and self-fulfilment needs of the elderly.

3.4.1 Basic healthcare service

Primary healthcare services can help the elderly meet their everyday needs and safety needs. These services include universal service, complex service, and medical services.

- Universal service:

personal care, transportation services, home-delivered meals, meal preparation, laundry, grocery shopping, other housekeeping items, physical exams, haircuts, home maintenance services, medication guides, physical examinations and re-examinations, blood pressure measurement, blood sugar monitoring.

- Complex service:

helping with paperwork, financial services, insurance service, nutritional support, day care, long-term care for chronic diseases.

●Medical services:

getting out of bed, assisted walking, assisted bathing, assisted dressing clothing, doctor care, nursing care, wound dressing, ostomy care, intravenous therapy, medication administration, health monitoring, pain control, dental care, diagnostic care, substance abuse treatment, preventative care, physical and occupational therapy, pharmaceutical care, medical escort service, emergency medical service, onsite medical care (Johns, 2021; “Health Services: Definition, Types & Providers”, 2018).

3.4.2 Psychological healthcare services

For the belongingness and love needs, and esteem needs of the elderly, psychological healthcare services are helpful to manage stress and improve mental health. The government, associations, or public welfare organizations can build community mental health teams that are responsible for assessing and treating older people with psychological disorders. The teams should consist of social workers, professional therapists, psychologists, psychiatrists, physical therapists, speech-language pathologists, and professionals. These experts can provide volunteer care, emotional support, mental health care, spiritual care services, psychological counselling services, chat services, psychological crisis intervention (PCI), mental health tests, mental health hotline, memory clinics, mental health education, and other services (Teng et al., 2009).

3.4.3 Healthcare service about self-fulfilment

A positive and supportive community should understand how to encourage self-actualization among older adults. The community can create a supportive environment for older residents, facilitate lifelong learning activities, and encourage companionship from neighbours and family members. After basic needs can be met, elderly adults can focus more on self-actualization. They can participate in social work and creative programs to learn new skills or exercise their cognitive abilities. They can also cook for the homeless or offer informal education activities. These efforts not only benefit society, but also help them achieve self-fulfilment (Wellpathadmin, 2019).

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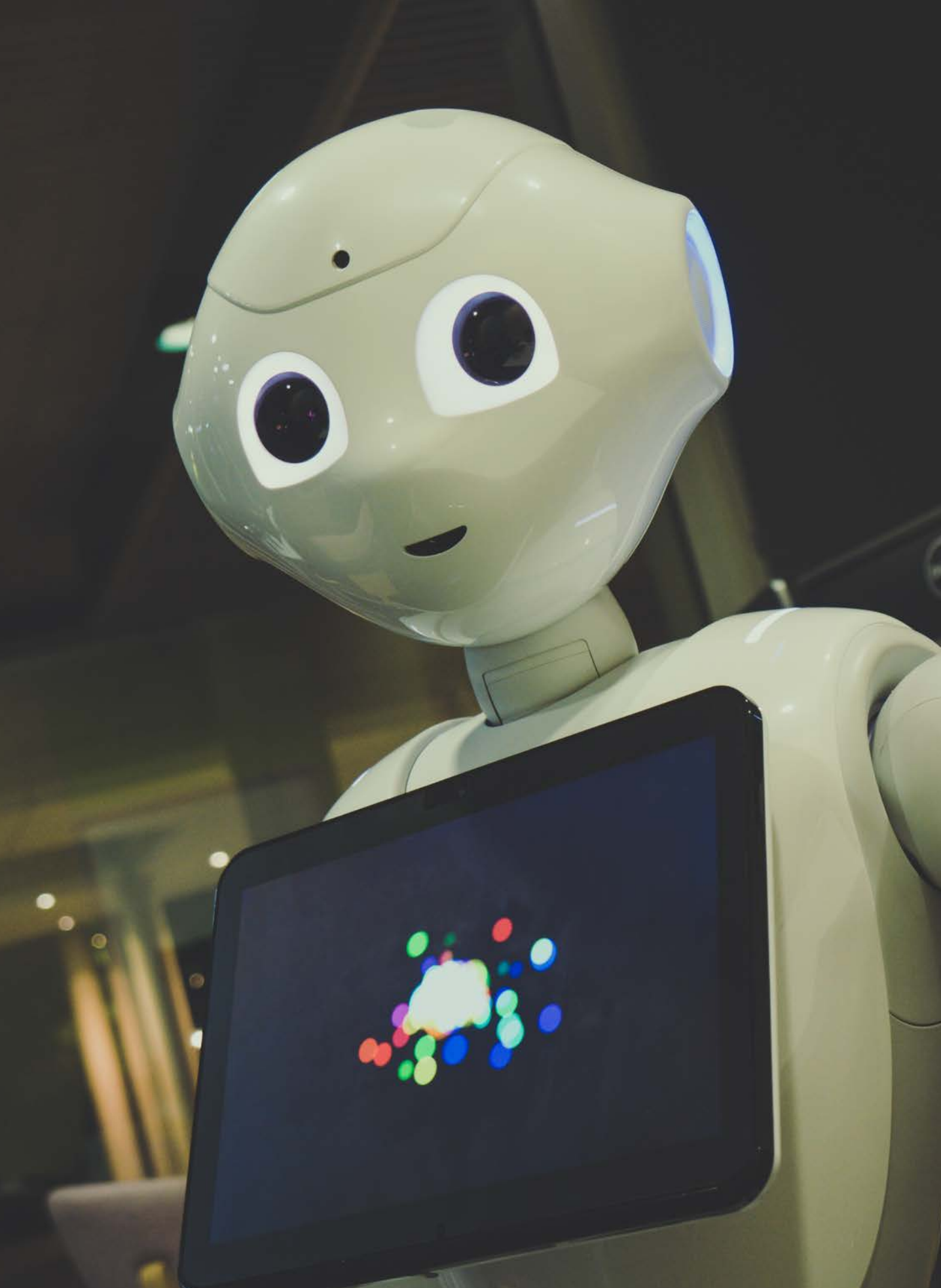
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CHAPTER 4

AGEING AND DIGITAL TECHNOLOGY

4.1 Introduction

4.2 Digital accessibility and digital
inclusion

4.3 Case study

4.4 Research hypothesis: Smart
healthcare service system based on
AloMT

References

Part II Research Answers

Part II — Research questions

RQ1 What is the differences between Italy, China, and Japan's healthcare service systems?

RQ2 What is the Chinese medical insurance system, and how does it work?

RQ3 What types of healthcare service models are currently available?

RQ4 What age is considered elderly in China, Italy and Japan?

RQ5 What are the needs of the elderly?

RQ6 How to help the elderly bridge the digital divide?

Both ageing and digitalization are social phenomena. We have entered a digital society, where digital technology is used in all aspects of life. With the widespread use of digital devices and platforms, the elderly, as a digitally disadvantaged group, also face increasing difficulties. The digital divide includes three aspects: access to technology, the ability to use digital technology, and the results and effects of the use of digital technology. The research about digital accessibility and inclusion helps meet these challenges. Some emerging technologies can also help achieve this goal. When ageing faces digitalization, both need to make changes and compromises. Elderly people need to embrace digitization, while digital technology, devices and platforms should become more age-friendly. Based on these studies, I propose a research hypothesis: smart healthcare service system based on AIoMT (AI + IoMT). The system is based on the architecture of IoT with four layers, and the digital healthcare service platform is the core. Because the system contains many stakeholders and social institutions, it is difficult for a single organization or institution to complete the construction of such a system. I consider the organizational structure of the system, describe the service process and summarize the service scenarios. Finally, a business model canvas is created. Although my research aims to help the elderly deal with the digital divide, it will still be difficult and complex to give a perfect answer for RQ6. Bridging the digital divide for the elderly requires a joint effort by the whole of society.

Sia l'invecchiamento che la digitalizzazione sono fenomeni sociali. Siamo entrati in una società digitale, in cui la tecnologia digitale è utilizzata in tutti gli aspetti della vita. Con la diffusione di dispositivi e piattaforme digitali, anche gli anziani, in quanto gruppo digitalmente svantaggiato, affrontano difficoltà crescenti. Il digital divide comprende tre aspetti: l'accesso alla tecnologia, la capacità di utilizzare la tecnologia digitale, i risultati e gli effetti dell'uso della tecnologia digitale. La ricerca sull'accessibilità e l'inclusione digitale aiuta ad affrontare queste sfide. Alcune tecnologie emergenti possono aiutare a raggiungere questo obiettivo. Quando il tema dell'invecchiamento affronta la digitalizzazione, entrambi devono affrontare modifiche e compromessi. Le persone anziane devono adottare la digitalizzazione, mentre la tecnologia, i dispositivi e le piattaforme digitali dovrebbero diventare più a misura di anziano. Sulla base di questi studi, propongo un'ipotesi di ricerca: sistemi

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di servizi sanitari intelligenti basati su AIoMT (AI + IoMT). Il sistema si basa sull'architettura IoT con quattro livelli e la piattaforma di servizi sanitari digitali è il fulcro. Poiché il sistema coinvolge molti stakeholder e istituzioni sociali, è difficile per una singola organizzazione o istituzione completare la costruzione di un tale sistema. Nel capitolo prendo in considerazione la struttura organizzativa del sistema, descrivo il processo e riassumo gli scenari del servizio. Infine, ho creato un modello di business canvas. Sebbene la mia ricerca miri ad aiutare gli anziani ad affrontare il divario digitale, sarà comunque difficile e complesso dare una risposta perfetta per RQ6. Colmare il divario digitale per gli anziani richiede uno sforzo congiunto di tutta la società.

4.1 Introduction

4.1.1 Background

In the book *Being Digital*, Nicholas Negroponte pointed out that human beings live in a digital virtual space where people use digital technology to engage in activities such as communication, learning, work, etc. Human beings will move toward an entirely digital society. Digital technology is also changing the way people grow old. Many daily demands can be met by the services provided by digital platforms or applications, such as Facebook, Ins, what's up, etc.

The COVID-19 pandemic has also accelerated digital transformation and raised awareness of the importance of digital technology in achieving UN Sustainable Development Goals progress (SDGs). Due to the COVID-19 pandemic, the public has increased their attention to medical and healthcare services, and digital services and Internet applications have been accepted and used by more and more people. Some companies have attempted to use ICT, cloud, big data, blockchain, and artificial intelligence (AI) in healthcare services.

During the coronavirus pandemic, digital technology has played an important role in the operation of healthcare institutions. Family members, for example, can use mobile applications to learn about the physical condition of an older person in a healthcare facility. Healthcare institutions can publish information on the Internet platform to seek funding. Smart medical devices can assist the elderly in managing their health. Smart wearable devices can monitor body temperature in real-time, avoiding the need for frequent body temperature measurements during an epidemic. Digital technology has helped reduce the work intensity of nurses and caregivers.

This change has affected the healthcare industry. As a comprehensive service industry, it contains a diverse array of industries, covering medicine, medical equipment, education, finance and other healthcare services. The digital transformation of the healthcare industry is dependent on the transformation of related industries. Future trends include the use of emerging technologies and personalized healthcare.

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The elderly should also actively embrace emerging technologies. Products and services that assist the ageing population in maintaining an active lifestyle are needed. Emerging technologies, particularly new information and communication technologies, have the potential to improve quality of life and social connectedness in later life. It is critical to assist the elderly in mastering digital technologies so that they can gain access to information, public services, and opportunities for social participation (Neves & Vetere, 2019).

Mastering digital technology has become a key component of what it means to participate in society fully. If we do not provide older adults with technology access and training, they may be disengaged from society, worsening an already worrisome trend of isolation and loneliness among the elderly (Jessica, 2019).

Many older adults need to learn how to use digital technologies to keep in touch with their family members and alleviate feelings of isolation. Some internet applications can help them keep updated with the latest information and advice (Malcolm, 2021).

The fact is that a large number of older people, particularly those over 70 who cannot use mobile phones, are likely to face difficulties in daily life due to a lack of digital skills. This leads to the digital divide, a new form of social inequality because of the unequal access to emerging digital technologies. There are three digital divides: the first is access to technology; the second is the use of digital technology (such as a computer); and the third is the results and effects of the use of digital technology (Attewell, 2001; Van Deursen & Helsper, 2015; Wei et al., 2011).

Older adults aged 65+ can obtain digital skills through training programs or courses to deal with these problems, but other solutions are required for older people aged 80+. An elderly-oriented design needs to be considered in digital devices, services, products, and interaction. This can reduce the barriers encountered by the elderly. At present, middle-aged people can use some digital applications. They have mastered these skills. When they are old, the digital divide may be narrowed.

4.1.2 Emerging Technologies

Older adults need to adapt to digital technologies, especially during the pandemic. People need to keep a safe distance while maintaining daily communication and activities in order to reduce the spread of COVID-19. Digital devices make contactless interaction between people possible. This also caused other problems. When it comes to digital devices, the elderly are frequently at a loss. Therefore, how to enable the elderly to enjoy the services and convenience brought by digital technology passively is very important. While studying emerging digital technologies, we also need to consider which smart technologies can help the elderly bridge the digital divide.

Artificial Intelligence (AI) is a subfield of computer science (Fig.4.1). Machine learning is an AI application that allows computers to think like humans by learning from past experiences or historical data. Deep learning is a subset of machine learning, and as a self-adaptive algorithm, it can process and analyse data using hierarchical neural networks

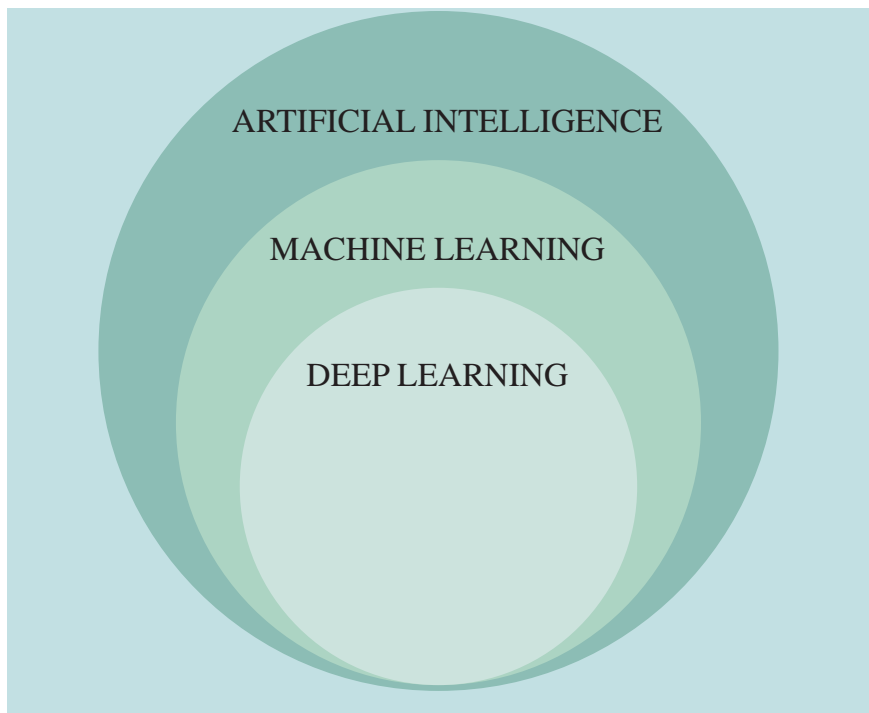


Fig.4.1
Artificial
intelligence (AI),
machine learning
and deep
learning

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(Marshall, 2021). These digital technologies and advanced algorithms can be used in medical diagnosis, prediction, healthcare and other applications.

Big data is vital for deep learning. The increasing amount of data can significantly improve training performance and deep learning capabilities. Predictive modelling, user behaviour analysis, and other advanced data analyses can all benefit from big data. An information system can collect, store, and process data and then present visual information. People can manage information conveniently in this way.

Blockchain technology can be used to record information, and in this system, the information recorded is almost impossible to be changed. It can be used to diagnose and treat the elderly, ensuring that all medical procedures can be traced and cannot be changed.

Cloud computing can help store, analyse, back up, and recover data. Hybrid clouds can realize data sharing and applications between public and private clouds. With lower latency and a faster response, 5G can change our lives and bring people a better experience. Telehealth allows people living in remote areas to enjoy high-quality medical services.

At present, devices with embedded sensors can be connected to the Internet. Smart home enables people to control different devices in the home. Based on IoT, some functions, such as remote health monitoring and emergency notification systems, can be achieved. These functions can help the elderly live more securely.

4.2 Digital accessibility and digital inclusion

4.2.1 Digital accessibility

Digital accessibility is the process of making digital products (websites, mobile apps and other digital tools and technologies) accessible to everyone. It is about ensuring that all users have access to the same information, regardless of their disabilities (Enginess, 2019). Jonathan Lazar, Daniel Goldstein, and Anne Taylor defined accessible technology as a technology that can be utilized effectively by people with disabilities (Lazar, Goldstein, & Taylor, 2015). In 1990, the Americans with Disabilities

Act (ADA) was enacted to provide protections for people with disabilities in a physical environment, but it is also applied to online business and education (Guv, 2020). Attewell (2001) describes the digital divide as the technology gap between the people who have digital skills and those without skills.

In 1996, the World Wide Web Consortium (W3C) promoted web accessibility as a vital goal of its overall mission. W3C developed the Web Content Accessibility Guidelines (WCAG) as a technical standard outlining guidelines for making web content accessible to people with disabilities. WCAG is constantly evolving, and new updates to the guidelines are published regularly. The current standards, WCAG 2.1.1, focus on a wider range of people with disabilities (OmniUpdate, 2021).

Digital accessibility should ensure that older people can interact with digital technology without barriers. Good usability improves the digital experience of the elderly. It is important to rethink the relationship between the elderly and digital technology and establish a connection between them.

4.2.2 Digital inclusion

Digital inclusion is the idea that digital technology should be available to all people regardless of age, economics, cultural background, language, geography, computer literacy, access to connectivity, and disabilities (OmniUpdate, 2021). Digital inclusion refers to the activities necessary to ensure that all individuals and communities, including the most disadvantaged, have access to and use information and Communication Technologies (ICTs). Digital equity is a condition in which all individuals and communities have the information technology capacity needed for full participation in our society, democracy and economy. Digital equity should ensure all people have access to the information technology needed for full participation in our society, democracy and economy, and access to essential digital services (Ndia, 2021).

For the elderly and those having physical or mental disabilities or belonging to other minority groups, their needs are likely to be ignored in the design of digital applications. This caused the digital divide. Participatory design and a multidisciplinary approach may be needed to deal with this problem. Older adults also are required to learn new skills for using these new digital technologies.

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Digital technologies should be divided into active digital technology and passive digital technology. Active digital technology means that older people can play an active role and master these technologies by learning skills. Passive digital technology means that older adults do not need to learn how to use these technologies, and these digital technologies or devices can help them or provide services for them. Passive digital technology may be better for those with physical or mental disabilities. Regardless of the type of digital technologies, their applications all need to follow some principles of elderly-oriented design.

4.3 Case study

Emerging technologies, particularly mobile and wearable technologies, can play a critical role in meeting the needs and aspirations of an increasing number of older adults (65+) and the oldest-old people (80+). Cardinaux, Bhowmik, Abhayaratne, and Hawley (2011) indicated that “Ambient assisted living (AAL) has the ambitious goal of improving the quality of life and maintaining the independence of older and vulnerable people through the use of technology.” (p. 1). Health monitoring wearables (HMWs) are an emerging technology for healthy and active ageing in older adults and can avert potential hazards in their lives (Fang & Chang, 2016; Kang et al., 2010; Li, Lee, & Xu, 2020). The demand for remote healthcare monitoring increases because of reduced health system resources (Deen, 2015; Møller & Kettley, 2017). Some cases demonstrate the importance and role of digital technology in the daily lives of the elderly.

4.3.1 Smart home

Smart homes with a technologically advanced system can enable domestic task automation and provide higher security (Lê et al., 2012). As people age, older people aged 65 and over are likely to need a caregiver or a home that has been outfitted to accommodate the common frailties of age (reduced vision, decreased mobility, increased risk of falls). As a user-friendly solution, smart home devices can help take care of the elderly and help them live independently in their own home. Various sensors, discreet cameras, security systems, smoke alarms, medical alert systems and voice-activated speakers can make everyday life more convenient and safer (Rachel, 2021).

A company named Bticino developed a smart home automation system. The MyHOME_Up smart system includes all digital devices in the home, and users can control these devices in real-time through smartphones and App (Fig.4.2).

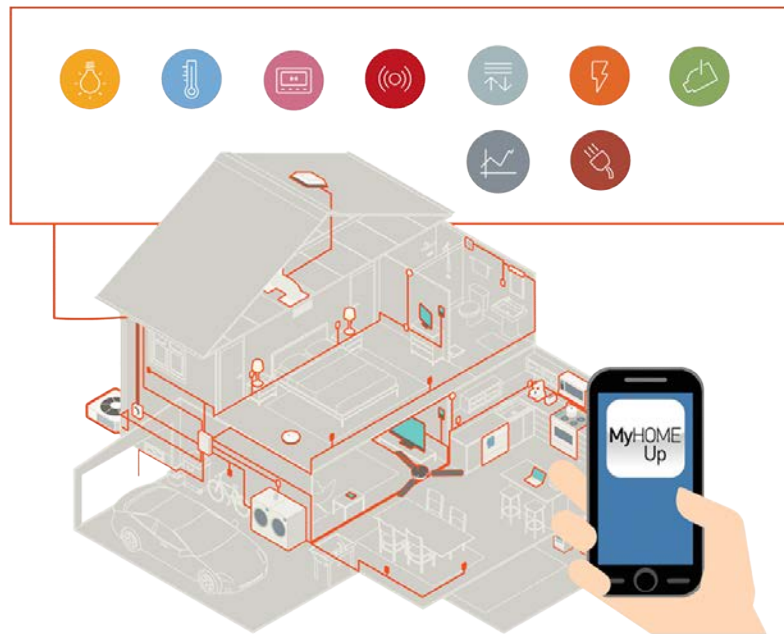


Fig.4.2
The smart system of
MyHome. Bticino.
From: <https://www.bticino.it/smart-home-o-domotica>

The GrandCare system is a connected health solution for the elderly and disabled. It changes the way healthcare is delivered by allowing people to remotely monitor seniors' vital signs and quickly determine whether a medical visit is required. Wireless motion and sensors can monitor daily activity levels (GrandCare systems, 2021). Older adults and people with chronic diseases can use the touch screen to look at their health parameters and access video chat, emails, and calendar events (Fig.4.3).

For the elderly, a smart home system is functional and practical. The smart door lock is a good example. Instead of a key, a digital code or a fingerprint can unlock. Older users can go keyless and not worry about losing their keys. Smart locks can be allowed to add authorized users for regular visitors such as caregivers, houseworkers, or other family numbers. In the smart home for seniors, medical alert systems are essential. If older adults have an accident or sudden illness, the system

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Fig.4.3
Grand Care systems.
From: <https://www.grandcare.com/>



Fig.4.4
Qtug. From: <https://www.kinesis.ie/qtug/>

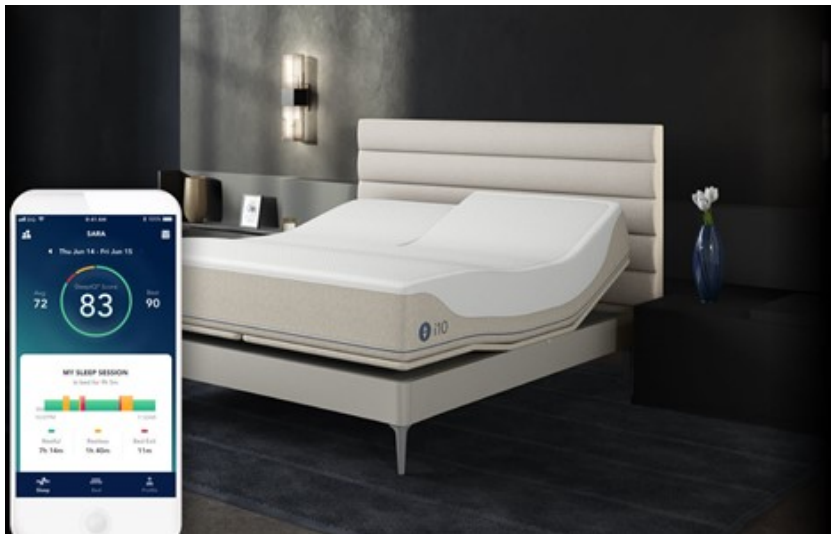


Fig.4.5
Smart mattress
from Sleep number.
From: <https://www.sleepnumber.com/pages/health-well-being>

will send emergency information to the contact person and family doctors. This way can avoid serious consequences (Carlos, 2021).

4.3.2 Smart devices

Qtug is a fast and efficient tool for identifying older adults at risk of falling (Fig.4.4). Based on data collected by wearing sensors in the legs, it can produce a fall risk score. In less than 5 minutes, it can provide an assessment of gait and mobility, frailty, falls risk, and a detailed breakdown of the TUG test, including standing, sitting, walking, and turning (Qtug, 2021).

Sleep Number is a company that manufactures smart mattresses with a large number of sensors and voice recognition (Fig.4.5). Sleep Number's mission is to improve lives by individualizing sleep experiences. Automatic adjustability and our digital health platform are features of Sleep Number. SleepIQ sensing technology uses high-resolution ballistocardiography readings sampled several hundred times per second, providing full body measurement. The embedded software employs advanced biomedical signal processing and algorithms to monitor body movements, position changes, time to fall asleep, and breathing and heart rate in real-time (Sleepnumber, 2021).

CarePredict is a medical alert system and features an innovative device to predict health risks. The wearable wrist device can track movements and heart rate and monitor the daily activities of the elderly via sensors (Fig.4.6). If The physical data of the elderly is outside the normal range., their relatives will be notified promptly. This can help identify health risks such as falls from trips, slips or heart attacks (Caring.com, 2021).

4.3.3 Smart application

Nectarine uses innovative AI-based technology to help seniors live more fully and independently. The system includes a waterproof wristband, a hub, and satellites placed around the home (Fig.4.7). When needed, the system alerts their relatives or caregivers through an app on their mobile phones. The mobile app provides 24-hour remote monitoring without compromising privacy (Fig.4.8). The service ensures that if older people experience a health issue, help is always available (Nectarine Health, 2021).

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Fig.4.6
Tempo™ Series 3.
From: <https://www.carepredict.com/news/carepredict-launches-tempo-series-3/>

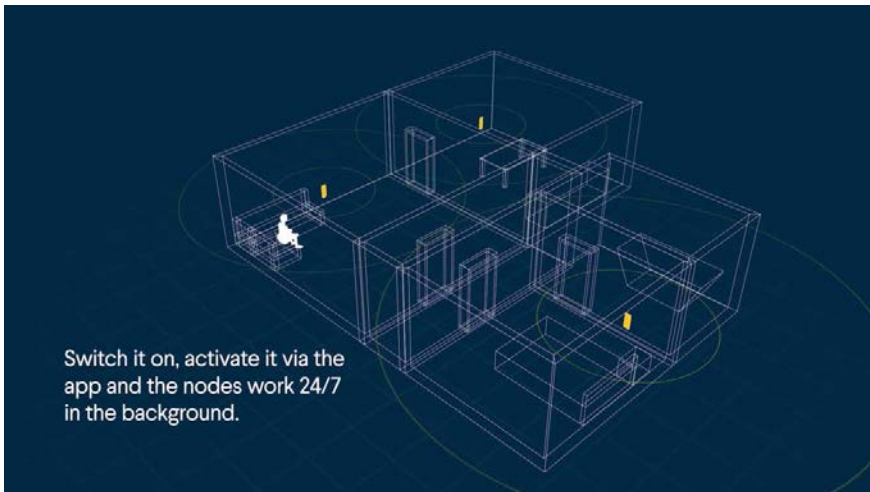


Fig.4.7
Home care system.
Nectarine Health.
From: <https://nectarinehealth.com/>

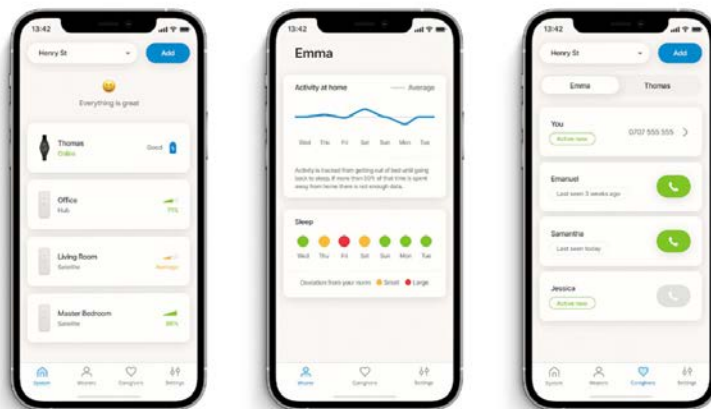


Fig.4.8
The mobile app.
Nectarine Health.
From: <https://nectarinehealth.com/>

4.3.4 Smart platform

As a leader of the healthcare service industry, JoyDigit China has developed an open IoT data platform for senior living (named JoyDigit NexIoT) through integrating big data, artificial intelligence, the Internet of Things, blockchain, mobile internet and other innovative technologies. The advanced IoT platform can connect hundreds of smart devices. Based on this platform, the JoyDigit team cooperates with the real estate industry, financial industry, insurance industry, and health service industry in some areas (such as health education and smart cities). They build a digital ecosystem for the elderly, which includes service systems, medical systems, cultural and tourism systems, and related industries (Zhao et al., 2020)

In order to effectively promote the digital transformation of senior care service, JoyDigit China has proposed a methodology named iSpeed (Fig.4.9), which includes standardized process, service personalized & experience, all-engaged, intelligent empowered, effective decision, and data-driven (JoyGigit, 2021).

Under the coordination of the local municipality, the I-CARE-SMART project bring together the research & development sector, business sector, health & social service provider sector and the elderly community to start a long-term co-creation and cooperation. The goal of this project is to integrate the identified needs of both the elderly and healthcare service providers into each phase of the innovation cycle for SMART



Fig.4.9
JoyDigit NexSight
platform <http://www.joydigit.com/about-joydigit/>

solution (planning, developing, prototype, validation, marketing and follow-up). The project provides a comprehensive toolset with practical guidance on how to engage seniors and businesses in user-focused co-creation and open innovation. Additionally, the project creates a “SilverStar” platform to facilitate co-creation processes across borders. The platform will support (i) the visibility of the identified innovative solutions; (ii) the creation of a virtual community to encourage and facilitate transnational collaboration and co-creation of innovative solutions for elderly care (Interreg Central Europe, 2021).

4.4 Research hypothesis: Smart healthcare service system based on AIoMT

In the digital era, traditional healthcare models have been difficult to meet the various needs of the elderly, and in some cases, it may pose a challenge to their happiness and health. With the development of society and the digital transformation of various industries, digital innovations also are reshaping the healthcare service system. In order to establish a healthcare service system that is more in line with modern lifestyles, theoretical research should precede practice.

This digital healthcare service system is different from the traditional healthcare model and is in line with the development of the digital society. The smart system can integrate and coordinate social systems to realize the dynamic and refined management of the elderly. In this system, a digital healthcare service platform is the core. By using digital sensors, smart devices, the Internet of Things, big data, cloud/edge computing, artificial intelligence and other advanced technologies, the system can observe and analyze the lives of the elderly, dynamically access their information and data, connect people, materials and institutions, and then actively manages and responds to their demands in an intelligent manner. The system can promote interaction and cooperation among social institutions and all stakeholders, help organizations and individuals make informed decisions through information sharing, facilitate the rational allocation of resources, and ensure that older people can get the services they need (Tian et al. 2019).

As digital applications have penetrated all aspects of people's lives, no

matter where the elderly is, they cannot avoid interacting with digital devices. All interactions and activities could generate data. These data can be saved and uploaded to different data centres, and then sent to the smart healthcare service system. The longer the elderly use it, the more data the system will collect. Along with advanced deep learning algorithms, this system will continuously optimize based on the recorded information to form a model that is more in line with their daily life and physical conditions. After returning home, according to their daily habits, the system knows what they will do next and helps them do it in advance, and they do not need to do it again. Based on big data analytics and AI, the system can make predictions, create a reminder and provide various services for older people. This system can be considered as a personal digital butler to take care of the elderly. It can allow the elderly to obtain smarter, accurate, convenient, professional, and diversified services, thereby helping the elderly cope with the challenges of ageing.

Through smart devices, the physiological data and behavioural data of the elderly can be obtained, but all information and data are encrypted and will only be shared with medical institutions and family members in emergencies. It will not intrude into the life of the elderly or interfere with their decisions. The system will remind them or give emergency assistance only when the physical frailty indicators are outside normal. More importantly, the elderly do not need to learn how to use this system. This system is a passive digital technology. It will serve the elderly silently in daily life and will not even be discovered by them.

This system integrates social institutions, including banks, supermarkets, transportation, hospitals, restaurants, shops, pharmacies, e-commerce companies, etc. Government supervision can ensure data security and prevent privacy leakage. The information platform and data centres can summarize the information and resources of all stakeholders, and through big data, these resources can be effectively allocated to reduce service costs and improve service quality. Thanks to the government's support and supervision, this system can break industry barriers and promote information sharing among various stakeholders. From the government's perspective, this system can also reduce the service gap between different regions and promote social equity by increasing or reducing taxes and subsidies. In the future, the smart healthcare system will reshape the healthcare industry. Finally, the elderly can enjoy a safer, more convenient, and happier life.

4.4.1 System design

Smart healthcare service system has been applied in various fields, for example, the electronic medical record (Shaikh, Parvati, & Biradar, 2018), digital services for citizens (reservation, queue elimination ...) (Tian et al., 2019), early detection of disease (Jeong, Han, & You, 2016; Tuli et al., 2020), health service platform (Jiang, Wang, & Xu, 2021), and telemedicine system (teleconsultation, telemonitoring and telesurgery) (Abugabah, & Nizamuddin, 2020). In Italy, the national health system (Il servizio sanitario nazionale) recognizes 3 ways (Telemedicine, Teleconsultation, Telemonitoring) in which the relationship between doctor and patient can be managed remotely (Fastweb, 2021). Manogaran et al. (2018) designed an architecture to store and process sensor data. Karmakar et al. (2020) proposed a security architecture for smart healthcare network infrastructures. Catarinucci et al. (2015) proposed a smart hospital system to automatically monitor and track patients, personnel, and biomedical devices in hospitals and medical institutes. Bates et al. (2014) have presented six use cases where Big Data can help reduce healthcare costs. Rajavel et al. (2021) developed an IoT-based smart healthcare video surveillance system that provides reliable monitoring of remote and elderly patients without affecting network bandwidth and delays in response time. Based on edge computing architecture, Singh and Chatterjee (2021) proposed a smart healthcare system with high security, low latency, low transfer time, low power, and low energy.

Many researchers have studied smart health service systems from big data, data storage, architecture, IoMT (Internet of Medical Things), and they have provided various solutions for the system architecture from multiple perspectives. These studies contribute to the design of health care service systems, but there is little research on the smart health service system for the elderly. Much research focuses on technology development and the application of a smart system in a specific industry. These smart systems have only a limited range of applications. Second, the main purpose of these studies is to solve specific problems, and few think about how to integrate the elderly into the digital world. Therefore, in the future, is it possible to have a “meta-universe” that can correspond to the real world? The elderly can become “digital seniors” to communicate with other people and organizations. At the same time, the data in this virtual world can help the elderly in the real world. The

research hypothesis of a smart healthcare service system based on AIoMT (AI +IoMT) is proposed.

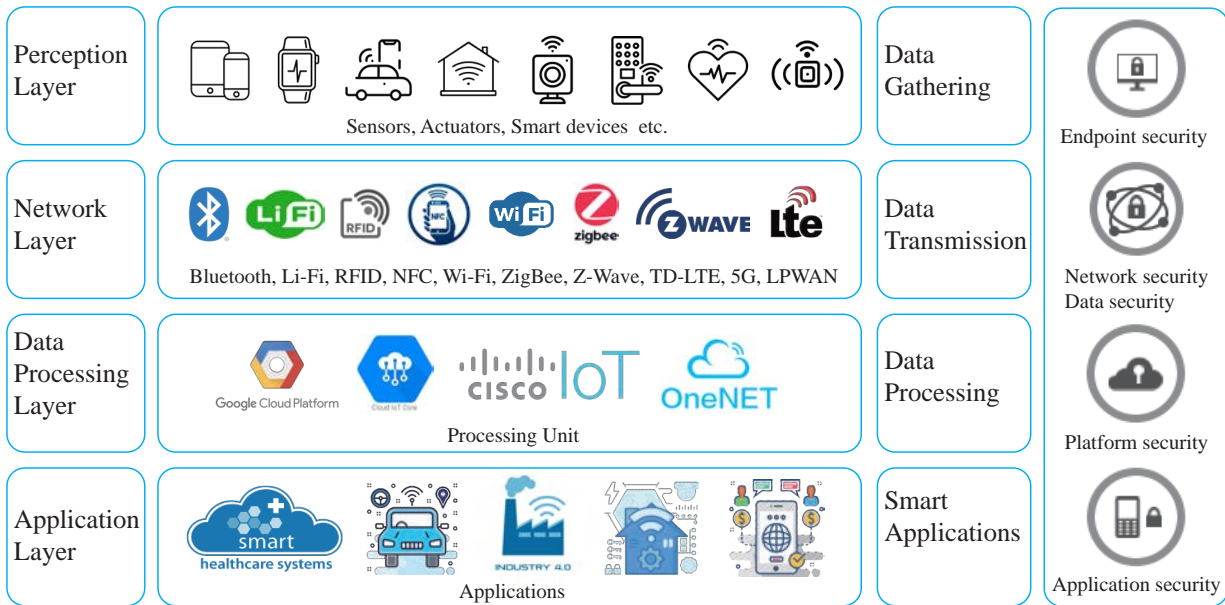
4.4.1.1 The architecture of IoT in the smart healthcare service system

This system is based on the Internet of Things (IoT). IoT has been defined in Recommendation ITU-T Y.2060 (06/2012) as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies (Kafle, Fukushima, & Harai, 2016).

In the smart healthcare service system, this architecture can be divided into four layers: the perception layer, network layer, data processing layer, and application layer (Fig.4.10).

Perception layer: Cameras, sensors, actuators, smart devices, IoT terminals belong to this layer. These objects obtain Internet addresses through the IPv6 protocol and connect to the Internet. These objects can

Fig.4.10
The stages of IoT architecture



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monitor various physical/environmental parameters, receive data, and then send data.

Network Layer: There are two modes of Internet connection: wired and wireless. Wireless technology, due to the difference in effective transmission distance, can be divided into short-range wireless (Bluetooth, Li-Fi, RFID, NFC, Wi-Fi, ZigBee, Z-Wave), medium-range wireless (LTE-Advanced and 5G), long-distance wireless (LPWAN, VSAT and other technologies). According to specific requirements, there are different internet connection modes to choose from.

Data Processing Layer: In the IoT ecosystem, this is a processing unit where data is pre-processed and then sent to a data centre. Various software applications can access the data centre and prepare for further operations. Big data, blockchain, software-defined networking, storage, data centres, secure communications, anti-virus software, artificial intelligence, etc. can be grouped into this layer. This layer is the interface between the application service and network layers, supporting various software applications.

Application Layer: Various industries transfer the data collected by their devices to their IoT servers through the network. These high-value data can improve efficiency and provide intelligent services; Data centres or the cloud is the management stage of data where data is managed and used by end-user applications. This layer contains VR/AR, human-computer interaction, service-oriented architecture, sustainable development, etc. Some applications become possible, such as smart medical care, smart home, smart transportation, community services, commercial finance, and mobile payment.

Security is the most important challenge of the Internet of Things. Security work needs to be guaranteed in terms of endpoint security, network security, data security, platform security, and application security.

4.4.1.2 System architecture

This smart healthcare service system does not simply integrate digital technology with traditional healthcare services but establishes a connection between the elderly and digital products, and introduces

smart devices and products into homes, industries, and social institutions. This system can obtain data about daily activities, physical and mental conditions of the elderly through smart devices at the perception layer, and predict the services needed by the elderly with advanced digital technology and algorithms. This system can supplement and improve existing healthcare services, passively support the lives of the elderly, and create a new experience that can improve their quality of life.

The first layer is the perception layer (Tab.4.1). As the basis of data collection and information processing, the perception layer is the key for turning seniors into digital seniors. Core technologies are Computer vision, Automatic Identification and Data Capture (AIDC), Natural Language Processing (NLP), Context Awareness and Sensor Technology. Computer vision can extract information from the scene at which older people are located by simulating the human visual function, and then send the data to the data centre for processing. AIDC can use computers, cameras, scanners or other devices to identify older people and collect their data automatically. NLP can realise effective communication between people and computers. Context-awareness is the ability of a system to make a response and action based on the collected data and

Tab.4.1
Layer, function, and
technology of the
digital system

Layer	Function	Technology
1. Perception layer	Data collection	Computer vision, Automatic Identification and Data Capture, Natural Language Processing, NLP, Context Awareness and sensor technology
2. Information layer	Data organization, storage, transmission and security	Data organization: Preprocessed data Storage: MySQL, HBase, Elastic Search Transmission: short-range wireless, medium-range wireless, long-distance Security: encryption techniques, certificate authority etc.
3. Core algorithm	Simulate the human brain to provide solutions	AI, Machine learning, Deep learning
4. Application layer	Service providers	App, digital platform etc.

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the current situation. Sensor technology collects information by sensing the surrounding environment or specific substances such as brightness, temperature, humidity, sound, gas, and location. Health conditions, the current position of older people, and environmental information can all be collected with these technologies. This is the first step in transforming senior citizens into digital citizens (Sui, 2020).

The second layer is the information layer which consists of a data layer, a network layer, and a security layer. It is responsible for data organisation, storage, transmission and security. According to different data types, stakeholders will organise data collected by the first layers, use MySQL, HBase or Elastic Search to store data, and create new databases, such as healthcare services databases, GIS databases, Financial & Economic databases, etc. These databases form a large data platform. The network layer can summarise, exchange, and transport information through wired and wireless networks (data, feedback, instructions). The security layer mainly guarantees data security during storage and transmission, avoiding data security risks such as data loss, accidental exposure, etc.

The third layer is the core algorithm. The system can use advanced algorithms such as AI, machine learning, and deep learning to simulate the human brain and constantly optimise solutions through big data training. This system can better assist the elderly in their lives and help them solve problems.

The fourth layer is the application layer. This layer includes service providers, service platforms, Apps and other stakeholders. Each service provider or stakeholder can provide healthcare services to the elderly according to solutions offered by the system. Older people can actively contact service providers or platforms in this layer to ask them to provide healthcare services.

In the system, according to some reservation information (such as hotel reservation, ticket reservation) or daily activity log, if the system considers that there will be some changes or emergencies after integrating various information from other stakeholders, the system will also notify the older person and give suggestions. If the system predicts that an older person needs services, it will ask the service provider to confirm with the older person whether she/he needs services. The older person can make their own choices according to the situation (Fig.4.11).

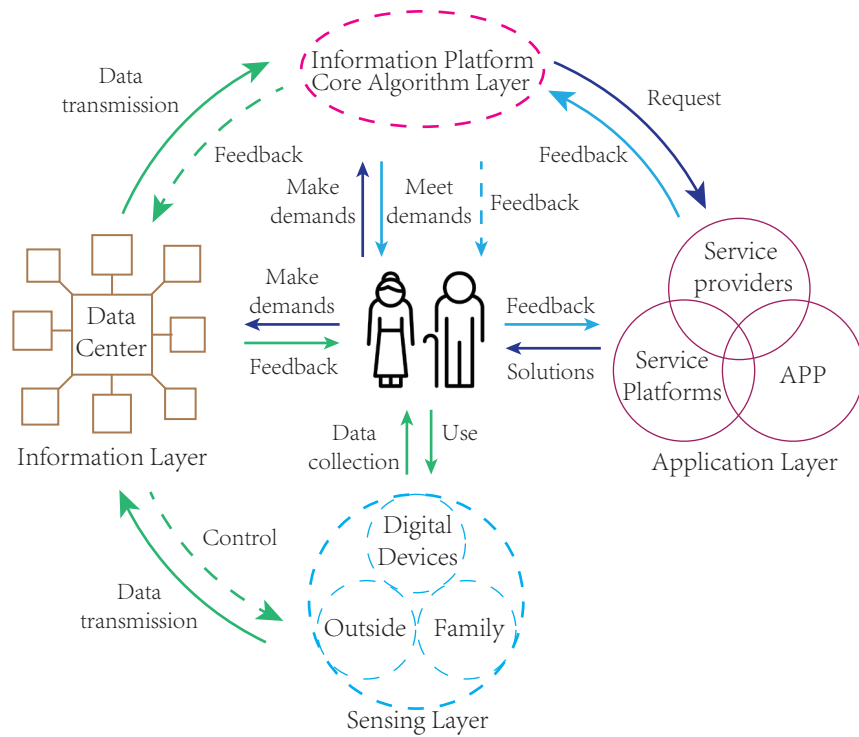


Fig.4.11
Service flow
diagram

In the service process of the system, older people need to use various digital devices and sensors to collect raw data by activity sensing. All raw data from devices and sensors are transmitted to the data centre of each industry where raw data is filtered and the features are extracted. The smart AI system transmits the pre-processing data to the information platform. If there are any problems with the data, the system will give feedback to the corresponding data centre. Based on big data, the smart system can analyse data and information of each older person and make predictions. If the data and predictive information show that the health indicators of older adults are/will be beyond the standard range, the system will give feedback and suggestions to them. They can also directly put demands on a data centre, the information platform, or service providers/platforms. Then, these stakeholders will give feedback to them.

The smart healthcare service system is to build a digital world parallel to the traditional physical world and is composed of smart homes, various industries, public organizations, and social institutions, as shown in Fig.4.12. This is an assisted living system that can ensure the safety of the elderly in their daily lives and make their lives more convenient. After these data are uploaded to the information centre and are classified, the data of each registered older person will be integrated. Through artificial intelligence analysis, the map of the social activity of the elderly can be

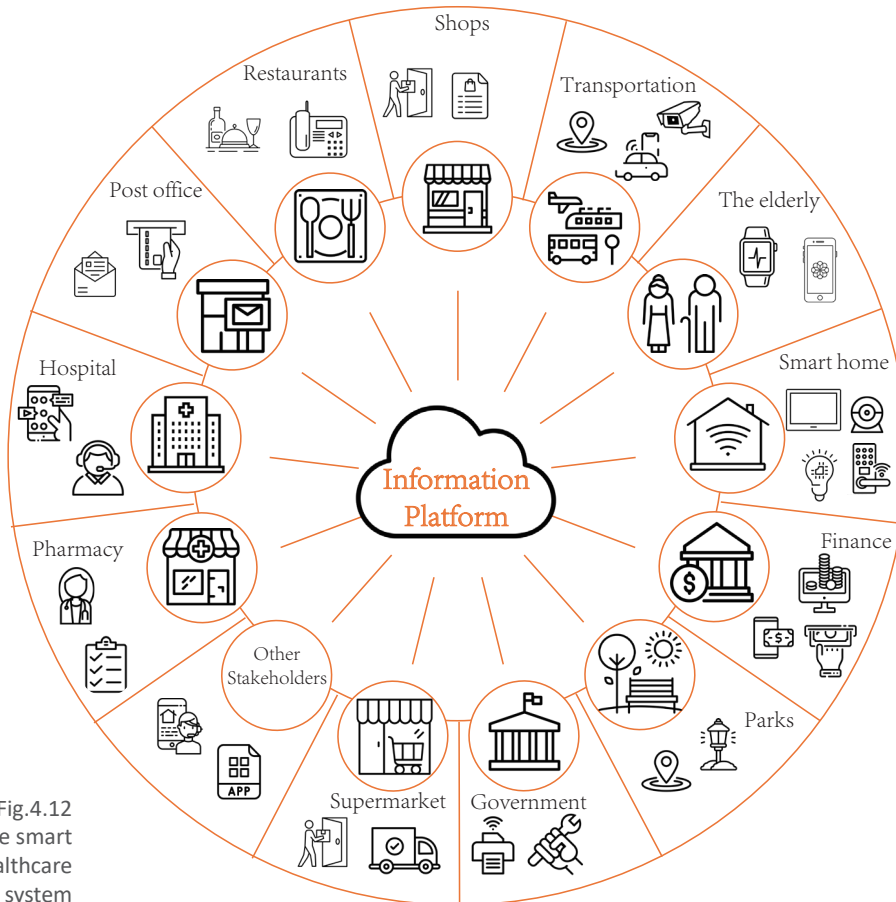


Fig.4.12
The smart
healthcare
service system

In this system, the elderly can enter this digital world through mobile phones, smartwatches, or other digital devices they wear. Smart home can connect various sensors and digital devices. Stakeholders from various industries and public organizations can collect data through their smart devices and services.

formed. This map includes all the activities and related data generated by an older person in a day. The elderly are considered a source of information, and their activity is creating data. With the help of artificial intelligence, these data passively assist the life of the elderly, remind and help them when necessary.

In this system, the information platform is at the centre, and each stakeholder (social institutions, public organizations, etc.) also forms their own data centre. These information centres need to exchange data with national information platforms, upload data and receive feedback from the national platform. Since the national information platform can receive data from stakeholders in all industries, organizations, etc., it can understand the living conditions of the elderly in each region. The collected information and data can help the country formulate relevant policies to redistribute economic and welfare and ensure social equity. From a global perspective, each country can form its information platform. Different countries can also exchange information and complement each other's advantages, thereby promoting the inclusive social development of the entire world.

4.4.1.3 Information security

This system collects data and information from many industries and institutions. Security, the primary attribute of big data for governments or healthcare stakeholders, describes the extra care needed in healthcare data where security, privacy, authority, and legitimacy issues are concerned (Jee, & Kim, 2013). Data security and privacy measures for the systems are paramount. It is necessary to employ security and privacy architectures in the smart system. Since the author is not an expert in this field, some suggestions and ideas from other researchers can be referred to.

Vučinić et al. (2015) proposed OSCAR, an architecture for end-to-end security in the Internet of Things. Alphand et al. (2018) suggested IoTChain, a combination of the OSCAR architecture and the ACE authorization framework to provide an E2E solution for secure authorized access to IoT resources. Yang et al. (2019) presented a privacy-preserving smart IoT-based healthcare big data storage system. The main three functions of this system are smart cross-domain data sharing, smart self-adaptive access control in normal and emergency situations, and smart deduplication. Cheng et al. (2019) designed an efficient community medical IoT node secure two-way identity authentication method and proposed a secure and reliable update mechanism to update authentication keys and session keys. Deebak et al. (2020) proposed a mutual authentication scheme to secure SHS, which centered on the IoMT (Vaiyapuri, Binbusayyis, & Varadarajan, 2021). Sanaz Rahimi

Moosavi et al. (2015) develop a secure and efficient authentication and authorization architecture for IoT-based healthcare. In general, edge computing, machine learning, Artificial Intelligence (AI), blockchain, biometric technologies, nanotechnologies can contribute to enhance security and privacy measures of the smart healthcare service system (Karunarathne, Saxena, & Khan, 2021).

4.4.2 Organizational system design

The previous content described the IoT architecture of this system, but this does not guarantee the smooth operation of this system. It is also necessary to consider the following questions. What is the structure of this system? How can older people's data be exchanged and shared? What steps are taken to make these service scenarios a reality? What services does this system provide for the elderly? What are the key nodes in the service? Who will assist in connecting the relationships between the various stakeholders? Who is responsible for each key step? These questions will be answered.

4.4.2.1 Case research

Many companies have entered the healthcare industry and established smart health service systems. In 2013, Google invested in two companies, One Medical and Doctor on Demand. One Medical is a membership-based primary care practice. Their members can schedule appointments, renew prescriptions, and access comprehensive care and virtual care by the mobile APP (One medical,2021). Doctor on Demand is an integrated virtual healthcare company. With 24/7 access to doctors, psychiatrists, psychologists, therapists and other medical experts, care is always available for users. Users can select their favourite doctor and meet with a therapist or psychiatrist via video from smartphones, tablets, or computers (Doctor on Demand, 2021). Amazon care organizes a team of medical experts to provide healthcare services. When users need medical advice, they can connect with a doctor for a video visit without waiting for a consultation in hospitals (Fig.4.13).

Fastweb Smart Health also provides a certified solution for home remote monitoring and diagnosis support, designed to improve therapeutic compliance, reduce medical expenses and ensure effective monitoring of real-time clinical parameters. The platform, aimed at public and private

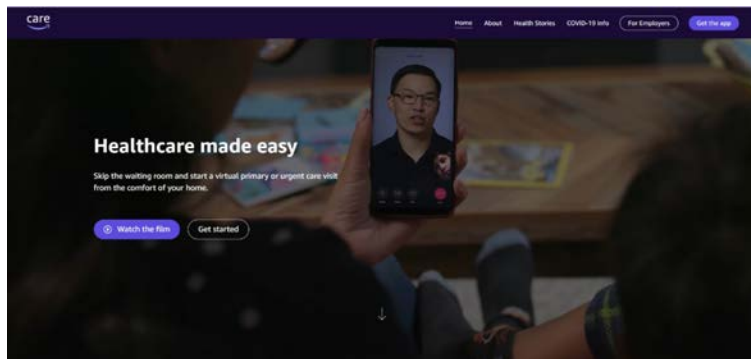


Fig.4.13
Amazon care. From:
<https://amazon.care/>



Fig.4.14
Fastweb Smart Health. From: <https://www.fastweb.it/grandi-aziende/iot/scheda-prodotto/smart-health/>



Fig.4.15
Alipay App and website. From: <https://www.alihealth.cn/>



Fig.4.16
The website of JD Health. From: <https://global.jd.com/>

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health facilities and health insurance companies. The smart h healthcare system can make healthcare services more inclusive, effective and economically sustainable (Fastweb, 2021).

As a Chinese multinational technology company, Alibaba Group launched a Future Hospital Plan to facilitate the workflow efficiency in the current healthcare service in China. Users can use Alipay App to register for consultations, monitor queues, conduct payments, review results as well as report on user experience (Fig.4.15). In the next stage, Alibaba will establish a comprehensive online platform to allow virtually mobile prescription, medicine delivery, hospital transfer, medical care insurance reimbursement, commercial insurance as well as damage claims, as part of the improvement of healthcare reform in China. In the near future, Alibaba will further utilize its database and cloud computing capability to cooperate with wearable technology manufacturers, medical care institutions and even government agencies to construct a resource backed healthcare management platform (Scully, 2014).

As a Chinese e-commerce company, JD.com has built Health International Inc, China's largest online healthcare platform (Fig.4.16). The Company's technology-driven platform is centred on the supply chain of pharmaceutical and healthcare products and strengthened by healthcare services, encompassing a user's full life span for all healthcare needs. JD Health can provide accessible, convenient, high-quality, affordable healthcare products and services for everyone in China (JD Health, 2021). These experiences have provided some ideas and suggestions for the organization of the Smart healthcare service system.

4.4.2.2 Organizational structure

This smart health service system can contain many healthcare services and is more complex than the existing system. It is difficult for any single organization to complete the construction of such a system due to the complexity of the system and the involvement of multiple stakeholders. The construction of this system requires the support of a large amount of technology, human resources, and medical resources. Therefore, this system requires multiple key organizers to work together.

(1) Key resources

The core resources of this system can help identify who the key

organisers are. First, this system is for the elderly, and healthcare services is one of the most important core resources. Technology is also a key resource for the whole system. Medical equipment and smart devices are the basis of data collection, and therefore also belong to the key resources of this system. This system contains a large number of stakeholders, which requires an organiser to organise and connect all stakeholders. At the same time the system also involves a large amount of healthcare data and private information, which is important resources for a country and is required to be kept confidential. Data security should be taken seriously.

(2) Main organizers

The key resources of this system have healthcare services, technology, medical equipment and smart devices, healthcare data, and coordinators. Therefore, the main organizers of the smart healthcare service system should include the healthcare sector with medical resources, technology companies with Internet-related services and products, manufacturers of medical supplies, and the government with abilities to help break down industry barriers and connect stakeholders (Fig.4.17). Through working together, these main organizers are able to build and maintain the smart healthcare service system. They can set up a department or a joint-stock company responsible for this service system.

(3) Stakeholders

Stakeholders are composed of data collectors and service providers, including hospitals, pharmacies, nursing homes, banks, insurance companies, oil and gas companies (Eni...), telecommunications companies, transportation sector, catering industry, entertainment industry, social organizations, welfare agencies, home care agencies, Bar, Tabacchi, supermarkets, post offices, government departments, shops, technology companies, regulatory agencies and so on. All organizations or institutions that interact with the elderly belong to stakeholders.

(4) Target users

The target users of this system are older adults who live at home and can take care of themselves. Elderly people with intellectual disabilities and the disabled elderly can also join this system, but it may be difficult to use these services and functions by themselves. Their caregivers can use related services.

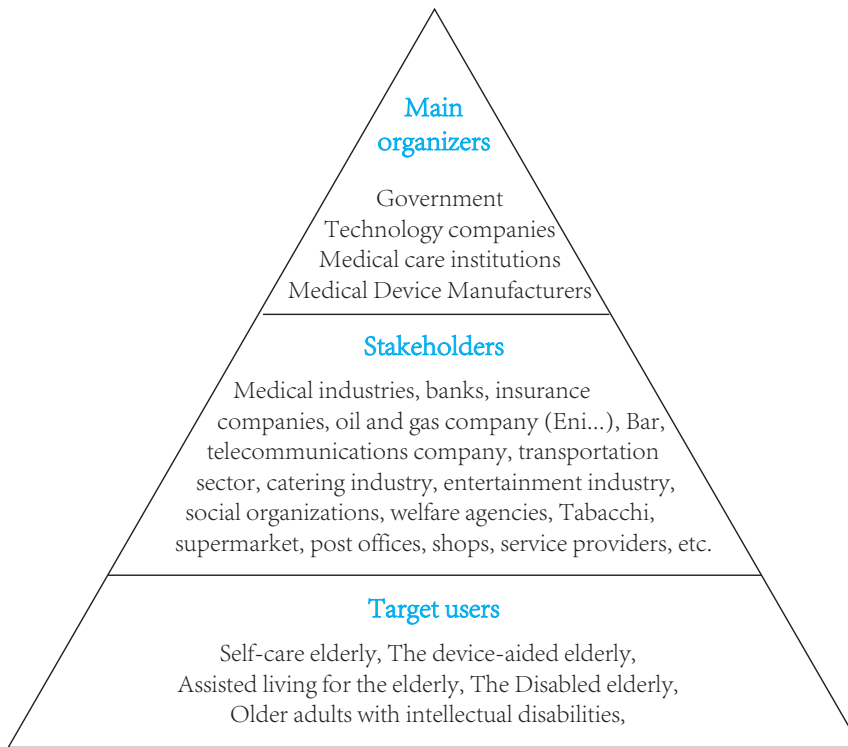


Fig.4.17
Organizational
structure

4.4.2.3 Digital service platform and data centres

In the organizational structure, the target user's data is transmitted to stakeholders' data centres, where the data is classified and pre-processed. The data flow in this process is shown in Fig.4.18.

Communication between the main organizers and the stakeholders takes place via an information platform. The pre-processed data from all stakeholders is transmitted to the hybrid cloud of the information platform (Fig.4.19). Through big data analytics and AI, the information platform will choose what information to share with the elderly and ask service providers to provide services. When service providers need relevant data during the service process, they can request the information platform to obtain the data stored in the hybrid cloud. Such an information architecture can help break the barriers among industries and stakeholders and promote information sharing.

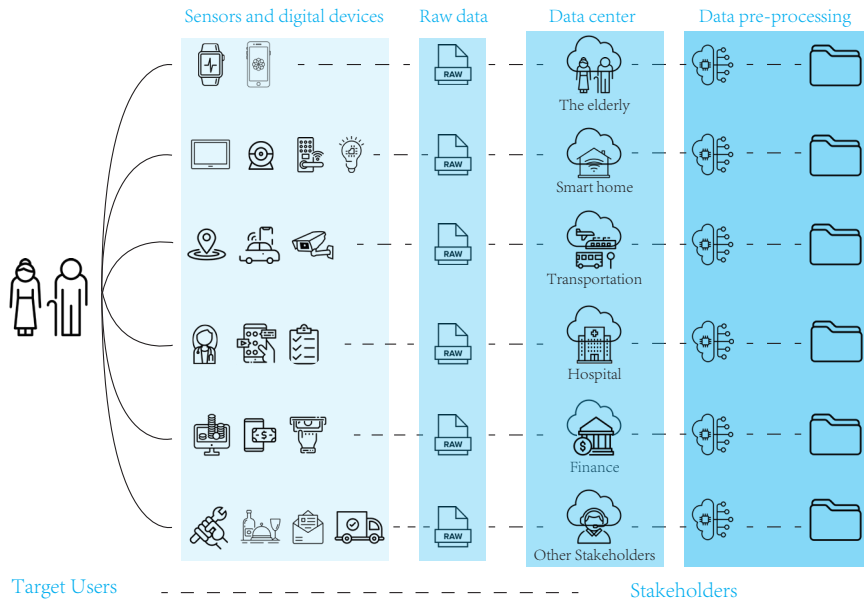


Fig.4.18
Data flow
from target
users to
stakeholders

The physical parameters of the elderly can be collected through wearable devices. Digital sensors or smart devices in various industries and public sectors can collect activity data of the elderly. These data are transmitted to the data centres of different stakeholders, where raw data is processed, filtered, and then the processed data is classified into structured data, semi-structured data, and unstructured data. After all data is encrypted, it is transmitted to the information platform.

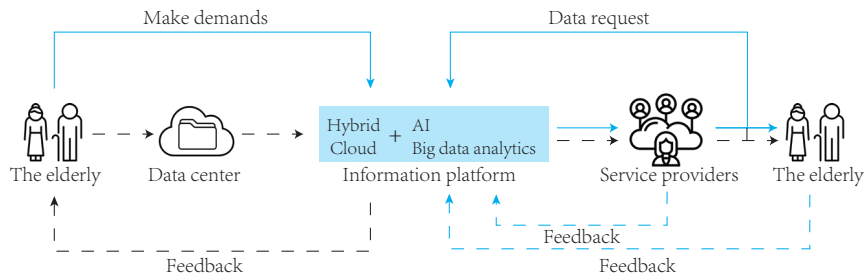


Fig.4.19
Data flow
from
stakeholders
to Main
organizers

The information platform includes service centres, supervisory departments, Information Communications Technology (ICT) department, the information security departments, management department, Internet of Medical Things (IoMT) departments, data storage and processing departments, legal department, R&D department (research and development) etc. The staff of service centres need to communicate

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with the elderly, record their service needs, and arrange service providers to provide corresponding services for them. Supervisory departments supervise the work of other departments and evaluate the service quality of service providers based on feedback from the elderly. The Information Communications Technology (ICT) department is responsible for maintaining and improving the architecture of the smart system, providing technical support, and ensuring the normal operation of the system. Information security departments need to ensure information and data security in all processes. The management department is to coordinate the work of other departments, optimizes service processes, formulate policies and development strategies, and promote cooperation between stakeholders. Internet of Medical Things (IoMT) departments are responsible for the design, production, installation, maintenance, and replacement of smart devices. The data storage and processing departments are responsible for data centres and cloud computing. The legal department is responsible for the management of contentious affairs and providing legal advice to the elderly. The work of the R&D department (research and development) is to provide customized and refined services for the elderly through advanced algorithms such as AI and big data analytics. Fig.4.20 shows the complete data flow of the smart healthcare service system.

4.4.2.4 Service Process

The elderly need to register for a membership before they can receive services provided by this system.

(1)Registration

First, elderly people need to register a new account in this system. They can make an appointment on the official website or APP, and then the information platform will assign staff from the service centres to visit elderly people to help them register. Registration information includes name, gender, age, family members, emergency contacts, medical card number, medical history, etc. All information is uploaded to the information platform. The information platform checks this information with the government, medical institutions and other organizations. Once the verification is complete, the platform sends a successful registration message to the elderly, and an appointment is made for a service provider to visit the home to install the smart home kit.

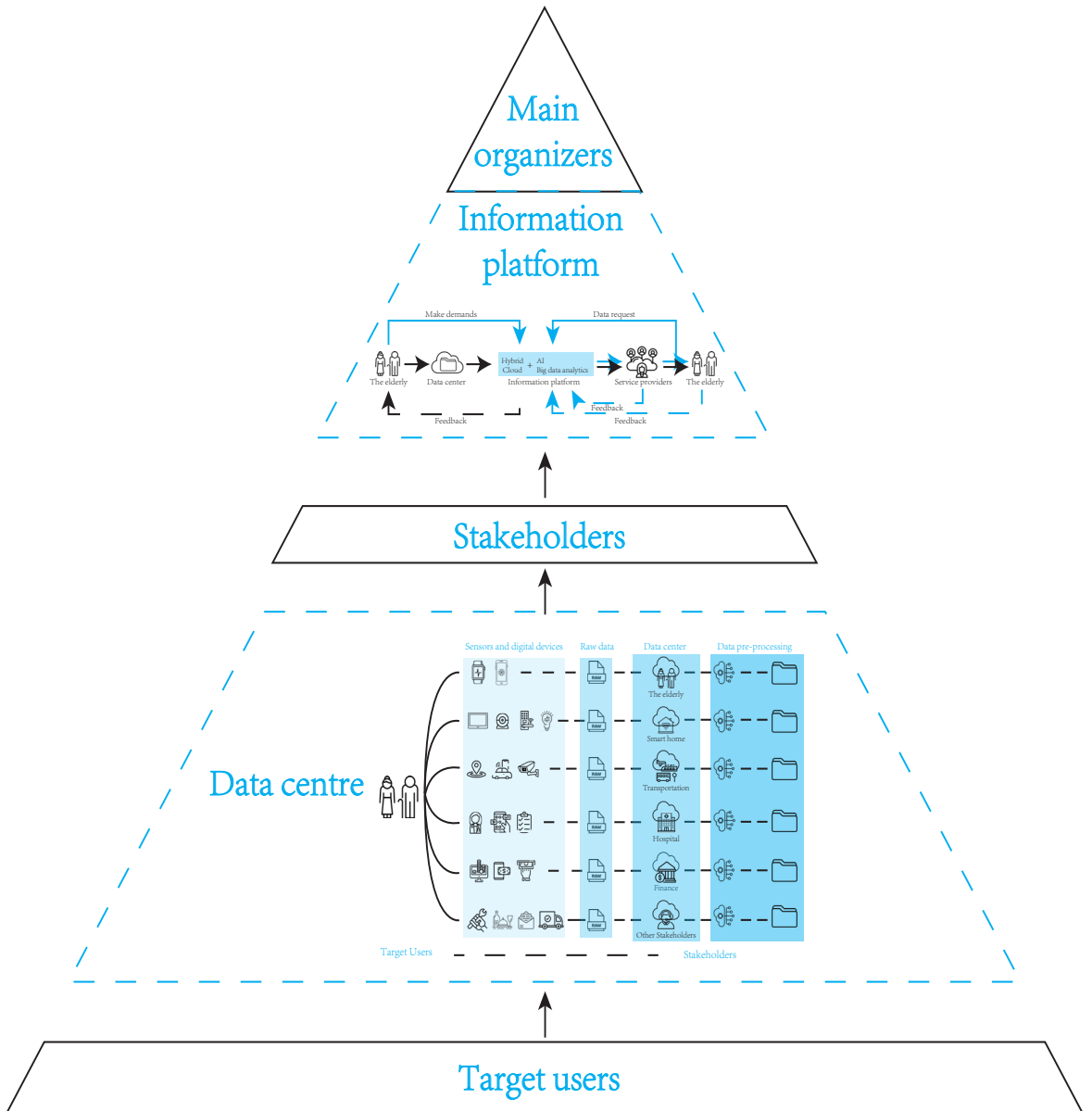


Fig.4.20
The data flow of the smart healthcare service system

(2) Installation of smart home devices

Smart home devices include a central control system (the brain of the smart home), whole-home WiFi, the wireless Programmable Logic Controller (PLC), smart speaker, screen (8.3", 10.2", 11", 12.9"), wearable devices (smartphones, smartwatch, smart glasses...), intelligent control systems (environment, lighting, water, safety protection, entertainment, shade curtains...), sensors (fall detection devices, human body infrared sensor, water leak detectors, propane/natural gas detectors, smoke detectors, temperature and humidity sensors...) and so on. According to the humidity, temperature, oxygen concentration and other indicators in the indoor environment, this system can provide a comfortable environment.

Older adults can choose smart devices and sensors they need to install. The staff will teach the elderly how to use the APP and leave the learning materials in the elderly's home. After the installation is complete, the staff will connect all the devices and sensors to the home network and test whether each one works at home.

(3)Application

When elderly people encounter problems or difficulties in life, they can contact the information platform via phone or mobile app to make an appointment for services they need. When service providers have provided the service, older adults can comment and give feedback on the service. The smart healthcare service system can connect to the data platform of the smart city. Thanks to the participation of a large number of stakeholders, this system can track the daily activities of the elderly, and send reminders and suggestions to the elderly when necessary. Wherever elderly people are, the system can obtain their location and track their health parameters. If an older adult is in an emergency situation or their physiological data changes too much, the system immediately gets the location of the elderly person and calls up surrounding digital camera and devices to see the current status of the elderly person. By AI and big data analytics, if the system determines that the older person is at a safety risk, it will send a message to emergency contacts and family doctors or hospitals.

4.4.2.5 Service scenarios

IoT/IoMT has become a trend in many research fields. The potential use of IoT in healthcare is massive and could be effectively utilized for disease prevention, early warning, health management and other aspects (Karunaratne, Saxena, & Khan, 2021). Future service scenarios can be considered after the smart healthcare service system is constructed. Service scenarios can be divided into daily living, medical and health care services, spiritual comfort, emergency assistance, legal aid. All types of elderly people can benefit from this system.

(1) Daily living

●Healthcare monitoring systems

Through various digital sensors in the home and wearable devices, the heart rate, blood oxygen, body temperature, blood pressure, respiration rate, blood glucose level, ECG data, and sleep can be monitored. When health parameters exceed reasonable thresholds, the smart system judges that the elderly may be at risk. An alarm is triggered, and the system sends information to a family doctor and family members. Family members can check the current health status of the elderly through cameras or smart speakers installed in the home.

●Smart devices

The smart door lock with fingerprint or facial recognition function can avoid the situation that the elderly cannot enter the home without the key. It can also keep track of the time when older people leave home and come back, which can help record the lifestyle of the elderly. Smart wearable devices such as smartwatches can track the real-time location of the elderly. Relatives do not have to worry about older people getting lost. The human body infrared sensor in the bedroom can detect the motion of the elderly at night and then turn on the night light. This interaction is convenient for the elderly to go to the bathroom.

●Indoor environmental sensors

With wind & rain sensors, Wi-Fi thermostats, air quality sensors and other digital devices, the smart system can measure, monitor and record environmental parameters in real-time, such as temperature, air quality, light intensity and humidity. When heavy rain has been detected or rooms need ventilation, the system can trigger an actuator that can automatically close or open the window. This system can help construct a comfortable and healthy indoor environment.

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●Meal reminders

Based on the physical condition of the elderly and the advice given to them by their doctors, this system can recommend relevant food and products to the elderly to help them recover and improve their health. When the elderly drink too much alcohol, this system will also remind them to pay attention to their health.

●Smart monitoring of electricity, water and gas

With age, the sense of smell of the elderly deteriorates, and they become less sensitive to certain gases (gas, natural gas, etc.). The safety of elderly people living alone in their homes has always been a key aspect of elderly care. Through water leak detectors, propane/natural gas detectors, smoke detectors, the system can detect leaks and then employ an audible alarm to close the valve. With age, the sense of smell of the elderly deteriorates, and they become less sensitive to certain gases (gas, natural gas, etc.). The safety of elderly people living alone in their homes has always been a key aspect of elderly care. Through water leak detectors, propane/natural gas detectors, smoke detectors, the system can detect leaks and then employ an audible alarm to close the valve. According to data from energy companies, if the energy consumption in a certain period is significantly greater than the average value of this period, the AI system will also detect leaks again through sensors to ensure safety.

●Digital skills

According to the personal needs of older people, the system can help them acquire different digital skills. Older people can be guided to learn how to use basic communication tools, access government digital services, and use e-Payment tools in a fun and easy way (Seniors Go Digital, 2021).

●Bill reminder

Elderly people need to go to Tabacchi, post office or bank to pay utility bills Every 2-3 months. In this system, these expenses can be paid automatically by a credit/debit card. This is very helpful for some elderly people with limited mobility.

●Shopping

In China and Italy, many supermarkets have home delivery services. If older people want to buy daily necessities online, they need to place an order on the APP or Website. This is difficult for the elderly without

digital skills. This system can simplify this process. They just need to say the name, brand and other information of a product they want to buy to service providers. They can compare prices, select the most cost-effective product and deliver it home.

- Transportation

This system can receive information from the department of transportation. According to the daily travel mode and destination of elderly people, before they leave home, this system can remind them of some precautions, such as the time of the general strike, parades, suspension of public transportation services, traffic congestion or other information through the smart device (mobile phone, IPAD, smart speaker...).

- Travel plan

After the elderly plan a trip and purchase the ticket, the system will give the elderly some travel advice about the weather, temperature, traffic conditions, etc, to help them prepare for the trip.

- Assisting with bathing

It is very difficult for the disabled elderly and the device-aided elderly to take a bath. Small spaces and slippery water may increase the risk of falls. Thermal shock from bathing may be a leading trigger for heart attacks, and family members lack professional knowledge and skills. The automatic bathing machine for seniors is expensive and is difficult to install at home. For improving the lives of older adults with limited mobility, the system can regularly ask the elderly whether they need hygiene services, such as bathing and showering assistance, grooming, shaving with an electric razor, oral hygiene. When they need some services, the system can ask service providers to provide professional services for the elderly.

- Local news and new policies

Sometimes, the elderly cannot receive local news and public notices. Thanks to the participation of social organizations, energy companies, and government departments, the system can receive this information (line maintenance, outage notifications) in time and notify the elderly through mobile phones and smart devices at home.

- Social activities

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According to the daily activities and hobbies of elderly people, this system can recommend some activities organized by various social organizations to them. These activities can increase the social participation of the elderly.

- Online car-hailing (one-click car hailing)

Barrier-free travel services are practical to older people with limited mobility. Their needs for taxi services are different from ordinary people. This system provides a one-click taxi booking service. Older people can directly communicate with a customer service staff of the information platform through “One-click” on APP to explain their travel destination. The service provider can meet their mobility needs in different situations. Considering the risks in the itinerary, service providers can use mobility aids, barrier-free vehicles and other methods to provide an overall solution for the elderly.

(2) Medical and healthcare services

- Medical services

Through deep learning of a large amount of medical knowledge, diagnosis and treatment manual, pharmacopoeia and successful cases, this system can find the best solutions for a variety of common diseases and obtain experience from famous expert teams. For some rare diseases, applying artificial intelligence technologies, such as natural language processing in medicine, data annotation, and knowledge graphs, can assist doctors in disease detection, diagnosis, and treatment. With the help of this system, doctors can improve their accuracy and efficiency. By comparing the monitoring results of the elderly with the results based on big data-based algorithms, the system can predict the health risks of the elderly and prepare for such risks in advance, such as staff deployment, emergency vehicles, medical equipment, etc. This can help the elderly reduce their health risks. With the application of low latency 5G technology, remote surgery has become possible.

- Medical resource sharing

This system can play an important role in improving the quality of healthcare services and addressing the shortage of healthcare. The distribution of healthcare resources in many countries is unequal. Some less developed areas lack hospitals, beds and expert teams, while in those regions with better economic conditions, healthcare resources are more concentrated and there are more specialized hospitals,

doctors, advanced technology and medical equipment (Chai., Zhang, & Chang, 2020). In an emergency, such as the covid-19 pandemic, medical resources in some areas cannot meet the current needs. This system can help to share and allocate medical resources. Developed areas can share medical equipment, materials and send expert teams to specific areas that lack medical to share experience and offer help.

- Telemedicine

Because this system connects the elderly to the hospital, those elderly people with mobility impairments can see a doctor at home through online meetings. Those elderly people who live in less developed areas can have opportunities to communicate with famous and experienced experts who work in other cities or countries and then obtain professional advice. Doctors can write a prescription and give advice based on previous medical records of the elderly. In non-emergency situations, the elderly can receive treatment without going to a hospital. This shortens medical time, improves the efficiency and quality of care, and allows for a high level of resource sharing.

- Delivery service of common medications

This system connects hospitals, diagnostic centres, pharmacy and other medical institutions. For some elderly people who have chronic diseases and need to take medication for a long time, the system can deliver the medication to them regularly, based on the prescription of the doctor or medical centre. Older people do not need to go to a pharmacy to buy medications. This service prevents the elderly from forgetting to buy medicine.

- Rehabilitation nursing

The Barthel index or FIM (Functional independence measure) provided by this system can help family members or caregivers to evaluate the abilities of the elderly systematically. According to the doctor's advice and the physical condition of the elderly, this system can provide the elderly with personalized nutritional plans and free rehabilitation advice to prevent complications and promote physical recovery.

- Nursing home

This system can improve the management of nursing homes. Daily monitoring can help doctors and care workers in nursing homes better understand the physical condition of the elderly. Daily monitoring can

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help doctors and caregivers in nursing homes to better understand the physical condition of the elderly. When an older person is at risk of a sudden and unpredictable deterioration of health or has a fall, the system sends an alert to doctors and healthcare workers. The elderly person can receive timely assistance.

●Cognitive training

The decline in abilities (mental abilities, cognitive ability) is noticeable for older adults with cognitive impairment. Cognitive training can help older people maintain or improve their cognitive abilities through structured and guided practice (Bahar-Fuchs et al., 2020; Irazoki et al., 2020). There is professional training equipment in hospitals or nursing homes, and doctors or caregivers can provide professional guidance to help the elderly in training. Due to the lack of equipment in the home, older people have no opportunity to receive training. The digital cognitive training tools in the system can provide scientific guidance and training suggestions for the elderly with cognitive impairment. Family members can use digital tools to train these older adults. The training results can be viewed on the system application.

(3) Spiritual comfort

This system provides an information platform and technical support for the elderly to communicate with others. The intelligent AI system can chat with the elderly and perceive and judge the emotions of the elderly. The system can give the elderly the best psychological support and spiritual comfort services based on machine learning technology. During the chat, the system will record the needs of the elderly and try to meet their needs.

(4) Emergency relief

Even in a familiar city, elderly people sometimes get lost. Wearable devices can help obtain their location. When they lose their way, family members can obtain the location and find them. Whether the elderly is at home or in the outdoor environment, sudden illnesses and falls may pose a threat to the health of the elderly. Smart devices and sensors can monitor their physical condition in real-time. When elderly people are at risk, this system can notify family members and doctors as soon as possible. The system can help reduce the health risks of the elderly and better protect the elderly. The medical history and personal information of the elderly have been uploaded to the system at registration. If an

older person in a coma is taken to a hospital, the hospital can access medical records from the smart system's cloud. This method can help doctors carry out a comprehensive and accurate medical diagnosis (Chen et al., 2018).

(5) Legal aid

This system can introduce legal knowledge to the elderly, guide the elderly to express their requirements reasonably, and improve the elderly's awareness of self-defence. This system will also push some legal knowledge related to daily life based on the daily activities of the elderly and use easy-to-understand language to help the elderly understand these laws. When elderly people have legal problems, this system can provide them with more convenient, high-quality and efficient legal aid services, and help the elderly protect their rights and interests.

4.4.3 The business model canvas

Intelligent technology has driven the reform of traditional industries. The business model has also moved from the traditional "product economy" to the new "service economy" and "system economy". We have entered a society centered on service. The model of selling products can no longer meet people's needs. The smart healthcare service system connects the elderly and service ecosystem, and can provide a complete healthcare service solution. The business model canvas can reflect systematically on the system's business model.

●Customer segment

Mass market: older adults who can take care of themselves, live independently and do not rely on other people., The device-aided elderly (semi-self-care elderly)

Niche market: Assisted living for the elderly, older adults with intellectual disabilities, The disabled elderly

●Value proposition

Like the freemium business model, this system can provide free basic or limited services to the elderly. As long as the elderly are enrolled in the system, they can receive these services. The system can provide older adults with safer, more convenient, and more personalized healthcare services, help them solve the problems in their daily life, meet their daily

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demands, and improve their quality of life and well-being.

●Channels

Awareness: When the elderly purchase national medical insurance, the smart healthcare service system can be recommended to the elderly. Some news TV shows can also introduce and explain the smart system to the public. This helps the elderly to understand the whole system.

Evaluation: Elderly people have opportunities to enjoy and experience some healthcare services. After the service is completed, they can evaluate the service and make suggestions for improvement.

Purchase: When older adults need healthcare services, they can request the service centre of this system. This system can arrange for service providers to provide services.

Delivery: In the service process, or in daily life, the information and advice provided by this system can help the elderly improve their physical health, quality of life and sense of happiness.

After sales: After the elderly successfully register as a member of the smart system, the system will continue to monitor the physical parameters of the elderly and be ready to provide services for them at any time.

●Key activities

Tracking health parameters of the elderly continuously: This system can monitor the health condition of the elderly in real-time.

Disease risk prediction:

Based on monitoring results, big data analysis, and machine and deep learning, the system can conduct targeted prevention and send the predicted results to elderly people in real-time.

Activity prediction: Based on the data and information from various stakeholders, this system can predict the activities of the elderly and provide suggestions.

Emergency rescue: When older people encounter an emergency (fall, sudden illness...) and their physiological parameters change too much,

this system can provide emergency medical services.

- Revenue streams

According to the physical condition of the elderly, they have different subscription fees for choosing. The higher registration fee means that the elderly can receive free services more times. Even if they have not registered as a member, they still have three opportunities to experience the free services brought by this system. If an older person does not receive any service within a year, the opportunities of services can be postponed to the following year. If elderly people use all service opportunities, they need to pay for the next service. The goal of the smart system is not to make profits, but to provide better, more professional, and customized services for the elderly. This system is more like a charity project than a commercial project.

- Key resource

Physical: The main organizers provide significant core resources, such as medical resources, equipment, and sensors.

Intellectual: The organizational capabilities from government, the medical capabilities of medical institutions, technical support from technology companies, data and information of the elderly collected by a large number of stakeholders and social institutions.

Human: doctors, caregivers, programmers, caregivers, customer service staff, service staff, etc.

Financial: They can set up a department or a joint-stock company responsible for this service system.

- Cost structure

Fixed costs: Operating costs, employee salaries, service costs, management costs, etc.

- Key partners

The key partners and main organisers are government, technology companies, medical care institutions, and medical device manufacturers. The government is mainly responsible for monitoring the entire system, protecting the system's data security, and promoting close cooperation of participants and stakeholders. The technology company is responsible

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for building the system architecture, improving system efficiency, and improving system security. Medical care institutions monitor the physical parameters of the elderly, ensure the safety of the elderly, and improve their health. Medical device manufacturers produce smart devices and provide maintenance, replacement and upgrade services.

●Customer relationship

This system is like a personal health housekeeper, taking care of the elderly in daily life, and is always ready to provide services for them (Fig.4.21).

4.4.4 The value of the system

No matter where elderly people are, it is inevitable for them to interact with various digital devices in the real world. In the digital age, they not

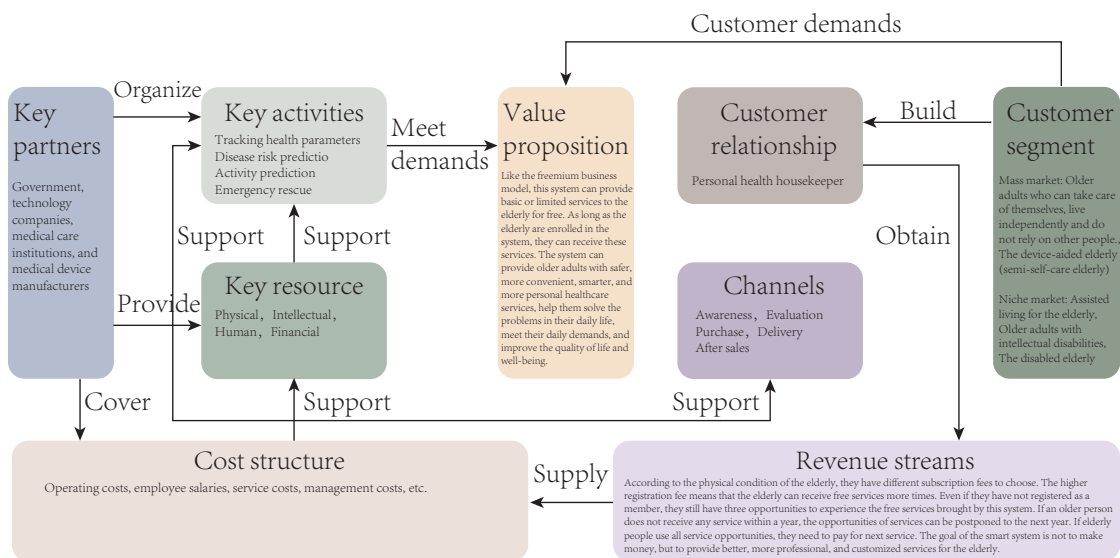


Fig.4.21
The business
model canvas

In the business model, key partners organize main activities and provide key resources. The cost structure supports the key resource, which decides key activities. Customers present their needs and build a relationship with the system by paying. Fees paid by customers are the source of revenue. The demands of customers are the value proposition. Key activities meet their demands. The channels are linked to key activities. The system can deliver its value proposition to its targeted customers through different channels.

only live in the real world, but they also need to live in a digital society. This smart system virtualizes real-world services, such as telemedicine, and introduces digital data and information into reality, such as monitoring the health status of the elderly. This system is the key to turning seniors into digital seniors.

In this system, the digital healthcare service platform is the core, and each stakeholder (social institutions, public organizations, etc.) also forms their own data centre. These data centres need to upload and exchange data with national information platforms and receive feedback from the national platform. Since the national information platform can receive data and information from stakeholders in different regions, it can obtain information on medical expenses, medical resource allocation, medical capabilities in each region.

The collected information and data can help the country formulate relevant policies to redistribute economic and welfare to ensure social equity. From a global perspective, each country can form its information platform. Different countries can also exchange information and complement each other's advantages, promoting social inclusion and sustainable development.

The smart healthcare service system builds a digital world parallel to the traditional physical world. It can integrate and coordinate social systems to realize the dynamic and refined management of the elderly. It can also promote interaction and cooperation among social institutions and all stakeholders, help organizations and individuals make informed decisions through AI.

The smart system improves the imbalanced distribution of medical resources, and ensures that older people have equal access to medical information and expert care. This system can complement and improve existing healthcare services and create a new experience that can improve the quality of life of the elderly. It allows the elderly to obtain accurate, convenient, professional, and diversified services, thereby helping the elderly cope with the challenges brought about by ageing, bridge the digital divide, and turn them into digital seniors.

The smart healthcare service system can use and allocate existing healthcare resources more effectively by connecting families,

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communities, nursing homes, service providers, medical institutions, governments, social organizations, regulatory agencies, and other stakeholders. Based on the Internet of Things, big data, artificial intelligence, and other advanced technologies, the system can provide 24/7, multi-level, efficient and convenient, customized, and personalized healthcare services for older people, and at the same time, monitor the quality of services. This system is user-friendly for those older people who are not necessary to visit a hospital or medical centre for treatment. The elderly can access their medical records at any time. Healthcare staff monitor their well-being and advise them remotely (Piniewski et al., 2010).

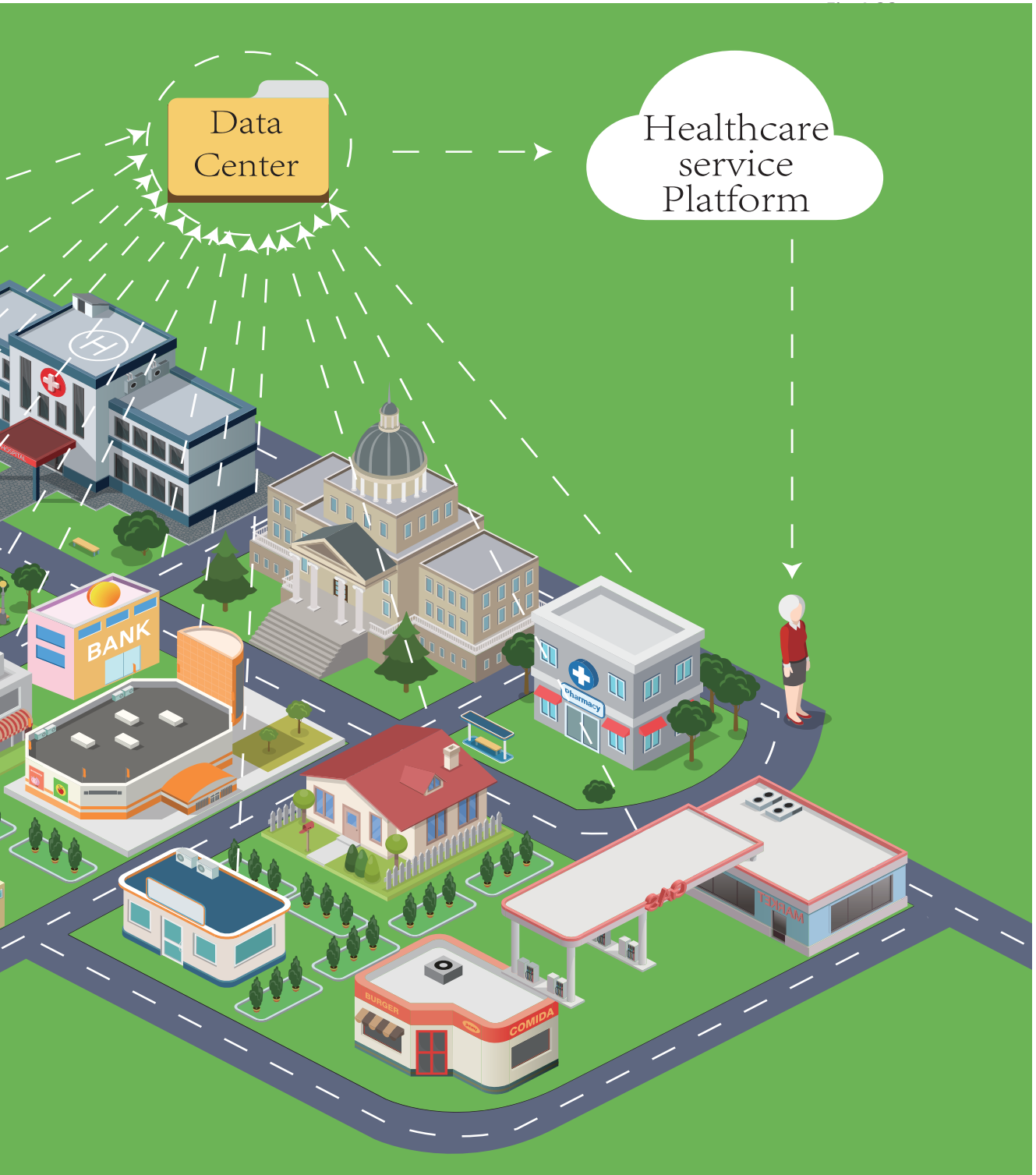
This system can create a community of elderly people with the same disease, so that they can communicate with each other. No matter where elderly people are, their information is exchanged and stored in data. Elderly people do not need to worry about their safety. If they are at risk, this system will give timely help. The above service scenarios are just some cases. In general, this system provides a platform that can incorporate more functions and services. There are still many possibilities that are waiting to be developed by researchers.

Some researchers think smart healthcare is a fundamental and valuable component of smart cities (Oueida, Aloqaily, & Ionescu, 2019). The development of smart cities is also likely to make smart healthcare a reality. In this system (Fig.4.22), cloud-based localization and IoT-aware techniques can be used to track and monitor older people to provide services necessary for their well-being (Piniewski et al., 2010).

This system may be more important and valuable for countries with a high proportion of elderly people. The smart system can improve the imbalanced distribution of medical resources, and ensure that older people have equal access to medical information and expert care. Through online services, healthcare and medical institutions in different regions can share and complement service resources, improve efficiency and quality of service, and promote social inclusion and sustainable development.



Fig.4.22
Smart healthcare
service system



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Part II Research answers

In this part of scientific research, I mainly study the healthcare service system in Italy, China, and Japan, the definition, classification and needs of the elderly, and the relationship between aging and digital technology, trying to answer RQ1-RQ6. The level of economic development, the number of elderly people and the retirement age in the three countries are different. As a result, each country's investment and emphasis on the healthcare service system are also different. Italy has better social security for the elderly than the other two countries. The elderly in Japan may have to work longer in order to get more pensions, whereas elderly people in China retire earlier. The medical expenses for serious illnesses of the Chinese elderly are relatively high. The healthcare service systems of the three countries are trying their best to enable the elderly to have a happier, healthier and more comfortable retirement life.

Through literature review, I summarize a total of 36 models of healthcare service. Currently, many elderly people and their adult children do not know which healthcare service models can be accepted by the elderly. Therefore, through the classification of these service modes, this research provides a clear path for the elderly to help them choose appropriate healthcare service modes.

Based on the classification of the elderly, studying and analysing the needs of the elderly can help to obtain the healthcare services they need. The traditional healthcare service system can help the elderly solve some problems in daily life, but sometimes, it is not always effective and timely. Moreover, with the gradual deepening of the study, I discover the complexity of the study on the elderly. Due to the decline in physical function and cognitive skills, any problem that it is easy to solve for young people may create a barrier for the elderly. With the development of digital technology, the widespread application of digital technology has caused a new problem, digital divide. Elderly people find it difficult to have access to and use digital devices, technology and platforms. Design and technology can help them bridge the gap between people's digital capability. Therefore, in the design phase of digital devices or platforms, Digital accessibility and inclusion need to be considered. This research proposes a hypothesis: smart healthcare service system based on AIoMT. In the smart system, the digital healthcare service platform is the core to connect the elderly with service providers. The research hypothesis

PART II : SCIENTIFIC RESEARCH

is based on speculative design and is a future design proposal. Although it is difficult to realize at present, design can make contribution to the organizational model, methods of providing healthcare services, and the design of digital healthcare service platform.

Therefore, this raises new questions that need to be solved in experimental research and design research.

PART III

EXPERIMENTAL RESEARCH

CHAPTER 5

**INVESTIGATION 1: WORKSHOP ON DESIGN
DRIVEN STRATEGIES PER LA MANIFATTURA 4.0 E
L'INNOVAZIONE SOCIALE**

CHAPTER 6

**INVESTIGATION 2: INTERNATIONAL SMART
HEALTHCARE SUMMER SCHOOL**

CHAPTER 7

**INVESTIGATION 3: CASE STUDY - NANJING
DRUM TOWER HOSPITAL**

CHAPTER 8

EXPERTS INTERVIEWS

Part III— Research questions

RQ7 In the current technical conditions and social environment, can smart healthcare service system be an effective solution?

RQ8 What are the most pressing issues that older persons confront when it comes to the digital divide?

RQ9 How are Chinese medical institutions assisting the elderly by a digital healthcare service platform?

RQ10 What types of solutions are feasible for a researcher to address the digital divide?

The experimental research describes a pilot study, an investigation, a case study and expert opinions to verify my research hypothesis and find a feasible solution. Investigation 1 is a pilot study to evaluate the feasibility of a digital platform to help the elderly overcome loneliness by organizing stakeholders to provide short-term social care activities. Its result can answer RQ7. In order to answer RQ8 and RQ9, in Investigation 2, we interviewed and investigated the elderly and explored their demands for digital healthcare services and pain points. The case study shows the workflow of a Chinese hospital and describes how the hospital provides healthcare services using a digital platform. These contents can provide an answer to RQ9 and RQ10. The expert interviews helped gain a better understanding of China's healthcare service system. Professors helped analyse the conditions for the realization of the hypothesis and advised about the specific field of action. The research results and suggestions provide guidance for my research output.

La ricerca sperimentale descrive uno studio pilota, un'indagine, un caso di studio e le opinioni di esperti per verificare la mia ipotesi di ricerca e trovare una soluzione fattibile. Investigation 1 è uno studio pilota per valutare la fattibilità di una piattaforma digitale per aiutare gli anziani a superare la solitudine organizzando le parti interessate per fornire attività di assistenza sociale a breve termine. Il suo risultato può rispondere a RQ7. Per rispondere a RQ8 e RQ9, in Investigation 2, abbiamo intervistato e studiato gli anziani e ha esplorato le loro richieste di servizi sanitari digitali, insieme ai punti deboli. Il caso di studio mostra il flusso di lavoro di un ospedale cinese e descrive come l'ospedale fornisce servizi sanitari utilizzando una piattaforma digitale. Questi contenuti possono fornire una risposta a RQ9 and RQ10. Le interviste agli esperti hanno aiutato a comprendere meglio il sistema di servizi sanitari cinese. I professori hanno aiutato ad analizzare le condizioni per la realizzazione dell'ipotesi e consigliato sul campo d'azione specifico. I risultati della ricerca e i suggerimenti forniscono una guida per i miei risultati di ricerca.



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DESIGN DRIVEN STRATEGIES

FOR MANUFACTURE 4.0
AND SOCIAL INNOVATION



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CHAPTER 5

INVESTIGATION 1: WORKSHOP ON DESIGN DRIVEN STRATEGIES PER LA MANIFATTURA 4.0 E L'INNOVAZIONE SOCIALE

5.1 Introduction

5.2 The role of the two training experiences

5.3 Conclusion

5.1 Introduction

Because the digital divide and digital inclusion present challenges for the elderly, it is vital to consider and verify the feasibility of a smart healthcare service system in the current technological and social environment. The research hypothesis includes a lot of social institutions, service providers and government departments. How to organize these stakeholders is complicated. In order to verify the hypothesis, it is essential to know how to connect diverse stakeholders and how to promote the integration of technology and services. Because the digital healthcare service platform is the core, evaluating the feasibility of a digital platform to provide healthcare services is necessary. A pilot study could be helpful.

The smart healthcare service system also needs to involve some information technology. Technological capability largely decides whether or not the system could be successful. It is necessary to learn the architecture of IoT, smart devices, ICT and other digital technologies.

5.2 The role of the two training experiences

Due to the above research needs, I attended in the Italian OD&M workshop "Design Driven Strategies" (Appendix 1 shows all the content and information). The workshop aims to train a figure who acts as a builder of 'bridges' and strategic connections between different stakeholders to facilitate collaborative and interdisciplinary communities around business challenges with social/environmental implications through a design-driven approach. In this workshop, I mainly engaged in two trainings.

The first training is a pilot study, which is conducted at Casentino. The goal of this small-scale preliminary study is to evaluate the potential for the smart healthcare service system. In the study, various stakeholders (the elderly, the government, children, children's parents, and Funding bodies) expressed varying goals and interests. The main purpose of the elderly is to overcome loneliness by participating in social activities. The government aims to enhance the well-being of older adults in an inclusive society. Children are eager to pick up some extracurricular skills.. Parents of children hope to expand their children's learning

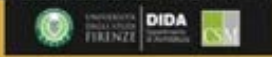
chances. Funding bodies need to promote their business (RV). This study shows the complexity of multi-party collaboration and that coordinating and harmonizing the needs of various stakeholders is a critical step. In the process of cooperation, the willingness of stakeholders is critical. Any project would be difficult to be implemented without their support. This research assisted me in comprehending the time and costs required. This social innovation solution provided more experience in deciding what resources are needed for the smart system, and it familiarized me with the procedures in the entire project. These experiences are helpful for me in organizing more comprehensive healthcare services. This pilot study adds credibility and dependability to the healthcare service from a social-practice perspective.

The second training is about information technology and digital technology. The workshop can provide excellent students with short-term mobility opportunities at the European universities that are partners of the project. I went to the Lodz University of Technology, Poland, for studying related technologies because professors from this university have been managing and coordinating EU research projects on Information Technology. In the university, I acquired skills in IoT, coding, robot creation and soldering. These digital technologies allow me to design and create a basic architecture of some simple systems. This training helps me assess the practicality and feasibility of the smart healthcare service system from the perspective of information technology and system architecture.

5.3 Conclusion

The workshop lasts for six months. The two trainings provided an opportunity to assess the feasibility of the research hypothesis and improve the hypothesis. The first pilot study confirms the effectiveness of this healthcare services system from the standpoint of social cooperation and innovation. However, this study is only an attempt to help older adults cope with loneliness. Seniors have other demands that need to be met. When it comes to smart devices and technologies, especially in the digital age, elderly people face lots of new issues. This requires further research. The second training gave me great technical support. With the help of the laboratory director and researchers, the architecture of the smart healthcare service system is evaluated and improved. These researchers also emphasized the importance of an age-friendly digital

platform for the elderly and suggested that a design contribution is more critical in the project research. In fact, in the current technical background, the success of this smart healthcare service system still faces numerous challenges. With the advancement of technology and the increasing acceptance of digital devices among the elderly, this smart system may play a more significant role in the future.



2020年江苏省研究生 国际智慧康养家具设计与工程 暑期学校

主办单位
江苏省农学类研究生教育指导委员会

承办单位
南京林业大学研究生院
南京林业大学家居与工业设计学院
南京林业大学国际教育学院



CHAPTER 6

INVESTIGATION 2 : INTERNATIONAL SMART HEALTHCARE SUMMER SCHOOL

6.1 Introduction

6.2 Project description

6.3 User research

6.4 Usability testing

6.5 The problems of digital healthcare
platforms and possible solutions

6.6 Conclusion

References

6.1 Introduction

The study in Investigation 1 explores a new type of healthcare service to help the elderly overcome loneliness. WhatsApp and several digital platforms were used to connect and organize seniors throughout the event. When using digital healthcare service platforms to receive healthcare services, because some elderly people do not know how to schedule a service appointment, they face many unimaginable problems. Due to the widespread use of digital healthcare service platforms, it is necessary to investigate whether the elderly can effectively use digital healthcare services platforms. This investigation 2 aims to know how elderly people receive healthcare services and what problems they encounter during using a digital platform. For the elderly with different physical conditions and cognitive abilities, it is important to have a deeper understanding of healthcare service needs and pain points for the elderly, and define which problems are difficult to solve due to objective reasons. Due to the COVID-19 pandemic, it is difficult for an unfamiliar researcher to enter an older person's home to have an interview. I organized and participated an international smart healthcare summer school. In the summer school, I lead students to observe and interview some elderly people that we are familiar with. The data help me classify these elderly people and analyse the problems they meet in using digital healthcare platforms.



Fig.6.1
International Smart
Healthcare Summer
School

PART III : EXPERIMENTAL RESEARCH



4位海外讲师, 4位国内教授, 2位讲师, 2位助教, 2家国内家居集团, 3家国外家具企业, 98位学员。

Fig.6.2
Professors and
designers from
universities and
companies

6.2 Project description

In August 2020, sponsored by the Jiangsu Provincial Education Commission and Nanjing Forestry University, I and Prof. Zhou Chengmin organized the "International Smart Healthcare Summer School" (Fig.6.1).

Because of the pandemic, it is impossible to organize an offline meeting. We invited Prof. Alessia Brischetto and Prof. Stefano Follesa from the University of Florence, Prof. Arianna Mazzeo from Harvard School of Design, Irene Burroni from CSM and other professors to give an online meeting (Fig.6.2). I led a small team to research the healthcare services system and platform.

6.3 User research

6.3.1 user survey

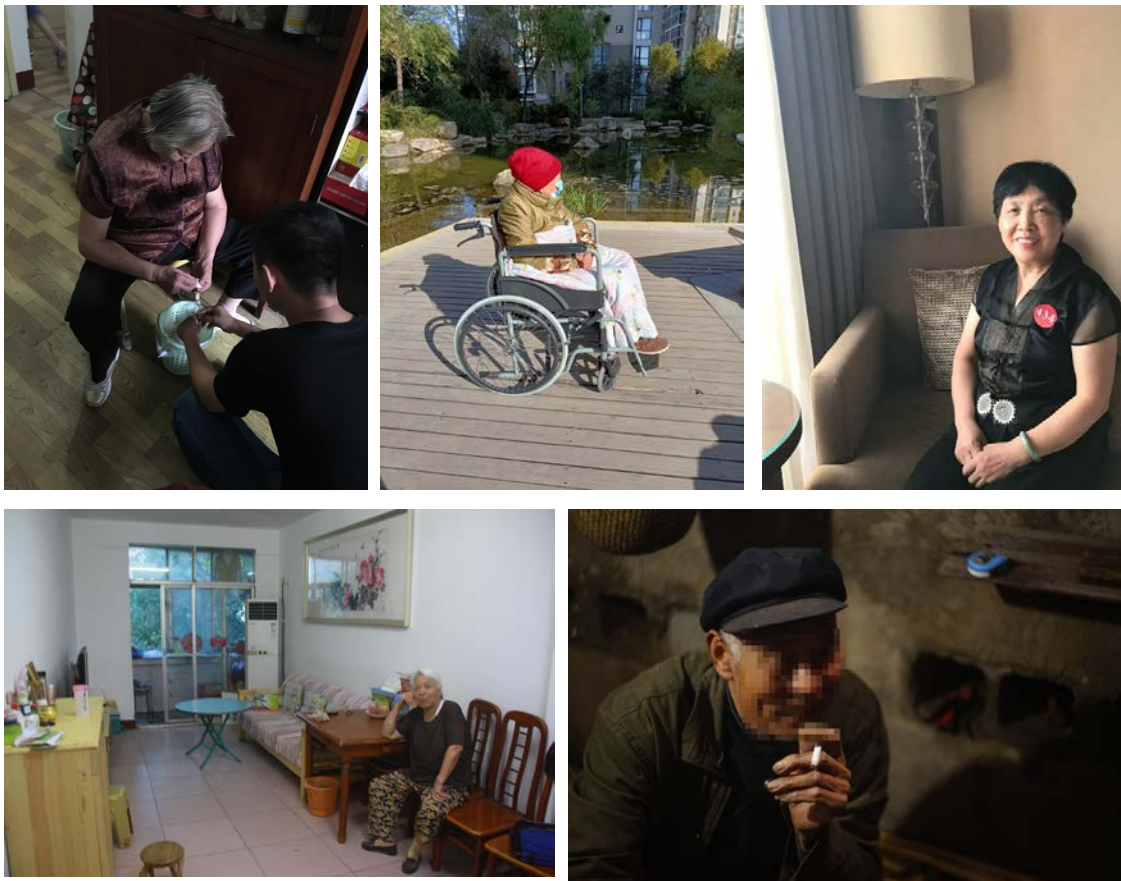
39 older adults were interviewed in the survey, including 15 men and 24 women (Fig.6.3). Their age is between 65-87. The level of education for most seniors is junior high school and elementary school. 47% of the elderly live with their spouse, 7% of the elderly live independently, while the others live with their children. Nearly 80% of the elderly have

Investigation 2: International smart healthcare summer school

a pension. 68% of the elderly use smartphones, and 18% use mobile phones for the elderly. 14% of seniors do not use mobile phones. If adult children teach young seniors how to use some simple services or functions on the digital healthcare service platform, they are willing to use these healthcare services. Sometimes, they can also explore new functions on some age-friendly digital platforms. For those digital platforms that they cannot understand, they do not want to use.

The daily life of the elderly is relatively simple and regular. Older adults who can take care of themselves get up at about 6 o'clock. After washing up, they begin to prepare for breakfast. They usually clean the room, wash clothes, read newspapers, or watch TV in the morning. At around 11, they buy some food in a supermarket and then prepare lunch.

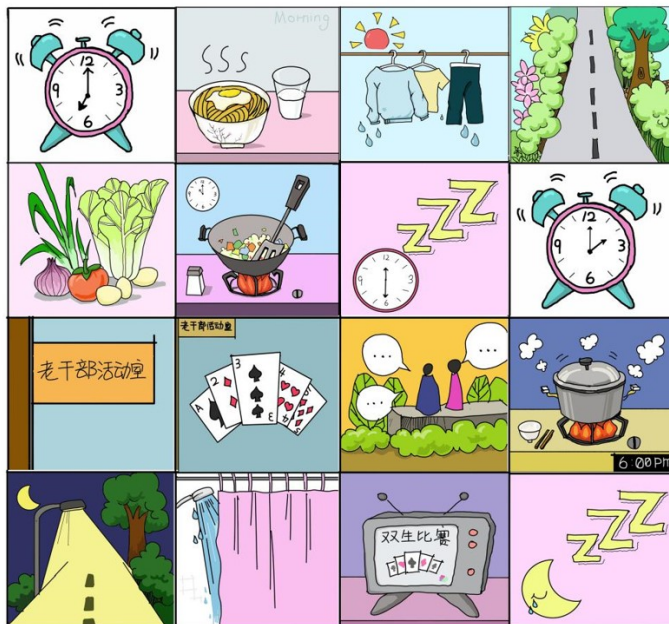
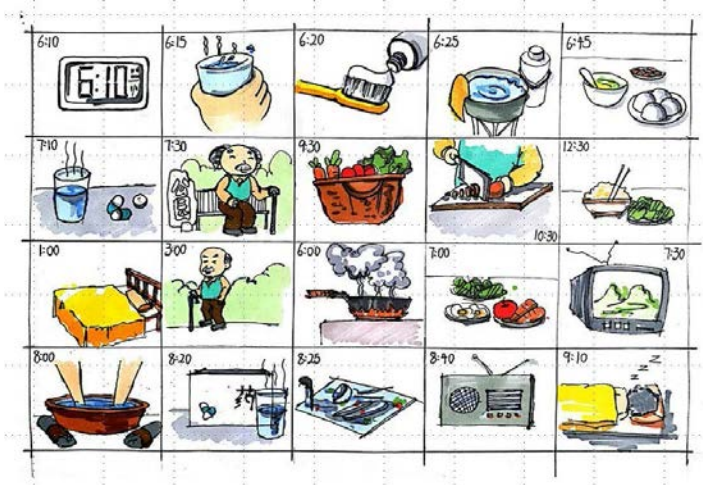
Fig.6.3
User research. From:
Shuang LIANG,
Fangming QIAN, Yao
CHEN, etc.



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After lunch, they take a nap and then go to the senior activity centre, stadium, chess room for some leisure activities, such as playing Mahjong, exercising, chatting, reading, etc. Around 6 pm, they came back home and began preparing dinner. After dinner, they soak their feet and watch TV. They usually go to bed around 9-10 pm (Fig.6.4).

Fig.6.4
User stories. From:
Yao CHEN, Jia LIU,
Yanxu HU, Ming YU,
etc.



6.3.2 Personas

Based on the survey results, older people can be divided into three groups, the primary users, secondary users, and the non-targeted customers of digital healthcare service platforms. Primary users are elderly people who can use the platform independently. Elderly persons who use digital platforms infrequently or indirectly are secondary users. The non-targeted customers are those users who will not choose to use digital healthcare platforms to receive healthcare services.

- Group A—The primary users

In the survey, the primary users of digital healthcare service platforms include elderly people who need follow-up consultations and medical advice, and those older people with chronic illnesses. They mainly want to learn about science-based health information and seek advice from doctors. Their goal is to improve their immune system and maintain a healthy status. In the study, the main users of digital healthcare service platforms included older people who are mentally well and can live independently and take care of themselves, as well as younger people. They mainly use the digital healthcare service platforms to learn about health-related information and seek advice. Their goal is to improve their immune system and maintain a healthy state.

The name of the older person is LI (Fig.6.5). He is 65 years old and graduated from junior high school. He is retired and lives with his wife at a big city. He can take care of themselves and are willing to accept new things. He knows how to use mobile phones and digital platforms and has some digital skills. He follows up with the information on how to keep healthy. They use digital health care platforms to communicate with online doctors for medication guidance and advice when they fell a little unwell and have inquiries about various health issues.

- Group B—The secondary users

Secondary users include elderly people with minor illnesses and those older people who need to be cared for by a caregiver. Elderly people with minor illnesses occasionally use digital health care platforms to ask about their health conditions and treatment recommendations, but they do so infrequently. Seniors who need a caregiver to look after them do not use digital platforms themselves, but their caregivers can help them ask for health advice online.

PART III : EXPERIMENTAL RESEARCH

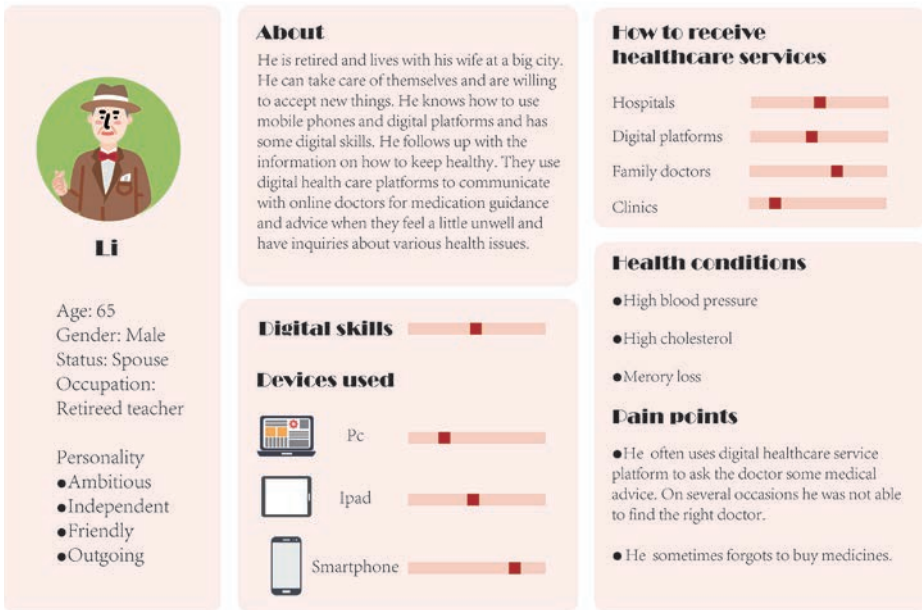


Fig.6.5
Persona A

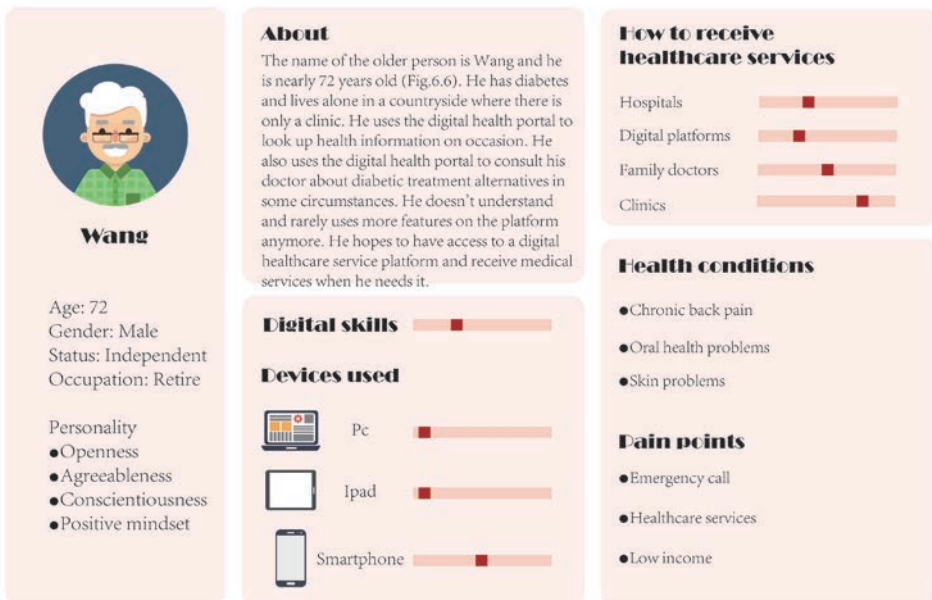


Fig.6.6
Persona B

Investigation 2: International smart healthcare summer school

The name of the older person is Wang and he is nearly 72 years old (Fig.6.6). He has diabetes and lives alone in a countryside where there is only a clinic. He uses the digital health portal to look up health information on occasion. He also uses the digital health portal to consult his doctor about diabetic treatment alternatives in some circumstances. He doesn't understand and rarely uses more features on the platform anymore. He hopes to have access to a digital healthcare service platform and receive medical services when he needs it.

●Group C—The non-targeted customers

The non-targeted customers include older people with complex chronic diseases, critically ill older patients and the elderly who lack digital skills. Older people with complex chronic diseases tend to receive health care services by contacting their family doctor or attending physicians who better understand their medical history. They think it is not very easy for doctors on digital healthcare platforms to meet their specific needs. Serious ill older patients are likely to be already in hospital or their treatment plan is very complex. Online healthcare services are unlikely to address their diseases. Seniors who lack digital skills cannot use

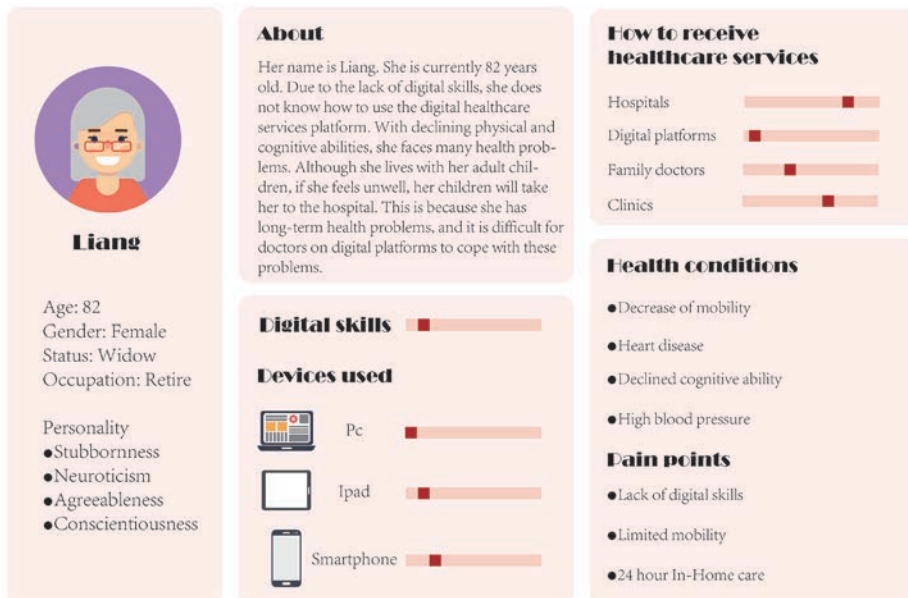


Fig.6.7
 Persona C

smartphones and digital platforms on their own. Therefore, these elderly people are not the target users of digital healthcare services platforms.

Her name is Liang (Fig.6.7). She is currently 82 years old. Due to the lack of digital skills, she does not know how to use the digital healthcare services platform. With declining physical and cognitive abilities, she faces many health problems. Although she lives with her adult children, if she feels unwell, her children will take her to the hospital. This is because she has long-term health problems, and it is difficult for doctors on digital platforms to cope with these problems.

6.3.3 Service demands

According to the survey, for older people, access to health information, online medical consultation, buying medicines online and disease management are four main demands for digital healthcare services.

- Access to health information

COVID-19 has broken the traditional service model of the offline healthcare industry and some offline services have had to be transformed into online services. Over 60% of elderly people learn about health information, the treatment and prevention of disease, and other related information from digital healthcare platforms. This percentage is still growing due to the impact of Covid-19.

- Online medical consultation

The convenience and flexibility of teleconsultation can help save time for older patients with minor illnesses. They do not need to go to hospital or see their family doctor, and can benefit from video or telephone consultations with experienced doctors.

- Buying medicines online

Older people are willing to buy healthcare products, non-prescription medicine, and home medical equipment on digital healthcare platforms. However, most of the time they prefer to visit pharmacies to buy prescription drugs.

- Disease management

Older patients with chronic illness can manage their historical medical records, prescriptions, appointment information, etc. through a digital

healthcare platform. However, according to the survey, most elderly people have not used online disease management module. Since this module is not well designed on many digital healthcare platforms, it cannot replace the services provided by family doctors.

6.4 Usability testing

Usability testing consists of a test guide, some questions for a short interview, and a usability testing (Appendix 2 shows these contents).

●Goals

The goal of this test is to find out what problems older people encounter when using the digital healthcare service platform, and to think how to enhance elderly people's experiences by improving the design and service of the digital platform.

●Methods

The test chooses a think aloud protocol as the research method. Older people can say whatever comes into their minds during they take a task. This might include what they are looking at, thinking, doing, and feeling. This gives observers insight into the participant's cognitive processes. In a usability testing context, observers are asked to take notes of what participants say and do, without attempting to interpret their actions and words, and especially noting places where they encounter difficulty. Tests may be completed on participants own devices or in a more controlled setting. Tests need to be video recorded so that developers can go back and refer to what participants did and how they reacted (Wikipedia, 2022).

●Task

According to the services available on the digital platform, older people can choose any service to experience. Older people are expected to complete it. During the process, older people can say anything you want, about their thoughts, feelings, difficulties, etc.

●Running the tests

The older person was 62 years old (Fig.6.8). He uses his smartphone every day. He usually receives healthcare services through hospitals and digital healthcare platforms. As a young senior, he has sufficient digital skills and can use digital platforms independently. Due to his

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rhinitis and skin allergies, he once received healthcare services on a digital healthcare platform called "Yu Zhong Yi". The reason why he first used the digital platform is that after a minor surgery, he wanted to understand his physical condition and get some prescription medication again. As this was inconvenient for him to go to the hospital again, he made an appointment with his attending physician through the digital healthcare service platform. This doctor knew his medical history, so the doctor prescribed the medication on the digital platform. The elderly person paid for the medication through the platform and the medication was sent directly to his home a day later.

The first step

The elderly person has a skin allergy recently. His task is to find a professional doctor for a video consultation. Because he had already registered an account on this platform, he skipped this step and opened the app directly. He browsed the content and features of the home page and then said it was difficult to find the service he needed (Fig.6.9).

The second step

The elderly person chose a virtual outpatient service. However, after he entered the module, he did not find the service he needed. After returning to the home page, he browsed the various modules again, and then chose a module named "the department of the hospital" (Fig.6.10). In this module, he selected the dermatology, skips the department introduction, and clicks on the "Find Doctor" option located below the digital platform (Fig.6.11). After reading the introductions of several doctors, the older user chose a chief physician.

The third step

In the doctor's profile, the user can view an introduction, service options, patient reviews and information on offline visits (Fig.6.12). There are 3 ways to communicate with the doctor. The first way is to communicate through text and pictures. The second method is through voice communication. The third way is the telephone communication. All three methods of communication cost about 7 RMB (about 1 euro). The elderly person browsed through the doctor's description and the service options on the page, and chose to communicate with the doctor via pictures and text.

The fourth step

The elderly person is then asked to fill in information about symptoms and a description of the physical condition (Fig.6.13). Some information (about medication, allergy history, past medical history, and marital status) is optional to fill in the form. The elderly person can also fill in information about what services they need from the doctor, such as prescribing medication, prescriptions and how to manage the illness. At this step, the elderly person feels that there is too much information to fill in. He does not like this way and prefers video communication. In typing, the elderly man makes several errors.

The fifth step

Next, the elderly man was asked to upload photos of his symptoms. He did not know where to take pictures or upload them, and he clicked the return button. After he made a mistake, the page pops up with an alert to confirm with him if he wants to leave. He chose to stay on this page. The older man did not know what to do next. After staying on this page for more than ten seconds, he discovered the option to upload photos. The old man uploaded the photo according to the instructions on the page. After all the steps were completed, he submitted a request for a medical consultation (Fig.6.14).

The sixth step

The old man was asked to pay the fee. The payment page shows the name and amount of the payment account (Fig.6.15). This APP is connected to WeChat, and the elderly can use their fingerprints to pay (Fig.6.16).

The seventh step

After the payment is completed, the elderly person received a confirmation message and wait for online doctor consultation (Fig.6.17). The elderly person complained that he was unable to see a doctor immediately and had to wait.

The eighth step

About 16 hours later, the doctor responded to the older man's request (Fig.6.18). The doctor made a diagnosis based on the older man's description and suggested that the older man could go to the hospital for a face-to-face treatment next monday afternoon or Tuesday morning.

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Fig.6.8
User testing



Fig.6.9
The home page

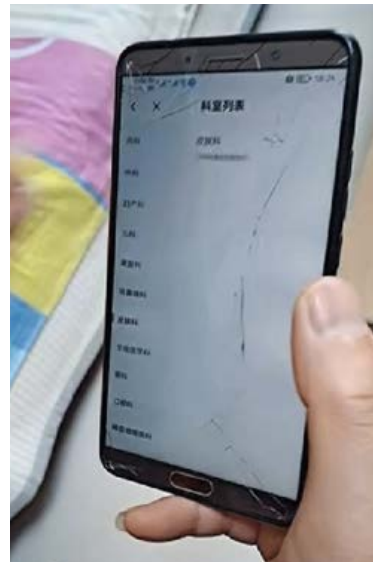


Fig.6.10
List of Departments in Hospital



Fig.6.11
List of doctors



Fig.6.12
Doctor profile



Fig.6.13
Fill in the basic information

Investigation 2: International smart healthcare summer school



Fig.6.14
Submit a request for a medical consultation



Fig.6.15
The name and amount of the payment account



Fig.6.16
Fingerprint payment

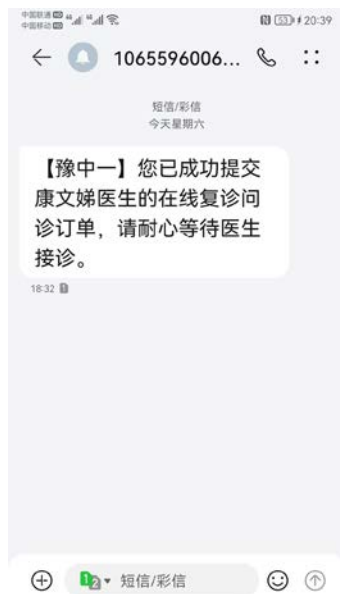


Fig.6.17
A confirmation message



Fig.6.18
Doctor's responses to patients' concerns

The older man thinks he still has to go to the hospital for this service. This is inconvenient and does not solve the actual problem. A total of eight steps are required to complete this service. In the actual situation, the elderly went through 17 steps. Nine of them were invalid operations due to misunderstanding and operation errors. Excluding the waiting time, the service took 12 minutes and 36 seconds. The older adult believes that the healthcare services provided by the digital healthcare platform are helpful for older patients with minor illnesses.

He believes that the first service experience (buying medicines directly from digital platforms) is better for him. He is satisfied with the healthcare services provided by this digital platform and is willing to receive services from this platform in the future. However, he prefers to go directly to the hospital in an emergency. Because doctors cannot directly see the patient's physical condition, it is better if the platform can provide remote video consultation. The older man rated the digital platform an 8/10.

6.5 The problems of digital healthcare platforms and Possible solutions

Elderly people need healthcare services provided by digital platforms, such as remote therapy, telemedicine, virtual care, and online doctor consultation. When they need to receive digital healthcare services, they usually ask for help from their adult children. This is because they have not developed the habit of receiving healthcare services through digital platforms. Moreover, these digital healthcare platforms serve all of people, not only the elderly. Therefore, the design of digital platforms is not age-friendly. According to the survey, the problems that older users have encountered can be funded. By analysing these problems, we can provide some possible solutions (Tab.6.1).

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Category	Problems / Pain Points	Solutions
Information presentation	The font on the digital platform is too small. Older people need to wear glasses to read the text clearly.	Increase font size
	The page layout is too complicated.	Simplified layout
	The pages contain too many services and functions. It is difficult to locate the functions and services.	Highlight key services and functions
	The names of some services and functions are difficult to understand	Don't use technical terms
	The doctor's areas of expertise are not clearly presented and can easily be overlooked.	Highlight the doctor's area of expertise
	Some options and tags are not accurately described.	Optimise the description
	Some options and labels are transparent and not easy to locate.	Remove the transparency tags
	Some icons are too complicated and unfamiliar.	Use specific icon designs
	Too much text	Voice introductions can replace text introductions.
	The buttons are too small	Increase the size
Digital interaction	There is too much information to fill in. Typing is too time consuming and complicated.	Voice input is the better option.
	Some information needs to be filled in repeatedly.	Optimise processes
	Staying on digital platforms for too long makes the eyes uncomfortable for the elderly.	Reduce screen time
	Waiting long time for online specialist consultations	Reduced waiting times
	Hope to communicate with the doctor in time	Real-time feedback
	There is not enough time to fill in the information on the digital platform	Extend the time limit
	Older people do not know which section on the digital healthcare platform they	Add the introduction of medical departments on

Tab.6.1
Problems, pain
points and
solutions

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Category	Problems / Pain Points	Solutions
Digital interaction	Older people do not know which section on the digital healthcare platform they should choose to receive services.	Add the introduction of medical departments on platforms
	The service staff can help with navigation during older people use a digital healthcare platform	Customer service available
	The touch sensitivity of the fingertips of the elderly will decrease with age, making it easy to touch by mistake when using a digital platform.	Increase button size
Design patterns	Menu has too many options	Keep the list short enough
	Navigation is not clear enough	Optimize navigation
	Online payment method	fingerprinting and facial-recognition payment
	The complex process in the digital platform.	Service process optimization
	Can't make an appointment	Adding a reservation module
Accessibility	The disease management module is not fully functional.	Improve and optimize the module
	Diseases surveillance	Adding the module
	Older people are worried about buying medicines online.	Enhance the credibility of the platform by showing official proofs such as licenses
	There are fewer doctors available on digital healthcare platforms	Increase the number of doctors available
	Lack digital skills	Learning video and tips
	Lack the companion	Companion care
	Loneliness	Spiritual comfort service
	Lack communication	Senior citizen online communities
	Death is as a source of anxiety	Palliative care
	Lack exercises	Online exercise coaching
	Decline in cognitive ability	Cognitive training
	Chronic disease	Health management
	Long-term care	Provide qualified caregivers
Forgot to buy medicines	Monthly purchase and deliver them home	

Tab.6.1
Problems, pain points and solutions

The following problems encountered by older users are difficult to be solved through the design of a digital platform. The solution to these problems requires a combined efforts of society, families and communities.

- Elderly people with cognitive decline are unable to make payments online. (Westlake & Culham, 2007).
- The elderly lack digital skills and cannot use digital platforms on their smartphone.
- Elderly people with memory loss sometimes forget to buy medicines on digital healthcare platforms.
- Elderly people lack the company of their family numbers and feel lonely. Social interaction is important for the elderly (Ten Bruggencate, et al. 2018). Digital platforms do not provide some services to deal with the problems. (Kirkland, et al. 2011).
- Cognitive and/or physical impairments can lead to difficulties in performing activities on a digital platform. (Westlake & Culham, 2007).
- It takes a long time for the elderly to go to the hospital to see a doctor. It is also difficult for the elderly to go to the hospital alone.
- Death has always been a source of anxiety for the elderly.

6.6 Conclusion

The research revealed that the main users of digital healthcare platforms include elderly people who need follow-up consultations and medical advice, those older people with chronic illnesses, and those with minor illnesses. The results help find the difficulties elderly people face in receiving digital healthcare services. After group discussion and analysis, the pain points of digital healthcare services were obtained. This research also confirms that some of the problems that prevent older people from using a digital healthcare platform are caused by the lack of age-friendly design on platforms. Therefore, it is important to consider how to improve the design and service process of a digital healthcare service platform so that the digital platform can be better used by the elderly. Design should play a more important role and contribute to an age-friendly digital platform.

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Photo by Xia Qiang

CHAPTER 7

INVESTIGATION 3 :

CASE STUDY: NANJING DRUM TOWER HOSPITAL

7.1 Introduction

7.2 Nanjing drum tower hospital

7.3 Healthcare processes in the hospital

7.4 Internet hospital

7.5 Conclusion

References

7.1 Introduction

Chapter 6 discusses the problems older people encounter when using digital healthcare platforms from the user's perspective. The chapter 7 examines how digital platforms provide healthcare services from the perspective of service providers. The research is mainly to analyse the work process and service process of one of the best hospitals in China, and to think about how to optimise their processes and service design of digital platforms. The goal is to help find solutions to improve digital experiences for older users.

7.2 Nanjing drum tower hospital

Nanjing Drum Tower Hospital is one of the earliest western medical hospitals in China, established by the missionary in 1892. The hospital is in Nanjing, Jiangsu Province, China. It is a comprehensive tertiary-A hospital, with a construction area of 225,000 m², 3800 hospital beds and more than 5000 employees. This is a public hospital established and managed by the government. Each year, the hospital admitted more than 64,000 inpatients, and treated 3.2 million outpatient visits and emergency cases. In China, there are 2996 tertiary hospitals until 2020 (including 1580 tertiary-A hospitals, the same level as Nanjing Drum Tower Hospital).

There is a helicopter landing pad on the roof of emergency medical centre. With the help of a helicopter, patients can quickly reach the operating room of the hospital for resuscitation (Fig.7.1).

Fig.7.1
Nanjing Drum Tower Hospital. Chinanews.
From: <https://www.chinanews.com.cn/tp/hd2011/2012/11-05/145218.shtml#nextpage>



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Fig.7.2

The building for outpatient service.

Chinanews.

From: <https://www.chinanews.com.cn/tp/hd2011/2012/11-05/145218.shtml#nextpage>

The outpatient service building of this hospital has five floors. Each floor has a registration office, a payment office, a pharmacy, an outpatient examination, an injection room, etc. If patients have difficulties to move, there are free electric vehicles that can bring patients to where they want to go. Starbucks and other dining venues are located on the first floor of the building (Fig.7.2). The inpatient building has a total of 14 floors. The first floor is the emergency department, and the second floor is a piano hall with a payment office and other departments (Fig.7.3) (Archiositions, 2021).



Fig.7.3

The inpatient building. From: Chinanews, (2021); Archiositions, (2021)

Chapter 7
Case study: Nanjing drum tower hospital



Fig.7.3
The inpatient building.
From: Chinanews,
(2021); Archiositions,
(2021)

7.2.1 Classification of Chinese hospitals

According to a hospital's ability to provide medical care, medical education, conduct medical research, and invest in medical equipment and devices, the Chinese government classified hospitals in a 3-tier system. Hospitals are designated as primary, secondary or tertiary hospitals. Every grade is further subdivided into 3 subsidiary levels: A, B and C. There are a total of 9 levels and one special level (3AAA) that is reserved for the most specialized hospitals, though no hospitals have yet been placed in this level.

- Primary hospital

A primary hospital is typically a community hospital that contains less than 100 beds. They are tasked with providing preventive care, minimal health care and rehabilitation services.

- Secondary hospital

A secondary hospital is a regional hospital or district hospital that contain more than 100 beds but less than 500. They are responsible for providing comprehensive health services and medical education and conducting research on a regional basis.

- Tertiary hospital

A tertiary hospital is a comprehensive, referral, general hospital at the city, provincial or national level with a bed capacity exceeding 500. They are responsible for providing specialist health services, perform a more significant role in medical education and scientific research, and serve as medical hubs providing care to multiple regions. Nanjing Drum Tower Hospital is a comprehensive tertiary-A hospital

7.2.2 Organizational structure

A hospital committee manages this hospital. It has 2 clinical colleges, 32 clinical departments, 32 medical technical sections, and 21 special research sections and laboratories. Noted advanced-level departments of the hospital include: anesthesiology, cardiology, cardio-thoracic, endocrinology, gastroenterology, haematology, hepatobiliary surgery, immunology, obstetrics and gynaecology, oncology, orthopaedics, pathology, respiratory, spine surgery, and urology (Nanjing Drum Tower Hospital, 2021).

This hospital has a geriatrics department, an integrated, multi-disciplinary unit providing healthcare to older people. There are 218 wards that can be allocated to the elderly. There are 162 medical staff members and 48 physicians on the medical team, with 6 chief physicians and 15 associate chief physicians. They can provide personalised, comprehensive, and systematic diagnosis and treatment for senior patients. Traditional Chinese medicine, rheumatism, respiratory system, geriatric nephrology, geriatric neurology, geriatric oncology, old age psychiatry, geriatric subspecialty medical clinics, and other parts of the department are currently available. The department has an online consultation system to provide remote medical services for older people with limited mobility.

7.2.3 Reservation methods

If older people want to visit the hospital, there are 6 methods to make a reservation.

- Telephone appointment: older people can make an appointment by telephone, and the telephone number is 025-12320.
- APP: An official APP is available for making an appointment.
- Website: Older people can log on to the official website (www.nj12320.org) to make an appointment.
- Internet hospital: Older people can search for the "Nanjing Drum Tower Hospital" mini program on WeChat and then select "offline consultation" to make an appointment.
- Outpatient: Outpatient doctors can help make appointments based on the patient's condition.
- Self-service kiosk: Older people can use their ID card to make an appointment on a self-service kiosk.

The elderly or family members can choose the way they like to make an appointment. The hospital issues appointment numbers seven days in advance. In order to make an appointment, it is necessary to provide the patient's name, ID number, and mobile phone number.

7.3 Healthcare processes in the hospital

The Internet platform is dependent on the hospital's service system. Therefore, an in-depth understanding of healthcare processes can help to improve online services.

7.3.1 Outpatient service

Patients went to the hospital to see a doctor. First of all, they need to have a medical insurance card. Those without a medical insurance card need to apply for a patient ID card, which can help collect medical information and register or buy medicines in the hospital. They can go to a self-service kiosk or the hospital registration desk to apply for the patient ID card, and then make an appointment for a speciality or a doctor. The second step is to go to the doctor's office. A doctor scans a patients' card and checks the patient's basic information. After communicating with the patient, the doctor checks the patient to diagnose and prints prescriptions and medical advice. If the doctor needs the patient to do some medical examination to help diagnose, the doctor will give the patient a checklist. In the third step, the patient pays medical costs at the self-service kiosk or the payment office and gets the payment slip. The patient can take the payment slip to the examination room for examination. After getting the inspection report, the patient can return to the doctor's office, and a doctor makes a diagnosis based on the report. In the fourth step, the patient takes the payment slip to the pharmacy to pick up medicines. If a pharmacist checks and finds a problem, the patient will be asked to return to the doctor's office for another examination. After the patient gets the medicine, the entire treatment process ends (Fig.7.4).

7.3.2 Emergency medical service

After patients are sent to the hospital, the triage registered nurse might assign patients a priority level based on current condition, according to the following scale: Level 1 – Resuscitation (immediate life-saving intervention); Level 2 – Emergency (life-saving intervention within 10 minutes); Level 3 – Urgent (treatment priorities); Level 4 – Non-urgent. Patients with serious illnesses and injuries will be sent directly to the

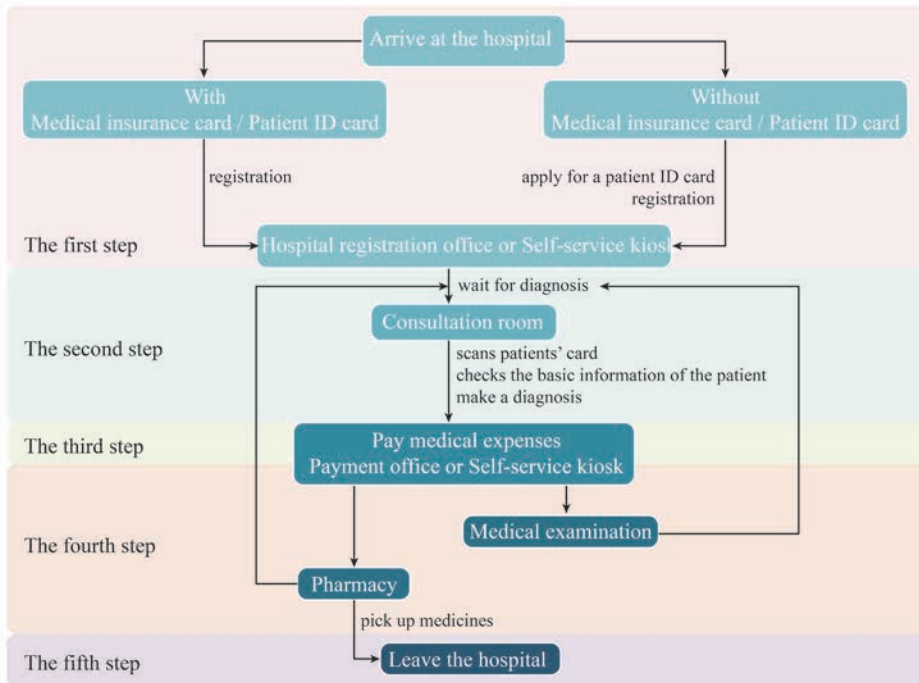


Fig.7.4 The outpatient department process

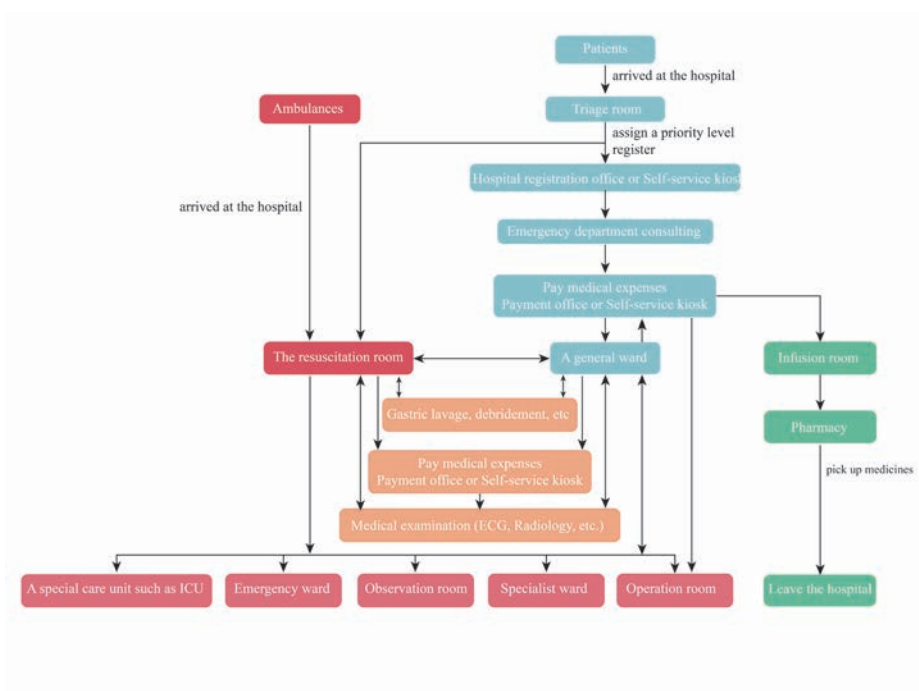


Fig.7.5 The process of emergency medical services

resuscitation room. According to the patient's health status, the doctor will transfer the patient to a general ward or to a special care unit such as ICU. According to the doctor's diagnosis and checklist, the patient is treated and checked. If the hospital cannot contact the patient's family numbers or check the patient's information, the hospital will still provide medical services. If family numbers come to the hospital, they need to register and pay the costs at a self-service kiosk or the hospital registration desk. Doctors agree to discharge the patient after the patient has recovered and various physical indicators have returned to normal. The family can take the discharge certificate to the payment office for financial settlement. Family numbers pay the medical costs, and the patient can leave the hospital (Fig.7.5).

7.4 Internet hospital

The Internet hospital of Nanjing Drum Tower Hospital has built a healthcare service platform to meet the diverse medical needs of older patients. Older patients can have online follow-up consultations with enrolled doctors. The Internet hospital provides digital prescription and home medicine delivery services. Older patients can receive prescriptions in real-time and choose to deliver medicine to their homes or pick medicines up at a pharmacy. The Internet hospital also provides electronic medical records that older patients can view anytime and anywhere.

7.4.1 How to use

The first step is to search and download Wechat through the APP store. Then it is necessary to search for Nanjing Drum Tower Hospital in the public account, and the public account of this hospital can be found. Entering the official account and clicking on the patient service below, patients can use the Internet hospital service (Fig.7.6).

There are many common medical services to choose from, including searching for departments/doctors, making appointments, online follow-up consultations, health consultations, payment services, inspection reports, health check-ups, hospitalization services, etc. Patients can also enter some popular departments to find more information and a doctor. In the learning centre, patients can learn medical knowledge. People can rapidly schedule a physical examination or renew an

offline healthcare service in the medical service column. Online doctor interaction, medical record delivery service, electronic invoice download, prescription consultation, health management, and online visit are the six service options available in the health service. The next column is a recommendation of famous doctors (Fig.7.7). The home page contains many services and functions. This layout is too complicated for the elderly and they also do not need to use all functions.



Fig.7.6 Find the Internet hospital. From: the mini program of Nanjing Drum Tower Hospital



Fig.7.7 Healthcare service provided by the Internet hospital. From: the mini program of Nanjing Drum Tower Hospital

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Before using these services, users need to fill in personal information, such as name, identification number, the phone number and create a password for registering an account (Fig.7.8).



Fig.7.8

Register an account.
From: the mini program of Nanjing Drum Tower Hospital



Fig.7.9

Health consultation.
From: the mini program of Nanjing Drum Tower Hospital

7.4.2 Service content

●Online health consultation and online registration

In the internet hospital, we can see the information of all doctors. Users can choose a doctor to send pictures and texts to communicate with the doctor. This online health consultation can eliminate geographical restrictions, and users can receive convenient and professional medical services anytime and anywhere. Currently, the services provided by the Internet hospital are charged, and the expenses cannot be reimbursed. According to the levels of doctors, the cost of this service is 1.5-8 Euros per time. In China, doctors can be divided into the physician, resident physician, physician-in-charge, associate chief physician and chief physician (Fig.7.9). This service only provides expert advice and does not provide any medical prescriptions and electronic medical records. The elderly can only communicate with doctors through text, and voice communication is not available. This design affects the effective communication of the elderly.

If patients need further treatment, they can book an appointment online for a consultation (Fig.7.10). Patients can choose a department in this appointment interface and then book an expert consultation or a general outpatient clinic service. After selecting an expert, users can see the time available and the number of appointments available. Every day, a huge number of patients are admitted to the hospital, and the majority



Fig.7.10 Making an appointment for healthcare service. From: the mini program of Nanjing Drum Tower Hospital

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of them wish to meet with an experienced expert, but this is difficult. Therefore, patients need to make an appointment in advance. It is not necessary for a general outpatient clinic service because whenever people go to the hospital, they can be checked and treated in the general outpatient clinic. In general, making an appointment can help save time in queues.

●Online follow-up consultation, online payment

In addition to choosing to go to the hospital, people can also choose online follow-up consultation. Patients can have an online meeting at home with doctors. Doctors can write prescriptions online, and pharmacists can review online to ensure medication safety. This service integrates the entire process of online consultation, prescription, and home delivery of medicines. Since it is a follow-up consultation, this service is only for people who have received treatment in this hospital in the past three months. Patients without medical records can choose health consultation services. The online follow-up consultation interface is accessible from the Internet hospital's homepage. After selecting a doctor, users can access detailed information about the doctor. The patient then needs to describe the state of his or her illness, upload previous medical records, and book an appointment. Depending on the levels of doctors selected, this service costs 1.5-6 Euros each time (Fig.7.11).

Fig.7.11
Online follow-up consultation. From: the mini program of Nanjing Drum Tower Hospital



● Electronic prescription, home delivery of medicines

After the doctor finishes the follow-up consultation, the patient can find the electronic prescription. The patient can purchase medicines online and fill in the delivery address. The medicine will be delivered to the home (Fig.7.12).

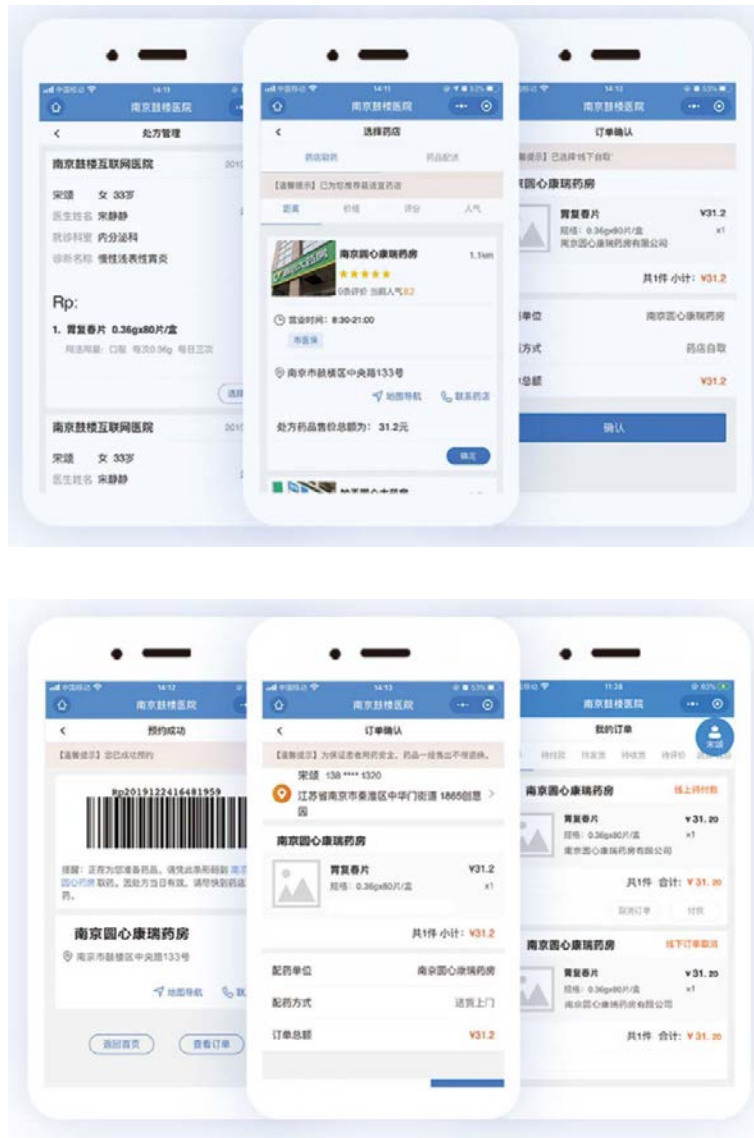


Fig.7.12 Electronic prescription, home delivery of medicines. From: the mini program of Nanjing Drum Tower Hospital

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●Internet + nursing

The hospital can provide quality nursing services. The first step is to add patients and complete identity authentication, and the second step is to select the hospital that provides services. The third step is to make an appointment online, submit a service order, and wait for care workers to come home and provide services (Fig.7.13).

● The live streaming in healthcare

Il live streaming rappresenta un nuovo modello di business che integra live streaming, e-commerce e intrattenimento, creando veri e propri spettacoli finalizzati (Alessio, 2021).

In China, many hospitals encourage some well-known doctors to live streaming. Knowledge transfer comes easy with the help of live streaming. In live streaming, people can enter questions. Doctors will respond to them and provide medical advice. This kind of interaction is unlimited, instant and accessible. This way attracts many people, especially those with medical needs, to watch and interact with doctors

Fig.7.13
Internet + nursing.
From: the mini
program of
Nanjing Drum
Tower Hospital



to get the answers they want. When the doctor answers other people's questions, it may also be a good way for the viewer to understand the disease (Fig.7.14).



Fig.7.14
The live streaming.
From: the mini
program of Nanjing
Drum Tower Hospital

7.5 Conclusion

With technology development, digital healthcare service platforms have become a trend. Many hospitals in China have established digital healthcare service platforms to provide people with various healthcare services. This reduces the strain on healthcare systems while also increasing healthcare efficiency. As a result of the epidemic's blockade, an increasing number of people have turned to internet medical services. For young people, these service platforms are effective and useful. The elderly can receive professional healthcare services at home. This is very helpful and valuable for those older adults with limited mobility. However, there are still many older people who have not developed such a habit.

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The digital platform of Nanjing drum tower hospital is also aimed at users of all ages and lacks a Senior's Version of Internet hospital. Therefore, the design, interaction method and service process of the platform are not friendly enough for the elderly. The size of fonts and buttons are too small, and it is difficult for the elderly to read the information. Some service bookings require many steps, which poses challenges for them. Some services in digital platforms are not available. In addition, especially when elderly people interact with digital platforms, they encounter more problems than face-to-face communication. In most cases, they receive online healthcare services with the help of their family members, due to the lack of digital skills. Apart from this reason, the complex layout and functions also make it difficult for the elderly to use. Sometimes what the organisers of a digital platform consider to be the right interaction and service flow may be difficult for the elderly to use. There are differences in perception between the service process planned by the digital platform and the service process the user experience. Because of these issues, older people prefer to seek medical assistance in a traditional setting, such as going to a hospital. Therefore, this Internet hospital needs to be improved and add a Senior's Version based on the characteristics of elderly users. This can make the digital platform more age-friendly.

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CHAPTER 8

EXPERT INTERVIEWS

8.1 Introduction

8.2 Interview 1:

administrator from Ninth People's
Hospital of Zhengzhou

8.3 Interview 2:

director from The Fifth Affiliated
Hospital of Zhengzhou University

8.4 Interview 3:

Prof. Jake Kaner from Nottingham Trent
University, UK

8.5 Interview 4: Prof. Lyndon Buck from
Aston University, UK

8.6 Interview 5:

a doctor from the Careggi University
Hospital, Italy

8.7 Conclusion

Part III Research Answers

8.1 Introduction

With the development of technology, Chinese hospitals are also embracing digital technology and establishing digital medical platforms to provide more convenient and accurate services for the elderly. Previous research has identified the digital divide between older adults and digital platforms. Expert discussions may help to explore a solution for bridging the digital divide. Interviews with hospital administrators can help understand their views on digital healthcare services and their suggestions for the Senior's Version. Interviews with professors can help me better understand how to use an Elderly-Oriented Design approach to improve existing healthcare service platforms and give me some suggestions about the contribution that design can make to the digital healthcare service platform.

8.2 Interview 1: administrator from Ninth People's Hospital of Zhengzhou

The first interviewee was a doctor from Ninth People's Hospital of Zhengzhou. This hospital of geriatric is well-known in China. Geriatrics is the most important speciality of this hospital. The feature of this hospital is that it can provide medical care services for the elderly in terms of prevention, health care, treatment, rehabilitation, nursing and hospice care. In 2012, this hospital established the "Henan Provincial Geriatric Medical Care Alliance", which integrated nursing homes with medical institutions. The hospital has created a green channel for the reserved patients of alliance members, and these older people prioritise medical treatment and hospitalisation. The cooperative model allows the elderly with minor illnesses to be diagnosed and treated in nursing homes. Elderly people with serious illnesses can be sent directly to the hospital for treatment. After older people are cured, they will be sent back to the nursing home. This hospital has many rehabilitation & exercise equipment, and online consultation is also available (Fig.8.1).

Q1: Based on your experience, which kind of healthcare services do you think is more important at present? What problems are difficult to solve?

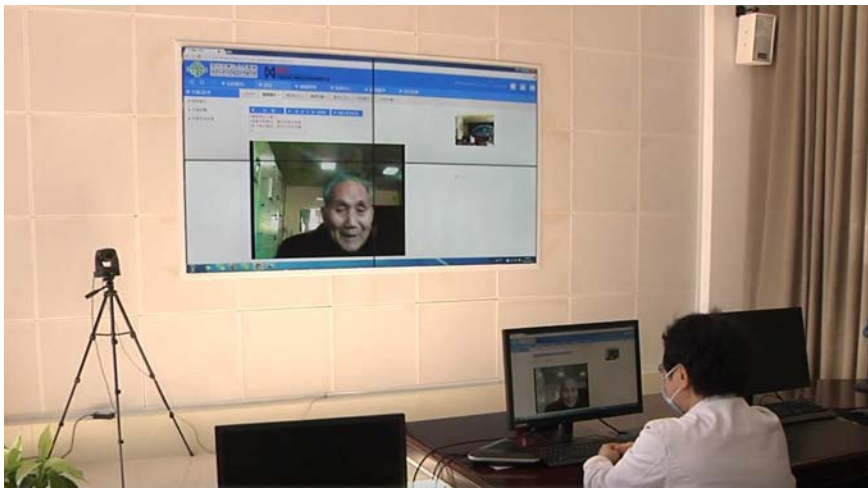


Fig.8.1

Healthcare services provided by the hospital.

Daxiang News. From: <https://share.hntv.tv/news/0/1460800909202284546>

Answer: At present, in China, most elderly people live at home. Mental comfort is particularly important for the elderly. Economic problems are a big problem faced by the elderly in China. If elderly people have no economic income but need to survive, how to solve this problem? From the perspective of human nature and morality, taking care of older people is a legal obligation for adult children. Article 49 of the Constitution of the People's Republic of China stipulates adult children have an obligation to support and take care of their parents.

Q2: What do you think are the characteristics of older people in China?

Answer: China will become the first country in the world to get old before it gets rich. People who are 60 years old are defined as the elderly in China. Because the average life expectancy has increased significantly, many people over 60 look very young. Secondly, the spiritual needs of the elderly are becoming stronger and stronger, and they have a lot of free time. The hierarchical consumption of the elderly is becoming more and more obvious, and the elderly care services are becoming more and more socialized. Furthermore, the increase in the consumption level of the elderly has led to more and more commercialization of healthcare services.

Q3: What problems are the healthcare services system currently facing? How should healthcare services be improved?

Answer: The ageing population has reached its peak in advance. With the increase in the number of elderly people, the financial burden of society has increased. The development of social welfare and healthcare services cannot meet the growing needs of the elderly. Adult children work in other places, and home care is becoming increasingly important. Elderly people have an obvious demand for medical care and life care services. Government departments need to attach importance to healthcare services for the elderly, encourage the participation of social institutions and non-profit organizations, and create an excellent atmosphere to improve the retirement life of the elderly.

Q4: What kind of smart services do you think the elderly need?

Answer: Elderly people need new digital or smart services, but they cannot be entirely dependent on these services. Some positioning systems can prevent disabled people and older people with intellectual disabilities from getting lost. For elderly people suffering from mental illness, such as dementia, it is necessary for them to use a positioning system to avoid getting lost. Smart emergency call systems, vital signs monitoring systems and other smart systems can help avoid accidents and help take care of older people, but there are certain drawbacks, and the privacy of the elderly may not be effectively protected.

Q5: What is the future development direction of smart healthcare services?

Answer: I personally believe that there are two general directions for smart healthcare services in the future. The first one is the application layer innovation. By using advanced technologies such as artificial intelligence and big data, the application of a smart healthcare service system can collect physiological data of the elderly, provide a health risk warning, and reduce the safety risks of the elderly. The second is high-tech smart devices that can allow the elderly to live independently to the maximum extent possible. For example, the new generation of exoskeleton robots from Fourier Intelligence company can help older wheelchair users stand up again and help them recover. By using smart sensors and devices with emergency alarms to monitor the physiological parameters of the elderly and environmental data, nursing workers can take care of more elderly people, which improves the efficiency of healthcare services. The application of smart devices and systems can shorten the response time and improve the safety of the elderly.

Q6: What do you think about the acceptance of digital technology by the elderly?

Answer: If these digital technologies or smart devices are perceived as beneficial and user-friendly, older people are willing to use them. Elderly people are reluctant to use smart devices they do not understand. Older people need various healthcare services, and they tend to come to medical institutions to receive healthcare services. Currently, they have not yet formed the habit of receiving services through the digital healthcare service platform. The possible reason is that they lack digital skills, and digital platforms are not enough age-friendly. It may be more difficult for the elderly to learn digital skills than we thought. A better solution should be to optimize the existing healthcare service platform. For example, our hospital website is designed for everyone. Due to low vision and other reasons, it is difficult for the elderly to use. We also want to improve the website and make it more age-friendly, but we are doctors, not designers. We do not know how to improve it.

8.3 Interview 2: director from The Fifth Affiliated Hospital of Zhengzhou University

The second Interviewee is the director from The Fifth Affiliated Hospital of Zhengzhou University. The Hospital is located in Zhengzhou, Henan province and is a comprehensive tertiary-A hospital. In the whole province, the service provided by this Hospital is the best. Related research is also relatively cutting-edge.

Q1: What is your view on China's healthcare service system for the elderly?

Answer: China's population is growing older quicker than that of other nations. The smart healthcare service system is a development trend. Chinses government pays more attention to elderly care services. At present, community healthcare services are still limited. There is an urgent need to integrate medical resources and nursing homes better, promote the development of smart healthcare services, and meet the diversified needs of the elderly. The digital healthcare service platform is a good idea, and many hospitals have built an online service platform to provide services for patients. This can help ease pressure on the healthcare service system. Young people usually use the platform to make an appointment for specialist consultations, which can help them save time. This online service process is a bit complicated, and it is indeed not easy for the elderly to use it.

Q2: What do you think of smart devices and smart technologies for the elderly?

Answer: There are already many smart devices. However, there are still few easy-to-use smart wearable products, and the situation of the elderly is very complicated. The existing smart devices cannot meet the different needs of the elderly. Intelligent technology can help the elderly in many ways, and it is worth researching and developing.

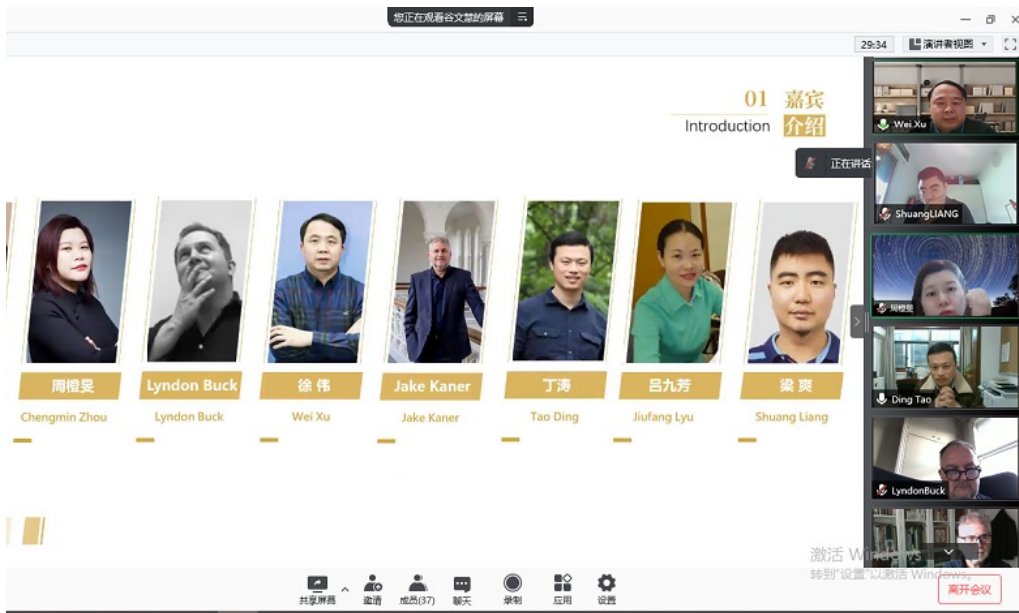
Q3: What healthcare services are currently available in nursing homes?

Answer: There are three main service models in nursing homes, daycare, long-term care, and disability care. Daycare centres are suitable for the elderly with mild disabilities. This group of older people cannot take care of themselves at home and needs to be sent to the daycare centre by their family members every day for simple meals and healthcare; Long-term care is to help meet the medical and non-medical needs of older people with a chronic illness or disability. Disability care is to provide practical help from everyday tasks to complex needs.

8.4 Interview 3: Prof. Jake Kaner from Nottingham Trent University, UK

On November 8-12, 2021, I and Prof. Zhou Chengmin organized an international workshop about ecological health design and engineering. In the workshop, I interviewed professors from Nottingham Trent University and Aston University, UK.

Fig.8.2
International
workshop: ecological
health design and
engineering



Professor Jake Kaner is the associate dean for research in the School of Art and Design. He is responsible for all research activities in the school. Professor Kaner's research interests cover design for ageing and well-being, post-industrial digital archives, and art and design materials. His current research areas are smart habitat for the elderly,



Fig.8.3
Online meeting with
Prof. Jake Kaner

intelligent furniture and sensory materials. He has been awarded funding from the AHRC, Erasmus +KA2/3, EU URBACT. He is also the editor of working group 1: Furniture and Habitat Industries in the European Sheldon project (Fig.8.3).

Q1: What is your opinion on the smart healthcare service system?

Answer: I think it is a good idea. We are working on it. You know. Sheldon is a multidisciplinary network supported by the COST Association to support the development of solutions that allow older persons to live safely, comfortably, and healthily at home through integrating design, ICT, ergonomics and health knowledge into furniture and building design. The smart service system is a future development trend. It is worth studying.

Q2: If we need to build a smart healthcare service system, what problems do you think we will face?

Answer: It requires strong leadership, and it requires you have a much better chance of achieving it. I mean, in the west, there are much more berries. As well you know, this kind of service system may be so commercial. There is a lack of trust. If you connect older people with hospitals, do they really want to share data to hospitals? I am not sure. During the process, the government may be critical. We (Sheld-on) are close to completion of our project tasks and are working on our final document, a white paper of recommendations to policymakers. In my opinion, I think building a smart healthcare service system is too difficult for you alone, and it requires the joint efforts of a team. According to your design, the digital platform is the core of your system. The platform can connect the elderly and service providers. It would be best if you thought about making the platform more age-friendly. This is the reason why older people are willing to use your platform. You also can give a design guideline. Operators of other healthcare service platforms can use your guideline to make their platforms much age-friendly.

Q3: Do you think China should develop a smart healthcare service system? In China, there are many new cities and new satellite towns. Local governments are building a smart city based on IoT and 5G. Governments hope to use different types of electronic methods and sensors to collect specific data to improve the operations across the city, to optimize the efficiency of city operations and services and connect to citizens.

Answer: It is an ideal insinuation, so in theory that China should advance much faster than the West, I mean maybe. In UK, a lot of cities are old. It needs to take a long time to improve it. But in China, I know, it is fast. You can build a building or a bridge in one month. It is incredible. There are indeed many opportunities to develop the smart healthcare service system in China, especially in some new cities.

Q4: What challenges have arisen?

Answer: Firstly, the adoption of technology by the older user is an issue.

Acceptance of technologies by older persons is challenging. Some older people do not like to use new technology. Covid-19 has halted progress and reduced participation. For us, we have to rethink networking tools. We also lack the collaborative effort to create smart solutions. Of course, modifying objectives has become a new normal.

8.5 Interview 4: Prof. Lyndon Buck from Aston University, UK

Prof. Lyndon Buck is a senior teaching fellow from Aston University. He works at the College of Engineering and Physical Sciences. He focuses on product design modelling and prototyping technologies.

Q1: Do you have any suggestions for the architecture of this smart healthcare service system?

Answer: The system you design is based on the architecture of IoT. It is a general architecture with 3-4 stages. The architecture is a system of numerous elements, digital sensors, protocols, cloud services, et al. This system is technically feasible, but you also need to consider the organizational structure of this system. It requires the support and cooperation of a large number of stakeholders. You can focus on a more detailed aspect of your smart system to complete it, for example, an age-friendly platform.

Q2: What can I do for an age-friendly digital healthcare service platform?

Answer: Many digital healthcare service platforms are currently not explicitly designed for the elderly. This makes it difficult for the elderly to use. It is necessary to improve the existing digital platforms. I think you can provide a design guideline and tell platform operators how to make their platform more age-friendly.

Q3: What technologies are currently used in digital devices, such as wearable devices?

Answer: Wearable devices can be divided into on-body devices and off-body devices. On-body devices are just like smartwatches or glasses. Off-body devices are fixed sensors or mobile phones. There are a lot of smart devices that are being used by the elderly, such as smartwatches, smart speakers, smart locks. Many researchers develop wearable devices by using Arduino. It is an open-source electronic prototyping platform enabling users to create interactive electronic objects. It is not very difficult for designers. You need to understand the knowledge about IoT and sensors. Then you can develop your prototype.

Q4: The smart system includes many wearable devices in the first layer. How to test a wearable device designed for the elderly?

Answer: We have a good relationship with some hospitals or nursing homes, so we can take our wearable devices to hospitals to do some tests. It is not difficult, but due to the pandemic, we have to stop our activities at present. We now test these devices at our laboratory.

8.6 Interview 5: a doctor from the Careggi University Hospital, Italy

Dr. Camilla Tozzetti is a doctor who works for the Careggi University Hospital. She needs to deal with patients almost every day and often works with doctors specialising in hygiene and health management.

Q1: Do elderly people in Italy use digital platforms to receive healthcare services?

Answer: Yes. I can give you an example. Due to covid-19, everyone needs to make an appointment to get vaccinated. As far as I know, in Italy, most older people complete their appointments through digital platforms. Older people who do not know how to use digital platforms or lack digital skills can seek help from a family doctor. Family doctors can help these older people make appointments. The digital platform is very useful.

Q2: What are you think for a digital healthcare service platform is particularly important?

Answer: I understand that you aim to organize a digital system or platform to facilitate contacts between the elderly population and hospitals. In fact, in Italy, family doctors are doing this work. As you said, people generally do not have a family doctor in China. When older people need to see a doctor, they go directly to a hospital. They will tell the doctor about their past medical history and related medical information. It may be difficult for some older people to describe this information accurately. Therefore, you want to solve this problem through a digital platform. The core of your research is to help the elderly contact the hospital to obtain some basic medical information. I think a medical memorandum or an electronic health record is critical.

Q3: How can this design guide play a critical role in the digital healthcare service platform?

Answer: According to your study, I believe that the design guideline should advise platform operators to keep track of the medical information of the elderly. First, older people should be encouraged to upload their personal information and past medical history onto a digital platform in order to create an electronic health record. This is very important for doctors. As a doctor, I need to know an older person's past medical history, allergies, and other medical information. Otherwise, I am unable to make an accurate diagnosis. With the help of digital platforms, the elderly can obtain electronic health records. Wherever an older person is, doctors can obtain his/her medical information through the digital medical card. This is a huge benefit to the elderly and doctors. As a result, a digital healthcare service platform can follow your guidelines to record the medical information of the elderly. However, elderly people may not be able to enter their information on their own, so you need to consider who can assist the elderly in completing this task, and this person must also have medical knowledge. Physicians and nurses from the community may be available.

Q4: For the elderly without children or those who lack digital skills, how should they use this digital platform?

Answer: This is indeed a problem. It is necessary to consider older people who live in remote areas, older adults who have no children, and

those who do not even have a computer or mobile phone. It would help if you thought about who can help them. In Italy, these elderly people can turn to family doctors or doctors from ASL (Azienda Sanitaria Locale). In China, community physicians, nurses, or neighbours may be able to help them get healthcare services provided by digital platforms.

Q5: At present, many elderly people still lack digital skills and have not yet developed the habit of using digital platforms. What is the value of the digital platform?

Answer: Yes. Many elderly people do not use these complex digital platforms, but this does not mean that the new generations of older people will not use them. Now many middle-aged people have mastered digital skills and often use digital applications. Ten years later, these problems will be resolved when they get older. Your research can be a smart healthcare service system for new generations of older people. Your research is also necessary and valuable.

8.7 Conclusion

The professors believe that the smart healthcare service system is China's future development trend. With the widespread use of digital healthcare service platforms, professors believe that the elderly indeed encounter many digital problems. Many digital platforms are aware of this situation, but they sometimes do not know how to improve their healthcare platform. Because changes in service delivery may bring changes in their income, organizational structure, number of employees and investments. This is a complex system, but design can still play an important role in improving the digital experience of older adults. This is an interesting and important research direction that a Chinese researcher should focus on. Experts believe that the effectiveness and impact of improving only one healthcare service platform is limited. It is better to provide a design guideline that can help almost all platform operators improve their existing digital platforms.

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Part III Research answers

There are four research questions in the third part. Two investigations and a case study help answer these questions. Based on the answers, experts give me some suggestions for further research.

Investigation 1 answers RQ7. This smart healthcare service system aims to meet the service needs of the elderly and enhance their service experience. As the core, this digital platform connects the elderly and service providers. In investigation 1, I put forward a plan to connect the elderly and children in remote areas. Through the organisation of digital platforms, the elderly can provide informal educational activities for those children. This improves the social participation of the elderly and helps them overcome their loneliness. The social practice helps verify the feasibility of a digital platform to provide healthcare services for the elderly. With the help of the laboratory director and researchers, the architecture of the smart healthcare service system is evaluated and improved.

In investigation 2, we interviewed and investigated 39 elderly people, and gather basic information and healthcare service needs of the elderly by using questionnaires, interviews, direct observation, usability testing, and other methods. Older people are divided into three user groups (the primary users, secondary users, and the non-targeted customers). By analysing their healthcare service demands and the problems they meet in receiving digital healthcare services, the pain points can be obtained. This provides the answers to RQ8. The result of usability testing answers RQ9. This investigation confirms that some of the problems that prevent older people from using a digital healthcare platform are caused by the lack of age-friendly design on platforms. Therefore, it is important to consider how to improve the design and service process of a digital healthcare service platform so that the digital platform can be better used by the elderly.

In order to answer RQ9 and RQ10, in the case study, I analyse the service contents and functions of the Internet hospital. All online healthcare services are based on offline services provided by the hospital. In order to improve the online service, I also need to describe the work process of outpatient service and emergency medical services in Nanjing Drum Tower Hospital. The digital healthcare service platform can provide

PART III : EXPERIMENTAL RESEARCH

people with many services, such as online follow-up consultation, health consultation, electronic prescription etc. By analysing the functions and services of the Internet hospital, I find the disadvantages of the digital platform. The digital platform is aimed at users of all ages and lacks a Senior's Version. Therefore, the design, interaction method and service process of the platform are not friendly enough for the elderly. For example, the page layout is too complicated to process. The size of fonts and buttons are too small, and it is difficult for the elderly to read the information. Some services on digital platforms are also not available. These problems cause the elderly to refuse to use this digital platform. It is necessary to have a Senior's Version of digital healthcare platform.

Hospital administrators and professors came to a consistent conclusion in the expert interviews. They think that receiving healthcare services through digital platforms has become a trend. Elderly people have not yet developed the habit due to the lack digital skills, and at the same time, digital platforms are not enough use-friendly. Therefore, it is necessary to improve digital platforms and make them more age-friendly. Following the advice of experts, it is better to provide a design guideline that can help almost all platform operators improve their existing digital platforms. I need to make a design contribution to the digital healthcare service platform.

PART IV

**PROJECT
RESEARCH**

CHAPTER 9

**DESIGN GUIDELINES OF DIGITAL
HEALTHCARE SERVICE PLATFORMS
FOR THE ELDERLY**

Part IV— Research questions

RQ11 How should a digital healthcare service platform for the elderly be designed?

RQ12 How to evaluate whether a digital platform is age-friendly?

The experimental research confirms the value of developing the design guidelines of digital healthcare service platforms for the elderly. Based on the key principles of User Interface (UI) design, User Experience (UX) Design, and service design, the guideline can be developed. It consists of six parts of design principles, evaluation mechanisms and empirical research. The research from Part 1 to Part 6 can guide the design of a digital healthcare platform, which gives a clear answer to RQ11. Part 7 (evaluation mechanisms) provides some evaluation tools and a checklist. The checklist that includes all design principles can be used as evaluation criteria. These studies can answer RQ12. Empirical research is used to verify the effectiveness of design principles and evaluation mechanisms.

La ricerca sperimentale conferma il valore che assume lo sviluppo delle linee guida progettuali per le piattaforme di servizi sanitari digitali per gli anziani. Sulla base dei principi chiave per la progettazione dell'interfaccia utente (UI), dell'esperienza utente (UX) e per la progettazione dei servizi, è possibile sviluppare una linea guida per le piattaforme digitali. Ogni piattaforma si compone di sei parti inerenti ai principi di progettazione, ai meccanismi di valutazione e ricerca empirica. La ricerca, che inizia dalla Parte 1 che si conclude nella Parte 6, può guidare la progettazione di una piattaforma sanitaria digitale, in grado di fornire una risposta chiara alla RQ11. La parte 7 (inerente ai meccanismi di valutazione) fornisce alcuni strumenti di stima, oltre che una checklist. La checklist, che include tutti i principi di progettazione, può essere utilizzata come criterio di valutazione. Questi studi possono rispondere così alla RQ12. La ricerca empirica viene utilizzata per verificare l'efficacia dei principi di progettazione e dei meccanismi di valutazione.



CHAPTER 9

DESIGN GUIDELINES OF DIGITAL HEALTHCARE SERVICE PLATFORMS FOR THE ELDERLY

- 9.1 Introduction
- 9.2 Framework
- 9.3 Manual
- 9.4 Part 1: User interface with understandable and perceivable information
- 9.5 Part 2: Digital interaction
- 9.6 Part 3: Design patterns
- 9.7 Part 4: Accessibility
- 9.8 Part 5: Service scenario
- 9.9 Part 6: Multi-channel learning
- 9.10 Part 7: Evaluation mechanisms
- 9.11 Empirical research
- 9.12 Conclusion

References

Part IV Research Answers

9.1 Introduction

Many hospitals, nursing homes, and the healthcare industry have established digital platforms to improve operational efficiency due to the development and implementation of digital technology. Digital platforms, as a crucial component of digital transformation, create an online area for transactions and interaction between a company and its customers. Although older adults have access to digital platforms, many of them struggle to understand and accept digital tools and services, resulting in a digital divide in their daily lives.

There are currently three types of digital divides: the first one is access to technology (whether older adults can get access to digital platforms and services); the second one is the ability to use digital technology (whether older adults can use digital platforms and tools); the third one is the results and effects of the use of digital technology (whether older adults can solve their problems and achieve their goals with the help of digital platforms) (Attewell, 2001; Van Deursen & Helsper, 2015; Wei et al., 2011).

Older adults often utilize internet-related smartphone capabilities like emailing and surfing, but just a small percentage use smartphones to access public services like the National Health Service. Despite widespread smartphone adoption, one possible reason for the elderly's restricted usage of specialized digital services is that their prior professions may have been marked by low IT intensity, resulting in less exploratory IT behaviour when they retire (Rockmann et al., 2018; Vassilakopoulou & Hustad, 2021).

Another practical reason is that these digital healthcare platforms were planned and built for everyone, not just for the elderly. Therefore, older people find it difficult to use these digital platforms. The General Office of the State Council of China issued a national policy 'Implementation Plan for Practically Solving Difficulties of the Older People in Using Intelligent Technology' in 2020. This strategy aims to address the issues that elderly people confront when adopting smart technology. Optimizing the online healthcare service platform for the aged and improving the health management service system for the elderly are two essential elements of this approach (State Council General Office, 2020). In 2021, the Ministry of Industry and Information Technology of China announced another plan — 'Special Action to Make Internet Applications

Elderly-Oriented and Barrier-Free' (MIT, 2021). The goal is to deal with the difficulties encountered by the elderly when they use Internet APPs or digital platforms.

Although web accessibility guidelines for older users have been published, there are few studies on the design guidelines of digital healthcare service platforms for the elderly. This guideline aims to make digital platforms more age-friendly to increase older adults' participation opportunities and address the challenges they face when using digital platforms so that they can take advantage of the services and convenience that digital healthcare service platforms offer. This guideline proposes translating the research and design principles into practical steps for each healthcare service platform. The design guidelines can be used to help build and improve a digital healthcare service platform for the elderly.

9.2 Framework

The level of physical function, learning ability and logical ability of older people decline with age. The elderly-oriented design is significant for a digital healthcare service platform and application. Age-friendly digital platforms should be easy to learn, use, and understand. This guideline offers recommendations on applying design principles to provide a positive user experience of digital platforms.

The design guidelines include seven parts:

Part 1 describes design principles of the user interface (UI) with understandable and perceivable information.

Part 2 presents the way of human-computer interaction with user interface (UI) components.

Part 3 describes the design patterns of an age-friendly digital platform.

Part 4 highlights digital inclusion and accessibility for older people with different disabilities.

Part 5 summarizes digital healthcare service scenarios, especially in a hospital.

Part 6 provides multi-channel learning methods for the elderly.

Part 7 gives an evaluation mechanism to help designers or policymakers evaluate their digital healthcare service platforms.

With the help of these design guidelines, a digital platform can become age-friendly and user-friendly.

9.3 Manual

The goal of this manual is to explain how to use the design principles to various stakeholders. This guideline is divided into seven sections and includes one empirical research. Some parts are tailored to the needs of relevant stakeholders. Stakeholders in the digital healthcare platform can employ a single part or a combination of parts depending on their needs. This guideline offers design principles, evaluation tools, a checklist, and empirical research to assist stakeholders in evaluating digital health care platforms, creating compelling designs, and ultimately meeting and exceeding the needs of older users.

9.3.1 Target users

The target users of this design guideline are mainly medical institutions, digital platform operators, designers, governments, private healthcare service providers, healthcare organizations, etc. At present, a large number of medical institutions have established a digital healthcare service platform, but they lack a senior version of the digital platform. This guideline can help healthcare organizations improve their digital platforms.

The design principles provided in Part 1 to Part 2 can be applied to improve the experience of older users. Part 3 provides recommendations on the availability of digital platforms on various digital devices. Medical institutions can improve their platforms' digital inclusion and accessibility according to the suggestions in Part 4. Part 5 is to transform offline services into online services, and the digital service scenario is the digital twin of the real-life scenario. Through digital transformation, the elderly can more readily accept online services. Part 6 is primarily designed for medical institutions. Due to the lack of digital skills, it is necessary to provide more opportunities for the elderly to learn how to use digital platforms. It is not enough for the elderly to master this skill only through instructional videos. They need instant interaction and feedback. Therefore, multi-channel learning is significant. Evaluation mechanisms in Part 7 include some tools used throughout the digital platform design process.

The design of a digital platform includes interaction design, system design, service design, UI design, user experience design, etc. Designers

of different career fields only need to refer to the relevant content in this design guideline. For example, UI designers only need to follow the advice of Part 1 and Part 3. Interaction designers only need to refer to the design guidelines of Part 2 and Part 4. Governments are not responsible for the specific design process, but they can use the tools in Part 7 to assess whether a digital health care platform is age-friendly.

9.3.2 How to evaluate the user interface of a digital healthcare service platform for elderly

This guide provides two methods to evaluate the user interface. The first method is heuristic evaluation. It is based on the rules set by Part 1, Part 2 and part 7. Part 1 and Part 2 mainly evaluate the visual design and interaction design of the user interface. In the checklist, the two parts have 72 evaluation indicators. Evaluators can use these indicators to evaluate the user interface. Based on each indicator, evaluators can assess whether the digital platform meets the evaluation criteria and then select an option from poor, medium, and good. Indicators with low scores indicate that older users may meet difficulties here. This approach can help evaluators identify UI problems on a digital platform. Evaluators can refer to the application case in empirical research (9.11.1 Evolution of a case). The wireframes in Part 7 can show the connection among all pages and help demonstrate which interface elements need to exist on a page. Evaluators can use it to simulate a task flow to assess the interactive complexity of a digital healthcare platform.

Another method is empirical evaluation. Evaluators can invite an older person to participate in a test and let the elderly user complete a task by using the digital healthcare platform. In this process, usability evaluation methods, such as think-aloud or the pluralistic walkthrough, can be used to identify usability issues in a digital healthcare platform. User testing in empirical research shows the details of the evaluation.

9.3.3 How to evaluate the user experience of elderly people

The best and most direct way is to survey older users and get their feedback. Appendix 2 provides a survey with an interview and usability testing. The survey aims to find what problems older people encounter

when using the digital healthcare service platform. First, the purpose of a brief interview with older people is to understand their basic situation and views on digital healthcare services. Then, they can be invited to participate in a thinking aloud test. They can try to schedule and receive a healthcare service provided by a digital healthcare platform. In the process, they can say whatever comes into their mind. This might include what they are looking at, thinking, doing, and feeling. At the same time, observers need to take notes of what older users say and do, and the task completion time. The whole test needs to be video recorded so that developers can go back and refer to what older users did and how they reacted. After the test, older users are advised to fill out a short user satisfaction survey. They need to describe the problems they encounter, alternative solutions and their evaluation of the services provided by this digital platform. When analysing the evaluation results, evaluators need to calculate the task success rate and the error rate. These metrics can help evaluate the user experience of the elderly.

The checklist can also be used to evaluate the user experience of the elderly. After the elderly complete the test, they can score all the indicators in this checklist. Indicators with lower scores indicate that the elderly had a terrible experience. These test results can help platform operators or designers to improve and optimize digital platform interactions and services.

9.3.4 How to design an age-friendly digital healthcare service platform

This design guideline provides a complete methodology. As mentioned above, it can be used as a design reference to help stakeholders evaluate and improve their digital health care service platform. When stakeholders need to build a new digital health care platform, this design guideline is a valuable and helpful reference. At the initial stage, the stakeholder map and ecosystem map in part 7 can be used to analyze stakeholders and find service opportunities. In the design phase, the wireframes can help analyze the connection among all pages and optimize the structure of the digital platform. The service roadmap, the user journey map, and the system map can visualize the healthcare service process from different perspectives and help stakeholders discover problems in the service process. Following this design guideline, an initial version of the digital healthcare service platform can be completed. During the

evaluation phase, the service prototype can be used to simulate a real interaction with different touchpoints. User testing can help understand real feedback from older users. Designers can continuously optimize and improve a digital platform based on the collected problems. With constant iteration, the digital healthcare service platform can become more age-friendly.

9.3.5 Summary

The guideline is designed for private institutions and public organizations, such as designers, medical institution, governments, hospitals, and other stakeholders who want to make their digital healthcare service platform more age-friendly. Designers or policymakers working on digital healthcare service platforms can use the guide as a reference standard. This guideline describes older adults' challenges while they use digital platforms. Each part contains design tools and methods that can help designers think about and solve the problems that older adults face. In the evaluation stage, design tools and a checklist can help designers or organizers evaluate and improve their digital healthcare service platform. User experience is significant. Designers or organizers can involve elderly users in the design phase of digital platforms. By explaining how the checklist reflects their personal experiences, elderly users can help evaluate a digital platform and make suggestions for improvement. Other stakeholders can benefit from these tools as well. This guideline can assist various stakeholders in identifying problems in their digital healthcare service platforms and determining where and how the platform can become more age-friendly.

9.4 Part 1: User interface with understandable and perceivable information

Performance expectancy was the primary use driver among senior citizens (Niehaves & Plattfaut, 2014). How information is presented on a digital healthcare service platform affects whether older adults are willing to use this information platform. A complicated design can make the elderly lose confidence. Due to physical and psychological factors, older people have relatively special characteristics of information exchange and language communication and usually have special requirements for the form of information presentation. Older people are accustomed to communication by word of mouth. Therefore, the information presentation methods need to focus on following characteristics.

9.4.1 Understandable information

9.4.1.1 Readable

- Digital healthcare service platforms need to be easy for elderly users to understand and operate, with simple functions. The page can directly show what healthcare services the elderly can get (Ministry of Industry and Information Technology of the People's Republic China, 2021).
- The expression of medical information should be simple, do not require the elderly to have background knowledge, do not use technical jargon (medical terminology) and system-oriented terms, and use understandable and readable text content (World Wide Web Consortium, 2018).
- On the digital platform, the elderly can choose the language they are familiar with.
- Digital platforms should provide subtitles for video or audio due to decreased hearing of elderly people.
- Captchas should be simplified to avoid characters and graphics that are difficult for the elderly to understand. Effective alternatives (such as repeatable audio captcha) can be used. It should also be designed according to the ability of the elderly.

- Information needs to be presented in a predictable order.
- When elderly people use digital platforms for the first time, the beginner's guide is important and can help older people learn how to use main functions (Hawthorn, 2006).
- All medical information needs to avoid the possibility of causing psychological stress to older people.
- Digital platforms should provide labels or instructions when older users are required to input contents.

9.4.1.2 Consistent identification

- A digital platform's overall look and feel should be similar across all pages, but this does not mean every page follows the same layout (Hart et al., 2008).
- All the repeating elements keep the same. Typefaces, backgrounds, colour schemes, and encouraging tone can be consistent, which can positively impact older people's experiences (World Wide Web Consortium, 2018).
- Visual consistency: all visual elements stay the same throughout the digital platform (Fig.9.1).
- Functional consistency: components with the same function keep the same form (Fig.9.2).
- Internal consistency: the visual and functional elements are shown in the same place (Fig.9.3).
- External consistency: icons should follow the existing platforms and cultural conventions.
- Real-world consistency: icons, words, and pictures should keep consistent with real-world experiences, observations, and perceptions. Older people can feel it is easier to understand and find the healthcare services they need.

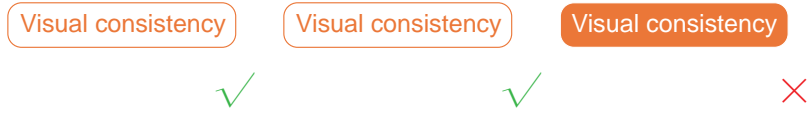


Fig.9.1 Visual consistency

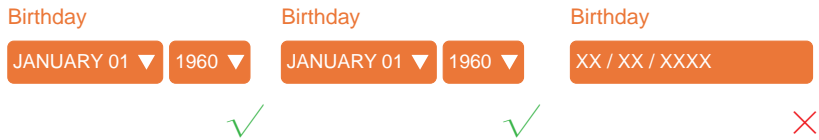


Fig.9.2 Functional consistency

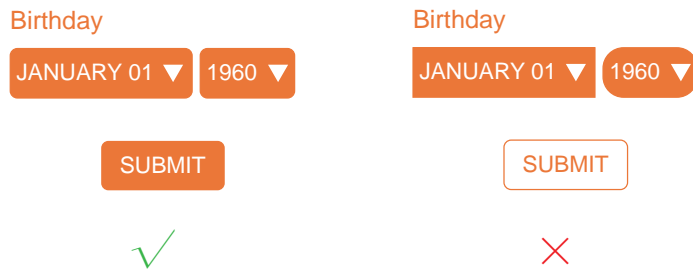


Fig.9.3 Internal consistency

9.4.2 Perceivable information

9.4.2.1 Text style

- Larger sans-serif fonts are recommended. Condensed fonts should be avoided (Fig.9.4) (Bernard et al., 2001).
- Do not use too many font types. The number of font types is limited to two at most. If there are two fonts on a web page, the two fonts must be in harmony (Fig.9.5).
- Using all capital letters can lead to higher levels of eyestrain and decreased readability.
- Fonts too similar can make text illegible, so each letter should have a distinctive shape (Fig.9.6 a). Letters that are airy and open are less likely to blur into closed shapes (Fig.9.6 b). Distinguishable beginnings and endings of letters help the eye recognize individual forms (Fig.9.6 c). Body text requires some contrast within letterform stroke width but should not go too far where certain strokes begin to disappear (Fig.9.6 d) (DeVos, 2021).

Fig.9.4
Sans-serif fonts

Sans-serif fonts

Sans-serif fonts
are recommended.

无衬线字体被推荐



Serif fonts

Serif fonts are not
recommended.

衬线字体不被推荐



Don't
use
too
many
font
types



Don't
use
too
many
font
types



Fig.9.5
Up to two font types

iILLI

BODONI



iILLI

TAHOMA



IILL

STENCIL



IILL

PERPETUA



Fig.9.6 a
Easily distinguishable
letters

C

BERLIN



S

CONSOLAS



C

COURIER



S

BRITANNIC



Fig.9.6 b
Easily distinguishable
letters

jaf

BERLIN



jaf

BOOKMAN



jaf

ACUMIN



jaf

BAHNSCHRIFT



Fig.9.6 c
Easily distinguishable
letters

Ags



Ags



Ags



Fig.9.6 d
Easily distinguishable
letters

9.4.2.2 Font size

- The font size depends on the distance between the reader and the screen. The font size in the main function and the main interface should be larger than 30 dp/pt. The font size of the main content area of a page should be not less than 18 dp/pt. This can ensure that older people have a pleasant and legible reading experience (Fig.9.7) (Dickinson et al., 2007; Abegaz et al., 2015).

- If possible, older people can adjust text size themselves (Fig.9.8).

- The number of letters on a line can contribute to the reader's fatigue, making sure line lengths are no more than 65 characters per line (Kamollimsakul, 2016).

9.4.2.3 Colour

- According to recommendations from the handbook of computer-human interaction, digital platforms can use a maximum of five (plus or minus two) different colours (Helander, 2014)

- Older users can have a better reading performance, if the platform uses black texts on a white background (Schaie & Willis, 2010).

- The colour sensitivity of older people experiences a decline with age, and they become worse at distinguishing between similar colours, especially in the blue and green range (Helve & Krause, 1972). Important interface elements should avoid using the two colours. Warm colours are better choices than other colours.

- High contrast can make the text much more readable on a device. The contrast ratio between text, images, icons and other elements is at least 4.5:1. It would be best to stay over 6.7:1 (Fig.9.9). If the font size is larger than 18 dp/pt, the contrast is at least 3:1 (Interaction design foundation, 2021; Alibaba, 2021). The line spacing in a paragraph is at least 1.5 lines. Some online tools can help test whether the contrast meets the standard of WCAG (Web Content Accessibility Guideline 2.0), such as WebAIM's Color Contrast Checker, Contrast-ratio, and EightShapes Contrast Grid, and Color Tool (World Wide Web Consortium, 2018).

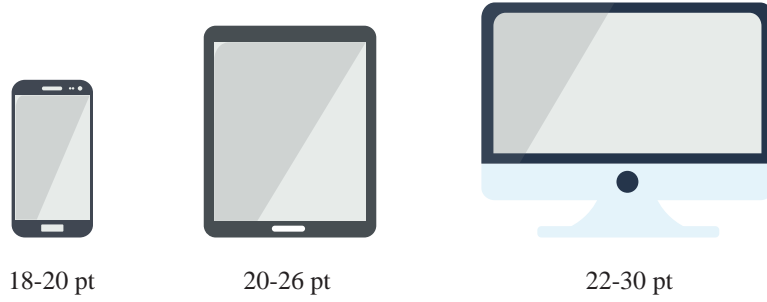


Fig.9.7
Front size

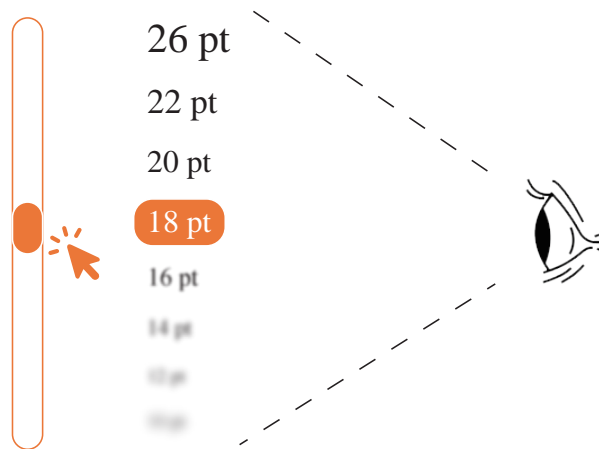


Fig.9.8
Text size

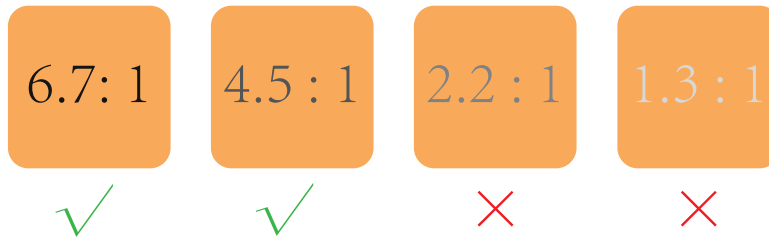


Fig.9.9
Contrast ratio

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- The movement and stroboscopic rate of dynamic visual elements should also be appropriately reduced.
- According to the order of physical memory, colours take precedence over graphics. Using the same colour for the same service can make services easier to identify. By adding attributes of colour, elderly people can easily have access to services every time.
- Colours are often used to communicate information such as errors, interactivity, etc. Textual explanations are helpful as a supplement of colour coding, as older people with colour blindness could understand.

9.4.3 Layout

- In the layout of digital platforms, the functions that the elderly frequently use should be given priority. All information should maintain high discoverability. A practical layout can avoid dividing users' attention between multiple tasks or parts (Hawthorn, 2000).
- The layout should use flat design, be as simple as possible, and avoid complicated decorative designs such as shadows, perspectives, and textures.
- Undo and return buttons should be available and easy to access.
- A search bar near the top of a digital platform is helpful.
- Each information area of a digital platform introduces healthcare service types and content gradually over time instead of all at once.
- Each service is distinguished by different colours and provides corresponding voice.
- Concrete icons or realistic pictures are easier to understand for the elderly than abstract icons. An icon should be accompanied by descriptive text as much as possible. Verb phrases are easier to understand than noun phrases.
- Small buttons should be avoided. There should be sufficient spacing between buttons to prevent accidental presses and touches.

- Due to spatial and working memory decline, elderly people are more likely to get lost while navigating, so a digital healthcare service platform should avoid a very deep hierarchy. The structure of primary navigation keeps simple (Hawthorn, 2000).

9.4.4 Region's cultural norms

- The use of governmental e-services can be improved by making them more engaging, interactive, and personal to address country or region cultural norms (Zhao et al., 2014). Each digital platform can choose a suitable information presentation method to highlight the local cultural characteristics and norms.
- Cultural inclusion is critical, and all information should not discriminate and urge the elderly.

9.5 Part 2: Digital interaction

Due to the cognitive differences of the elderly, the operating procedure of a healthcare service platform is better to keep consistent with routine operations of the elderly users. For them, the most important thing is to seek help and healthcare services without any problems while using the digital platform. If they find the use and interaction is too complex, there is a high possibility that they will stop using it. The complexities and some errors that might make the use of digital platforms hard should be avoided (Pollini et al., 2022).

9.5.1 Motor control

With age, the muscles and responsiveness of elderly people are not as strong as before. The method of operation should be as simple as possible, avoiding complex interaction.

- For elderly people with relatively normal manual dexterity, a button size of 16.51 mm square and spacing of 3.17 mm to 6.35 mm are acceptable. For elderly people with poor manual dexterity, a button size should be at least 19.05 mm square and a larger spacing, from 6.35 mm to 12.7 mm, are appropriate. Buttons to be clicked should be at least 9.6 mm

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diagonally (40×40 dp/pt). Interface elements should be at least 11 mm diagonally (60×60 dp/pt) (Jin et al., 2007).

- Important reminders or icons should be enlarged proportionally (Fig.9.10). Clicking is the most straightforward operation for the elderly and is better than sliding (Alibaba, 2021).

- For older users, tabbing is better design than drag and drop actions, voice call, slow motion interface (Al-Razgan et al., 2012).

- The slow movement and shakes of fingers could reduce the success of gesture interaction, so gestures with multiple fingers should be avoided (Fig.9.11).

- The digital platform can provide a large cursor for older people with low vision (Fig.9.12).

- In touch screens, an option of zooming or magnification is not the best solution, because elderly users need to use two fingers (Chung et al, 2011).

- The audio or video on a digital healthcare service platform should include clear and familiar playback controls to allow older users to understand how to control it.

- For the elderly, inputting is a complicated operation, and it is better to provide more default options. In each step, it just needs to focus on one chief function (De Barrosa et al, 2014).

- Typing was a source of difficulty for many older users. Alternative methods should be provided. If an older adult has to type, a touchscreen keypad may be a better choice (Chung et al, 2010).

- When elderly people log in to digital platforms, fingerprint login or face login are better methods, which can prevent them from forgetting the account and password.

- If older users need to submit information, some methods of error prevention need to be used. For example, submissions are reversible; Information should be checked for input errors and older users can have

an opportunity to correct them; A mechanism is available for reviewing, confirming, and correcting information before submission (World Wide Web Consortium, 2018).

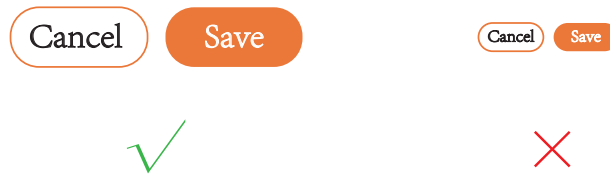


Fig.9.10 Large buttons

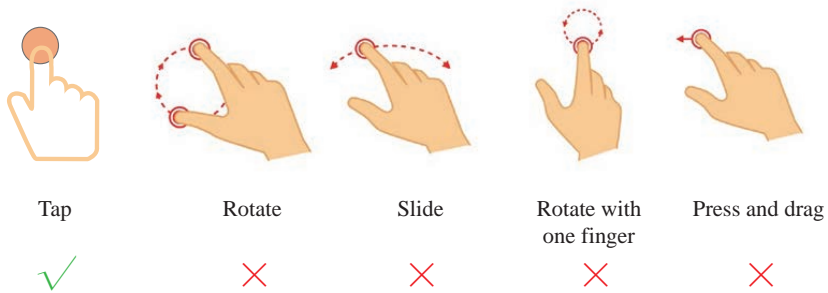


Fig.9.11 Avoid using these gesture interactions. From: Maryam (2021)



Fig.9.12 Large cursor

9.5.2 Navigation

- The navigational structure and menu headings of digital platforms should be simple. Designers should minimize sublevels in navigation and keep menus to a single function (Dickinson et al., 2007).
- Breadcrumb navigation is a way for older users to visualize their location on a digital platform, and it should be clear and prominent on every page so that elderly users can navigate easily back and forth or return to a page they are familiar with (Gossen et al., 2013).
- When elderly people focus on each functional module through the mouse, keyboard or other means, the module should have noticeable changes.
- Before the next step, elderly users need to be given effective prompts. When elderly people use contextual or other related functions, the digital platform should have significant operation guidance with text or picture, introduce these functions and services.
- Use the home screen menu as a safe point of return (De Barrosa et al., 2014).
- It is necessary to include a search bar with voice search so older people can search by voice (Fig.9.13). The exact keywords related to the search query should be provided (Käki & Aula, 2005).

Fig.9.13
Search bar with
voice search



9.5.3 Physical Limitations

- Clear feedback on progress and reminders of the end goal can help older users overcome memory issues (Hawthorn, 2006).
- The cognitive ability, vision, and hearing of elderly people become weaker than before, and the speed at which they process information and perform tasks slows, so they need more operation time without the time limit of server timeouts and inactivity warnings.
- Gradually introducing healthcare services can help prevent cognitive overload from slower mental processing speeds in the elderly population.
- Healthcare service processes should be completed within the same screen as much as possible, rather than multiple screens.
- Reminders and tooltips can make some actions more age-friendly.
- Avoid using only colour as a means of reminder. Text or voice are also effective alternatives.
- Procedures can be simplified by reducing unnecessary steps and minimizing the number of actions (Fig.9.14).

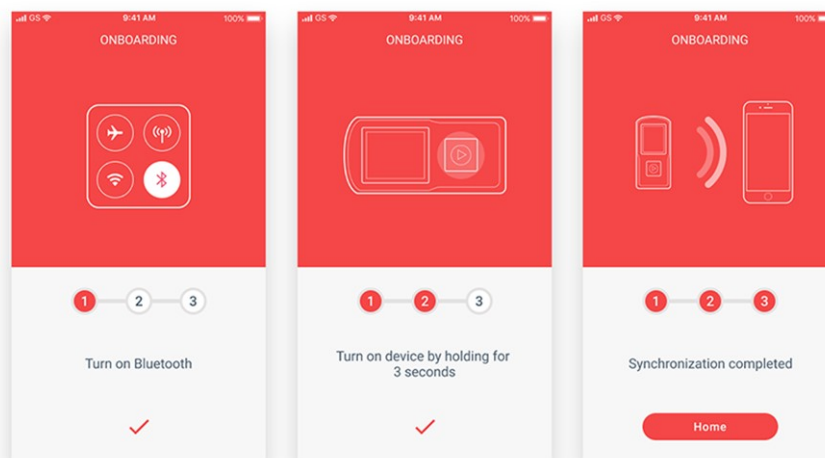


Fig.9.14
A simplified
procedure. From:
Sonohealth (2021)

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- Emotional support based on patience, praise, encouragement and comfort can help the elderly avoid anxiety and stress from digital devices or services (Xiong and Zuo 2019).
- After each step is completed, the system should encourage the elderly to have a positive attitude and confidence to complete the remaining steps.
- In healthcare service platforms, elderly people can establish contact with family doctors, adult children, hospitals, community care workers, etc.

9.5.4 Experience with technology

- Timely information feedback is essential because it can increase user stickiness and retention.
- Smart wearable devices of older people can be connected to the digital platform, which can collect and analyse data and provide some health advice. These suggestions are helpful to the elderly.
- Haptic, visual, and aural feedback can help older people confirm whether the operation is completed successfully (Lee, et al., 2009, September).

9.5.5 Distractions

- Unnecessary design elements could overwhelm older people and make it more challenging to accomplish what they are trying to accomplish.
- Graphics can be added only to help elderly users complete a task.

9.6 Part 3: Design patterns

9.6.1 Responsive design

- Contents of digital healthcare service platforms can be automatically resized and reshuffled to fit the dimensions of different devices. It can be accomplished with HTML templates or a mobile site.

Design guidelines of digital healthcare service platforms for the elderly

- The hamburger menu in the top corner is helpful for a mobile site (Fig.9.15).
- Illustrations or icons should use scalable vector graphics (SVGs) (Fig.9.16).

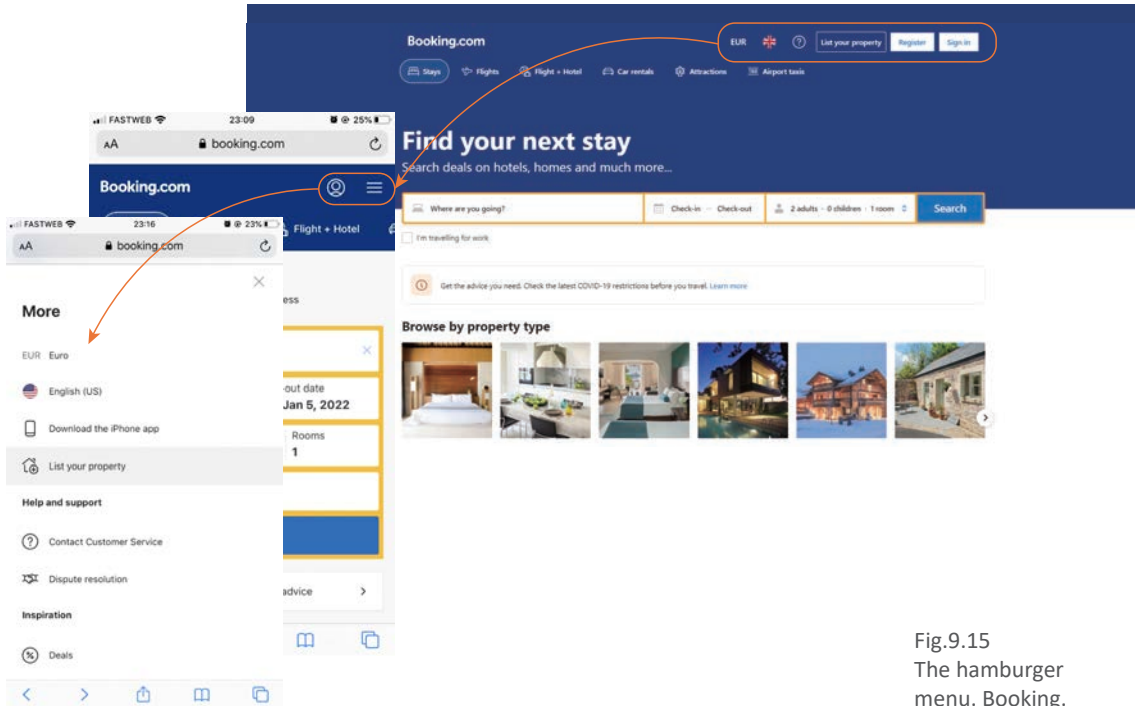


Fig.9.15
The hamburger menu. Booking.
From: www.
booking.com

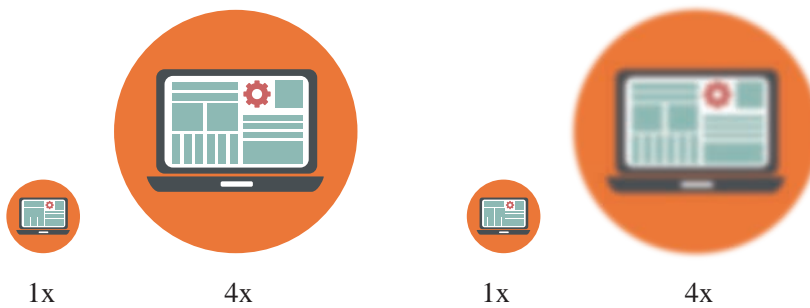


Fig.9.16
Scalable vector
graphics

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- It is essential to test the website's cross-browser compatibility.
- Clickable elements on mobile devices are at least 48 pixels in height.

9.6.2 Privacy and security of personal information

- Security issues cause anxiety to elderly users (Aula, 2005). Digital healthcare service platforms should guarantee data security and protect the privacy of elderly people.
- Elderly people may be more cautious than younger people about whom they share data with, and they need to choose which organizations and individuals they want to share information with.
- Privacy and security settings should be easy to manage. How information is used should be transparent.

9.6.3 Elderly-oriented design

- Do not make assumptions about prior knowledge.
- Older people are prone to read all the lines on the digital platform. Long lists should be avoided.
- Advertisements and pop-up windows will interrupt the operation process of the elderly and should be avoided as much as possible (Fig.9.17).



Fig.9.17
Stop ads and
pop-ups. From:
IntoZoom (2021)

- The user persona can help define target older users' behaviours, needs, interests, and motivators in the design phase.
- The digital platform should provide the elderly with staff service or other easier-to-understand ways to help them access healthcare services.
- When older people face problems, they are more likely to turn to online tutorials for help. It is necessary to explain how to use these functions.
- After an update, it is better to keep healthcare services in the same position. Otherwise, older people may be hard to find a new position.
- Older people can perform better when using touchscreen interfaces and tablets.
- Co-design: Co-design: The elderly should be included in the design process. User participation can contribute to the improvement of service. Some research methods, such as observation, thinking aloud, and scenario, can be used in the process.

9.7 Part 4: Accessibility

The goal is to make sure that all older adults (including older people with disabilities, impairments, and limitations) can use digital healthcare platforms. Designers of digital platforms need to thoroughly consider elderly users' ability and explore the most suitable interaction methods from physical interaction, virtual interaction, and voice interaction so that healthcare services can achieve barrier-free access (Pollini et al., 2022).

9.7.1 Additional aids

- Digital platforms can provide a screen reader to help older people with decreased vision hear text content. Voice readers require high voice clarity, slow speech speed, and repeatability.
- Screen readers cannot interpret images, artwork, drawings and other graphic elements, so adding text alternatives can be an easy way to make digital platforms accessible to people with specific disabilities.

9.7.2 Multiple interaction methods

- The use of the keyboard should be minimized (De Barrosa et al., 2014).
- Mis-clicks happen very frequently for older people. Error tolerance needs to be applied to form fields and search engines.
- Multiple interaction methods are necessary for older people with different disabilities, such as physical interaction, virtual interaction, and voice interaction.
- Platform operators can provide subsidies or incentives targeting specific digitally disadvantaged segments to encourage the elderly to use the platform (Talukdar and Gauri 2011).
- Tabbing with audio confirmation can help older people with reduced vision (Al-Razgan, et al, 2012).

9.7.3 Robust

- A screen-reading software is effective.
- Input assistance can help reduce errors that older adults make.
- Maximize compatibility with assistive technologies.

9.8 Part 5: Service scenario

- The digital platform should show common service scenarios so that the elderly can understand how to use these healthcare services in scenarios.
- Online registration and appointment
The elderly can make appointments for the hospital's department on a digital healthcare service platform (Fig.9.18). They can also ask customer service professionals or family members to help them do the same thing. According to the appointment, the platform can share personal information and historical medical records of the elderly to the hospital.
- These service scenarios should be displayed in the form of texts, pictures, or video.

●Online payment

Elderly people can pay online for their registration and medical costs (Fig.9.19).

Book an appointment

Date

JANUARY 2022 ▶

Su	Mo	Tu	We	Th	Fr	Sa
26	27	28	29	30	31	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	1	2	3	4	5

Time

14:00 — 14:30

14:30 — 15:00

15:00 — 15:30

15:30 — 16:00

16:00 — 16:30

16:30 — 17:00

16:00 — 16:30

16:30 — 17:00

Fig.9.18 Make an appointment

The figure shows two screenshots of a mobile application interface. The left screenshot displays a 'LISTA PRODOTTI' (Product List) with 7 items, including ACCAPY 30CPS 375MG, ABK DEPURKOM LIQUIDO 150ML, ADAPTIL TRANSPORT SPRAY 60ML, AGIPIU' VET POLVERE SPRAY150ML, ALLERDERM SPOT ON 2ML 6PIP, and ALLERDERM SPOT ON 4ML 6PIP. The right screenshot shows the payment screen with the same product list and a 'HOW WOULD YOU LIKE TO PAY?' section. The selected payment method is 'Credit card' (VISA). The card number, expiry date, and CVC fields are visible, along with a 'Save details for next time' checkbox and a 'Pay' button.

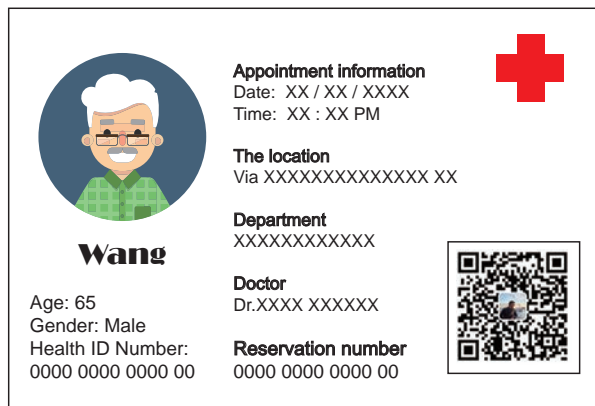
Fig.9.19 Online payment for medical costs

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●Digital medical card

After family members or the elderly pay the registration fee online, the digital medical ID card will be sent to the elderly's e-mail address, and they can also check the card, the department's location, and other information on the digital platform. They do not need to queue in a hospital for an appointment, and they can go directly to the consultation room (Fig.9.20).

Fig.9.20
Make appointments
on digital platform
and receive services at
a hospital



- The QR code

By scanning the QR code of the digital medical card on their mobile phone or a printed paper, the elderly can wait to enter the consultation room (Fig.9.21). Because the digital platform can share data with the hospital, the doctor can obtain historical medical records of the elderly by scanning the electronic medical card. After elderly people speak to a doctor about their health concerns, the digital platform can assist doctors in disease detection with big data analysis. The doctor can make a more accurate diagnosis. The platform can also show some successful cases as a reference based on the patient's condition. With the help, doctors can improve accuracy and efficiency. All medical records will be unloaded and stored on the digital platform.



Fig.9.21
Wait for
consultation

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● Home delivery service

Because all prescriptions, lists of medicines, doctor's orders, etc. are stored on the platform, the elderly can purchase medicines via the APP and choose to deliver medicines to their home. They do not have to go to the pharmacy. Elderly people with chronic diseases can also choose to deliver their medicines periodically (Fig.9.22).

● Navigation map

After older people arrive at the hospital, the digital platform (APP) will open the interactive map to help them find a way around the hospital area (Fig.9.23).

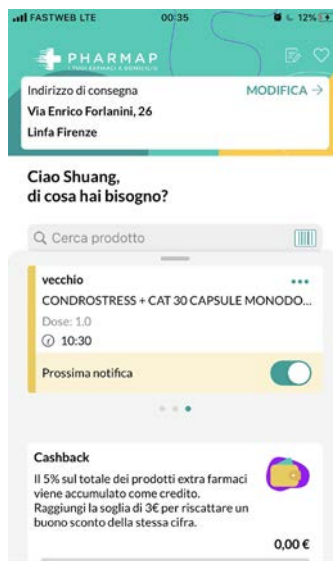


Fig.9.22
Deliver to their
homes. From:
Pharmap APP

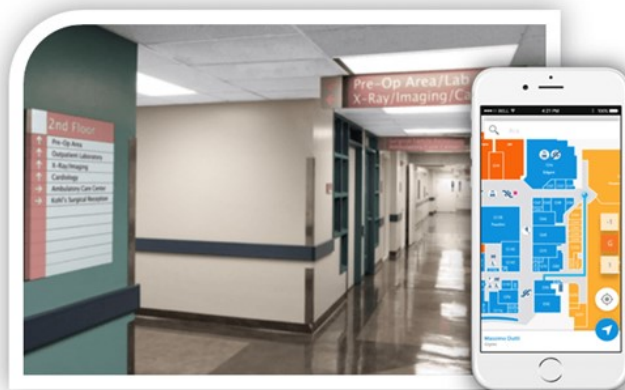


Fig.9.23
Positioning and
navigation Indoora.
From: www.indoora.
com

- Medical report online

After the examination, the medical report and analysis results will be automatically uploaded to the platform. Older people can receive the reports and results.

- Follow-up consultation online

Elderly people can make an appointment for a follow-up consultation online, and do not need to go to the hospital. The doctor can see the medical examination report from the system, and by video consultation, elderly people can communicate with the doctor online to get the doctor's advice. If the doctor needs to write a new prescription based on medical reports, the elderly can also check and purchase medicines through the platform (Fig.9.24). This is especially beneficial for the elderly with limited mobility.

- Input health information of elderly people into the digital platform

Family doctors or doctors from a community hospital can help the elderly input their private information and health information (such as age, blood type, past medical history, clinical information, allergies, medical records etc.) into a digital platform. In this way, older people can get their electronic health records.

9.9 Part 6: Multi-channel learning

- A study within the 28 member-states of the European Union shows that for e-Services, education is the most important factor (Bucea et al. 2020). It is crucial to provide older users with enough information and tutorials on digital platforms for helping them get healthcare services.

- The elderly may not actively access and use digital healthcare service platforms. In addition to online tutorials, platform operators can provide coaching services, community classrooms, and user manuals for elderly people to help them understand and learn how to use these service platforms. Proper training and education can help mitigate digital inequalities (Van Dijk, 2012).

- Digital platforms need to help the elderly build usage habits. If it is easy to access digital services, elderly people are more willing to build habits.



Fig.9.24
Consultation online

9.10 Part 7: Evaluation mechanisms

9.10.1 Tools

- Stakeholder map

Stakeholder map is a visual process of laying out all the stakeholders on a map. It can help identify which public organisations and private sectors can design, deliver, and distribute healthcare services. The map can help analyse the level of interest and influence of each stakeholder involved in a service, project, or product. Each stakeholder can be placed on the proposed matrix (Fig.9.25), to reflect on the type of interest that each of them has in a project/service and the level of influence that they can exercise. A digital healthcare service platform may include a lot of internal and external stakeholders. Comparing the position of various stakeholders can help to prioritise them.

All stakeholders can be divided into four categories:

High influence and highly interested people,

High influence and less interested people,

Low influence, highly interested people

Low influence, less interested people

By the stakeholder map, platform operators can find out who has the most influence and where resources are most plentiful. The most benefit is to find those who can benefit most (a specific group of people). For a healthcare service platform, older people and patients are the target users. The analysis result can help digital platform operators focus on marketing to target users.

Based on different categories of stakeholders, digital platforms can consider how they can organize stakeholders to provide healthcare services for the elderly (Fig.9.26).

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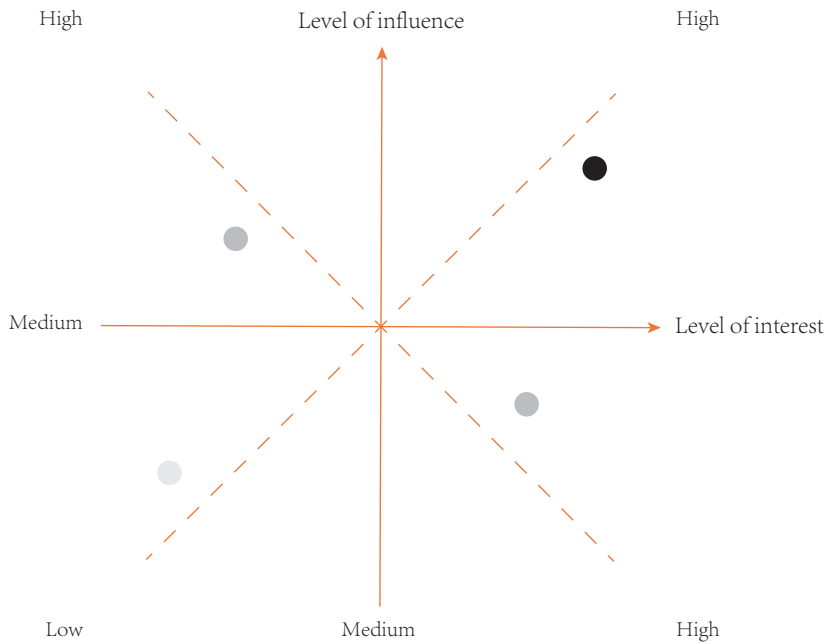


Fig.9.25
Consultation online

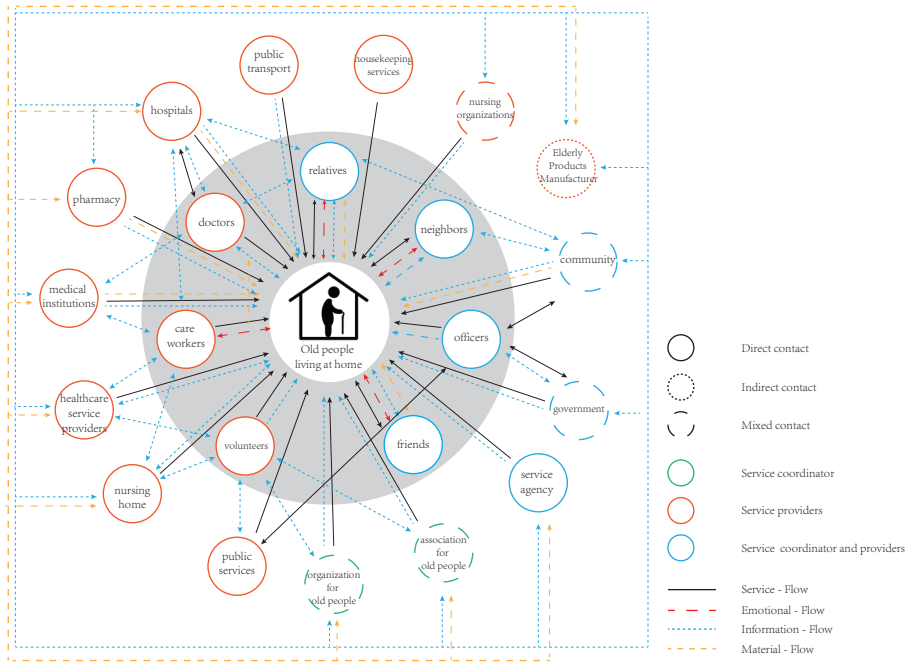


Fig.9.26
Value network for stakeholders

- Ecosystem map

An ecosystem map can help understand how older people are connected to other stakeholders, analyse how these stakeholders influence service, and use the insights to improve healthcare services of digital platforms.

For example, in fig.9.27, older users are considered as the centre of the visualisation and healthcare services for them are at the centre of this map. The three rings in this circle represent family, community, and society separately from the inside to the outside. Each ring contains possible stakeholders. A digital platform can consider what healthcare services they can provide in a different range.

The map can also be used for competitor analysis (Fig.9.28). By visualising the healthcare service ecosystem of other digital platforms, platform operators can have a deep understanding of healthcare services provided by their competitors. This way can help trigger innovation.

The ecosystem map can help find where no interactions occur among stakeholders, and then identify new areas of opportunity (Fig.9.29). By connecting different stakeholders, a digital platform can provide new or different healthcare services to meet the needs of the elderly.

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● Wireframes

Wireframes show the connection among all pages of the digital platform and demonstrate what interface elements need to exist on pages (Fig.9.30). It presents the design of a website service at the structural level and can provide a visual understanding of a page in the design phase. It can be used to test the interactive complexity of a digital platform. For each healthcare service, the designer needs to draw Wireframes to analyse the complete flow of the service. If a service requires too many steps or has a complex process, the designer needs to simplify the service steps and optimise the service flow. The wireframe is a valuable tool to assist designers in their analysis.

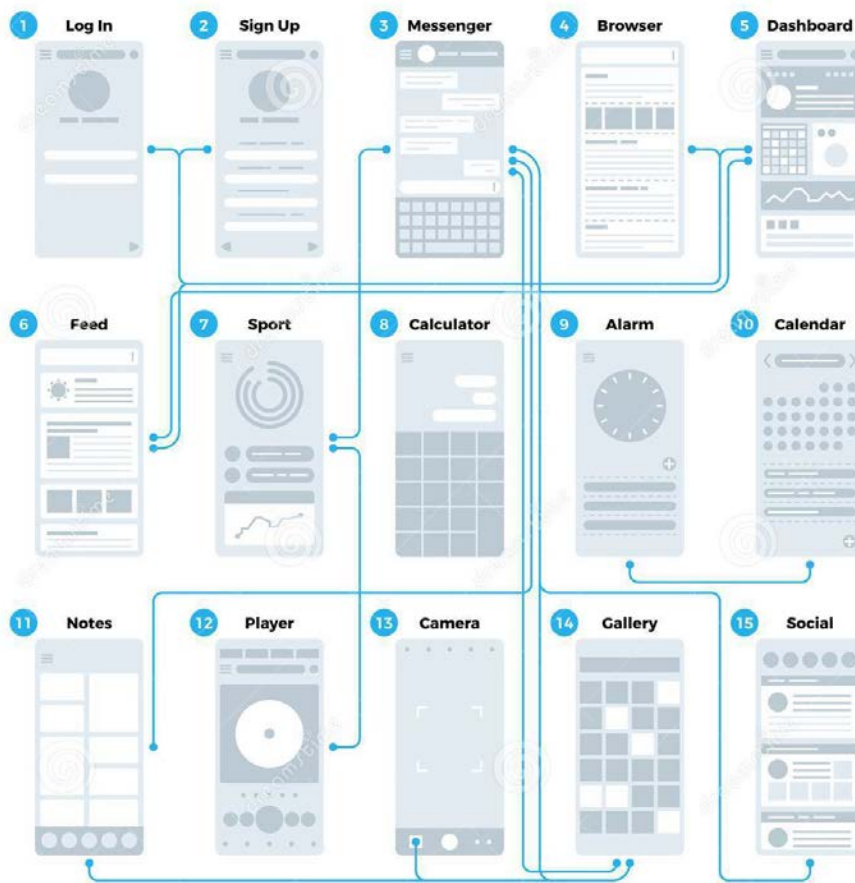


Fig.9.30
Wireframes.
Microone.
From: https://www.123rf.com/photo_97617216_ux-ui-application-interface-flowchart-mobile-wireframes-management-sitemap-vector-mockup.html

• Service roadmap

The service roadmap can visually describe the timeline for the progressive process of development, delivery and evolution of a service solution. It describes the entire process of a healthcare service and is an output of service processes (Fig.9.31). This map can help analyse the roles and tasks of each stakeholder in the delivery of healthcare services.

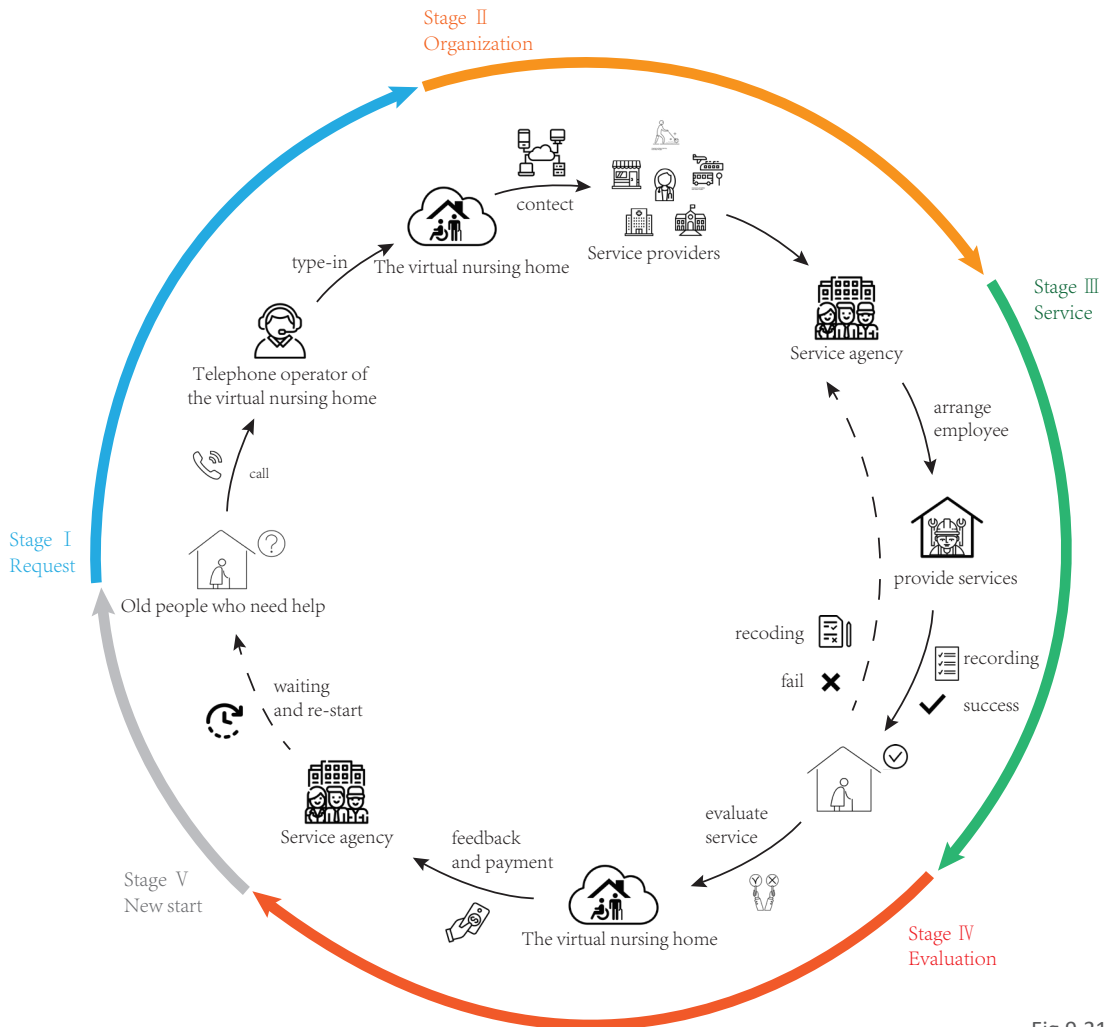


Fig.9.31 Service roadmap

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● User journey map

A user journey map can describe step-by-step how older users interact with healthcare services on digital platforms (Fig.9.32). It is a visual representation of the user experience and can help find what happens at each stage of healthcare services, what touchpoints are included, and what barriers older users may encounter. Designers can use this map to analyse each touchpoint in the whole user experience and understand the emotional changes of older adults when using digital platforms. The analysis results can help designers find pain points and opportunities. Designers can then plan an ideal user experience and optimize digital platforms for desired outcomes. A user journey map is an important tool for improving digital platforms.

Fig.9.32

User journey map.

Adaptive path. From:

<https://uploads.toptal.io/blog/image/124845/toptal-blog-image-15120270748-05-a8161ae1533217e319723040d36dbb0f.png>

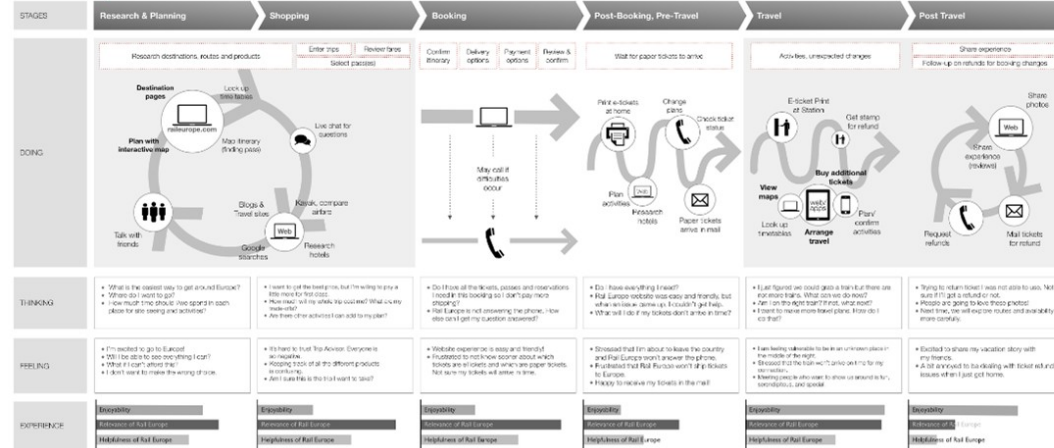
Rail Europe Experience Map

Guiding Principles

- People choose rail travel because it is convenient, easy, and flexible.
- Rail booking is only one part of people's larger travel process.
- People build their travel plans over time.
- People value service that is respectful, effective and personable.

Lens

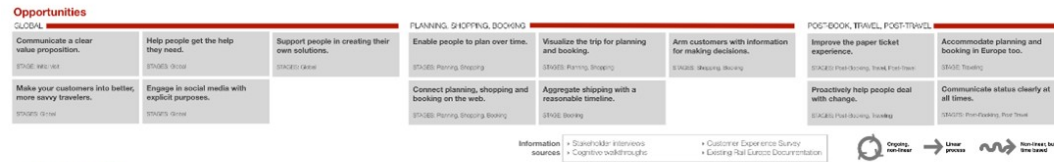
Customer Journey



Journey Model

Qualitative Insights

Quantitative Information



Takeaways

Information sources: Stakeholder Interviews, Cognitive Walkthrough, Customer Experience Surveys, Existing Rail Europe Documentation

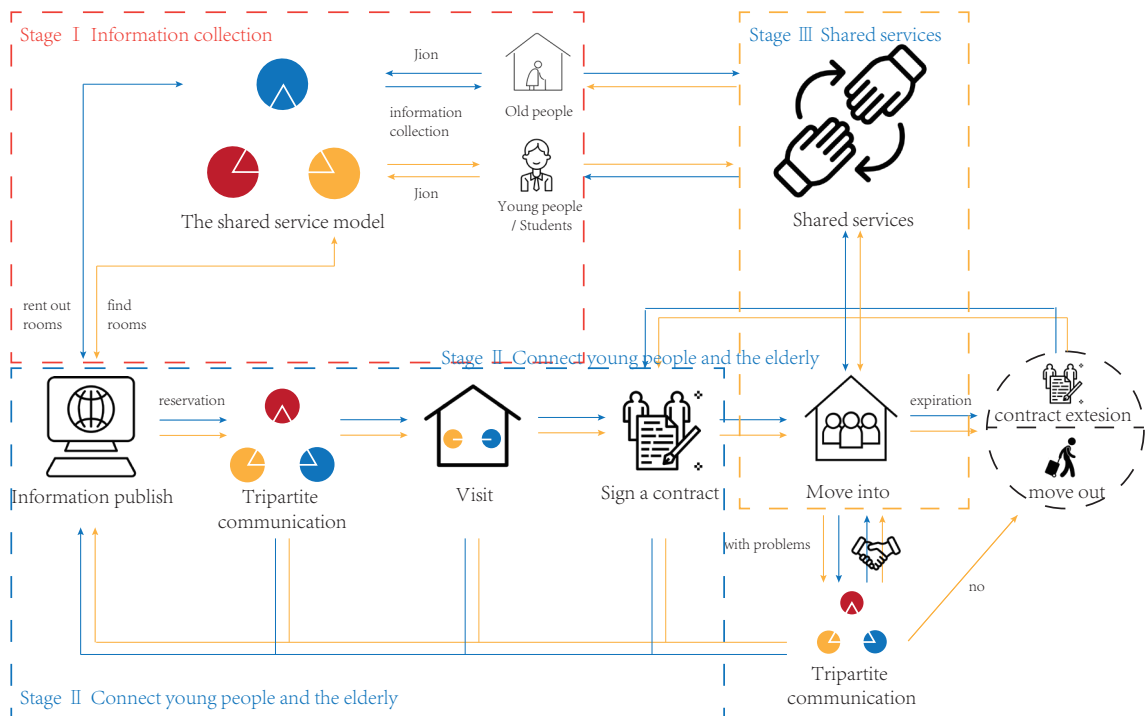
adaptive path

Experience Map for Rail Europe | August 2011

• System map

A system map can visualise all the actors and components involved in a service delivery (Fig.9.33). It can identify the stakeholders involved in the provision of a service and describe their relationships. It connects the stakeholders involved and uses lines of different colours to distinguish the different types of relationships (e.g. exchange of documents, information, money, ...). The system map emphasises the values they exchange. The map can provide a simplified understanding of a healthcare services system.

Fig.9.33
System map



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●Service prototype

A service prototype is an early sample of services and can be used to simulate a real interaction with different touchpoints. It can provide a specification for a digital system. Paper prototyping, digital mockups, and interactive digital prototyping are the most often used by designers. Paper prototypes are representations of digital interfaces on paper. They contain all of the wireframes and other components required for the user to interact. It is simple enough to allow the user to participate in testing. Digital mock-ups are unprogrammed representations of digital interfaces. It uses animations or links to simulate interactions. Interactive digital prototypes are full-fledged digital interfaces with real-world functionality.

Fig.9.34
Paper prototyping.
photo by
Alvaro Reyes on
Unsplash. From:
<https://unsplash.com/photos/qWwpHwip31M>



9.10.2 Checklist

I created a checklist that includes all key design factors of a digital healthcare service platform based on the above research. Appendix 3 shows the checklist as an evaluation method. The checklist is divided into six parts with a total of 110 evaluation indicators: Part 1 (40 indications), Part 2 (32 indicators), Part 3 (15 indicators), Part 4 (10 indicators), Part 5 (9 indicators), and Part 6 (4 indicators). Every indicator can be rated as poor, medium, and good, corresponding to 0, 1, and 2 points. As this checklist contains different types of stakeholders, some indicators are set for specific stakeholders. If assessors find that some indicators cannot be assessed, they can evaluate it as the medium. The total score is 220 points. A score over 130 means seniors can use the platform with some difficulty. A score of 176 or more indicates that the platform is age-friendly.

Designers, older people, platform operators and other stakeholders can use the checklist to evaluate digital healthcare service platforms and give the platforms an overall rating. After all indicators have been evaluated, the evaluator will get a score for each part and a total score for a digital platform. If a part has a low score, it is not age-friendly and needs to be improved. The checklist is an effective tool to help find and define the weak points of a digital healthcare platform for the elderly. With evaluation results, designers and platform operators can improve their platforms to make them more age-friendly.

9.11 Empirical research

Using the checklist to evaluate a healthcare service platform can help verify its validity, and the evaluation results can help find problems in the platform. An older person can also be invited to use the platform. Through a think aloud protocol and the interview study, the problems encountered by the older person can be identified. By comparing and analysing the results of the two experiments, the problems with the digital healthcare platform can be summarised. Designers and platform operators can then think of solutions to deal with these problems.

9.11.1 Evaluation of a case

In Chapter 6, the digital healthcare service platform called "Yu Zhong Yi" used by the elderly user is selected for evaluation. The digital platform was established by the First Affiliated Hospital of Henan University of Chinese Medicine. The hospital is a provincial comprehensive hospital of Traditional Chinese Medicine. Older people can use this digital platform on their mobile phones. Fig.9.35 shows the home page of this digital platform.

The checklist can be used to evaluate the platform (Appendix 3 shows the evaluation results). The homepage of this digital platform includes 8 main modules, online follow-up consultation, special medical service, outpatient service, cloud consultation service, introduction, list of departments, hospital map and prescription. These services are easy to access and understand. It's a pity that this digital platform is only available in Chinese and lacks an English version, so Chinese seniors are the main users. To use these services, older users need to register for an account (Fig.9.36). They were asked to fill in their name, ID numbers, dates of birth and mobile phone numbers. There is also information about medical history and allergies that they can choose to fill in or not. When typing, they can see instructions. After entering the verification code, older users can successfully register on the platform.

This platform provides some instructional videos on how to use healthcare services and other functions (Fig.9.37). In the readable indicator, the platforms can earn 12 points.

The overall appearance and feel of the digital platform are similar. Some

Design guidelines of digital healthcare service platforms for the elderly



Fig.9.35 The home page



Fig.9.36 Registration process



Fig.9.37 Instructional videos

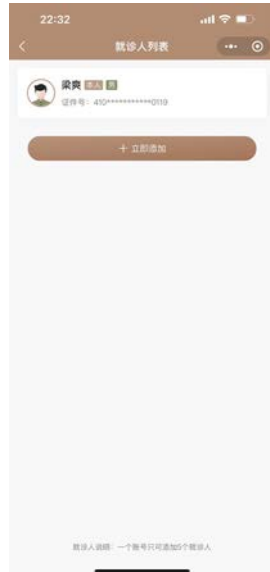


Fig.9.38 Click operations

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icons and visual elements keep consistent. In the indicators of consistent identification, the platform can get 11 points. The home page uses four fonts. The most important modules do not use sans-serif fonts, and sans-serif fonts are mainly used on other pages. In the indicators of text style, the platform can earn 4 points. The font sizes are small, and older users cannot adjust the font size by themselves. There is 1 point in the indicators of the font size. This platform mainly uses shades of brown, black fonts and white backgrounds. Some colours are similar, and older adults may not be able to recognize the difference quickly. With high contrast, the text is easy to read. When elderly users make mistakes, the platform will display text reminders. The platform displays a text alert when an elderly user has made an error. In the colour indicator, the digital platform only gets 9 points. In the layout of digital platforms, services and functions are displayed clearly. The return button is easy to find and use. There is a search bar at the top of the homepage. A voice reader is not available. In some services, the page hierarchy is complex. In this indicator, it has only 10 points. The digital platform does not show the region's cultural norms, so this item gets 1 point. Part 1 gets a total of 61 points. Almost all operations in this platform are done with a click (Fig.9.38). The button size is suitable, and the elderly do not need to use multiple fingers to operate. Older users have to input text by pressing the keyboard on the phone, it is easy to make mistakes. The fingerprint login and fingerprint payment are available. Information can be checked for input errors and older users can have an opportunity to correct them. The item of motor control earns 15 points. The platform does not include a breadcrumb navigation. It is difficult for older users to visualize their positioning, and there is not a home screen menu. When booking a service, the platform provides an operation guidance.

Older users with physical limitations are given sufficient time to complete an operation. Sometimes, older adults don't know what to do next due to a lack of guidance. In some cases, they need to swipe down from the top to fill in the information, and some content is required to be filled in repeatedly. The page does not have some tips to help the elderly reduce anxiety. These issues resulted in a low score (7 points) on this indicator. Elderly users can connect with their doctors through the digital platform, but users have to wait more than 10 hours to get feedback from doctors. The waiting time is too long. This digital platform cannot be connected to smart wearable devices. Only text feedback helps older people confirm whether an operation is completed successfully. The indicator

of experience with technology only got 1 point due to the bad user experience. When using this digital platform, elderly users usually focus on the information they need to fill out, and it is easy to ignore other important information.

The digital platform can only be used on the smart phone. Many healthcare services are not provided on the website. There is not a hamburger menu. Icons use scalable vector graphics. The platform can protect the privacy of elderly people. Older users cannot manage their privacy settings at the platform. The staff service is not available. There are not any pop-up windows. When older users meet problems, there is not any advice or guidelines. Older users can perform better in touchscreen interfaces. The part 3 gets 12 points.

The healthcare platform does not provide additional aids and different interaction methods to help older users with different disabilities. It is not an accessible platform, and this item only gets 5 points. The platform shows almost all service scenarios. Common healthcare services are available. The indicator of service scenario can earn 17 points. Some videos can help older users to understand how to access different digital healthcare services. Part 6 gets 4 points.

Overall, the digital platform gets a total score of 132 points. According to the evaluation criteria, the digital healthcare platform can basically meet the service needs of elderly users. According to the evaluation results, this digital platform has low scores in Part 2 (29/64), part 3 (15/30) and Part 4 (5/20). The reason for the low score in the Part 2 is that older users can only fill in an online form by hand, and this method is not suitable for illiterate or elderly people with hand disorders. Another reason is that the platform lacks an effective navigation system, and the elderly often get disoriented on this platform. Due to the lack of a digital website, the elderly cannot use the platform on different devices, which reduces the availability of the platform. Secondly, the service process lacks encouragement and necessary prompts for the elderly, which leads to a lack of confidence for elderly users to submit service requests successfully. That is why Part 3 gets a low score. This platform does not consider the needs of older users with different disabilities. It does not provide additional aids or multiple interaction methods to assist them in completing tasks. They are not willing to use the digital healthcare platform.

By using this checklist, the problem of the service platform can be discovered. The evaluation result can help platform operators and designers improve the platform and make the platform more age-friendly.

9.11.2 User testing

In order to validate the evaluation results of this checklist, an elderly user was invited to take the test. Analysis and comparison of these two evaluation results can verify the accuracy of the checklist and summarize the problems of the digital healthcare service platform. This provides a scientific approach for finding the most suitable solution.

This elderly user is 60 years old and just retired. Despite having a PC, she only uses her smartphone daily. When she falls sick, she usually goes directly to the hospital and has never received healthcare services provided by the digital healthcare platform. She believes she has the necessary digital skills to use these digital platforms, but she may need to spend time to learn how to use them. She is reluctant to accept digital healthcare services. She believes that face-to-face communication with doctors is more direct and effective than online communication, and she is unsure how to select doctors on digital platforms. Due to the pandemic, she has to start to use digital healthcare service platforms.

She needs to create an account because this is her first time using a digital healthcare platform. The elderly user needs to allow the digital platform to obtain her mobile number and send her a verification code. After receiving the verification code, she does not know where to input the verification code (Fig.9.40). She tried three times before finding the correct location. After logging in to the platform, she does not see the homepage's content but enters the list of doctors. For her, this is very confusing. She does not find a suitable doctor and has to return to the home page. She chose outpatient services after reading all of the contents on the page. On this page, she needs to complete the real-name verification (Fig.9.41), and then is asked to add personal information such as her name and ID number. Next, she needs to verify the information through facial recognition (Fig.9.42). After passing the verification, she must re-enter her cell phone number, verification code, and medical history. For elderly users, the registration process is already taxing.

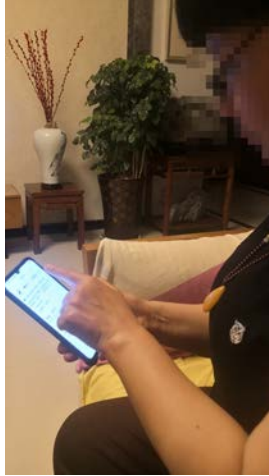


Fig.9.39
User testing

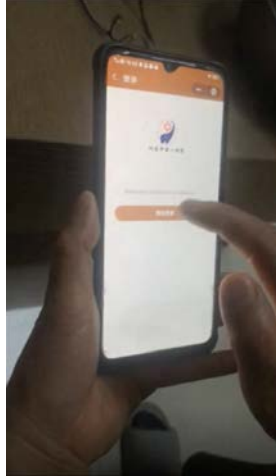


Fig.9.40
SMS verification



Fig.9.41
Real-name verification

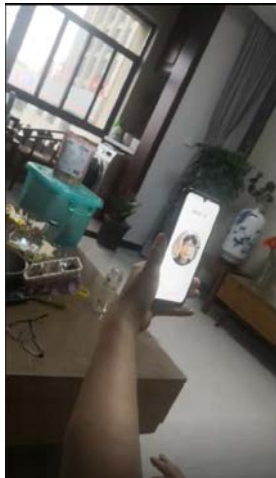


Fig.9.42
Facial recognition

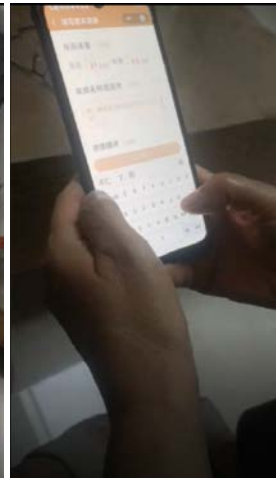
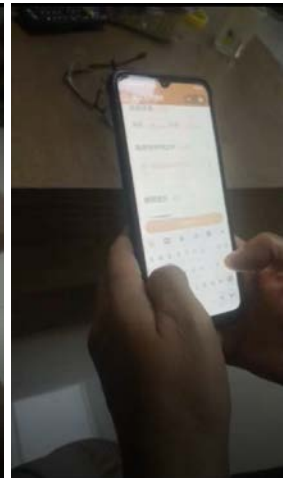


Fig.9.43
Fill in personal information and symptoms



When she completes the registration, the platform automatically jumps to the page for choosing a doctor. She becomes confused again. She currently has a little arm pain, but she does not know which doctor to choose. She spends more than ten minutes on this page but still cannot find a suitable doctor. She hopes that someone can help her. She has to go back to the home page again and enter the list of departments of the hospital. She does not understand the differences between some similar departments. She takes another 10 minutes to make an appointment with a doctor she feels could treat her ailment. The user was again asked to fill in personal information and symptoms in this process (Fig.9.43). The user displayed an attitude of boredom. When she fills in the wrong information, a prompt appears on the page. She can modify the information according to the prompts. After completing this task, she is asked to pay the fee. The service cost is described on the previous page, but she focuses on following the service process and does not notice the fee. She was a little surprised, but she pays by entering a password due to the low fee (about 1 euro). She completes the appointment and needs to wait for a response from the doctor.

It took the elderly user 35 minutes to complete the user registration and service appointment. She does not think it saves time. Throughout the process, she expresses various difficulties she encountered. I also observe that she sometimes needs to click the button several times before the page gives feedback. The progress is somewhat delayed. The lack of feedback can make the elderly user doubt her operations, which degrades the user experience. She also thinks the font size on the platform is too small. What is more, the digital interaction of this platform has made her feel bored many times. Typing also increased error rates, and she preferred to use voice input. Moreover, the whole process is a bit complicated, and she often does not know where she is, what to do next, and whether she is doing the right thing. This feeling made her doubt herself, and she does not want to use the platform anymore. she only gives this platform 6 points (out of 10 points).

9.11.3 Problems and solutions

By comparing and analysing the two experimental results, it can be found that the problems encountered by the elderly when using the digital platform are consistent with the assessment results of the checklist.

The platform only GETS a passing grade in both tests. This illustrates the effectiveness of the checklist.

Table 9.1 summarizes the problems of this digital health care service platform and proposes possible solutions. This is helpful and useful for platform operators and designers.

Tab.9.1
Problems and
solutions

Problems	Solutions
Part 1: User interface with understandable and perceivable information	
Older users do not understand the names of some services, such as cloud consultation service.	Use a more understandable name, such as online doctor consultations
The visual and functional elements are similar.	Increase the difference between different elements.
The homepage has four font types, and do not use sans-serif fonts.	Reduce font types and use sans-serif fonts.
The font size is too small.	Increase the font size.
older people cannot adjust text size themselves	Add the function
The colours of different interface elements are similar.	Increase the difference between interface elements
The digital healthcare platform has a deep hierarchy.	Optimize the hierarchy
Lack of the local cultural characteristics	Improve elements and icons
The places where important information needs to be filled in are not clearly marked.	Highlighting tips
Part 2: Digital interaction	
Inputting is a complicated operation for the elderly	Provide more default options or alternative methods
Lack of breadcrumb navigation. Older users cannot visualize their location on a digital platform.	Add the breadcrumb navigation
When elderly people choose a functional module, the status do not change.	the module should have noticeable changes.

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Problems	Solutions
Part 2: Digital interaction	
The service process is chaotic and easy to mislead users.	Optimize service process. After the user completes the registration, the user can go directly to the home page instead of other pages.
The search bar lacks a function of voice search.	Add the function
Older users are unsure of what to do next or if they're doing it correctly.	Add clear feedback on progress and reminders of the end goal
Lack of emotional support	Add some tips and encouragement
Problems with duplication of information	The same information is automatically populated in the form.
Lack of timely information feedback	Reduce waiting time
Part 3: Design patterns	
Lack of a service platform on the website	Make these services available on the website
Older users cannot choose who they want to share information with.	Add privacy management function
Older users expect an online customer service representative to help them find departments and doctors.	Add this service
Part 4: Accessibility	
Lack of a screen reader	Add the toolkit
The platform is not available for older people with specific disabilities due to lack of additional aids and multiple interaction methods	Platform operators need to consider the demands of these older people and add these functions and services.
Lack of click feedback effects	Sliding and clicking haptic or visual feedback on a touchscreen

Tab.9.1
Problems and solutions

Problems	Solutions
Part 5: Service scenario	
Low usage of service scenarios	Change the layout to highlight this module
The video of the service scene is not updated instantly	Regular update
Part 6: Multi-channel learning	
There is no way for older people to learn how to use the platform other than through instructional videos	The hospital needs to provide more opportunities for seniors to learn and use the digital platform.

9.12 Conclusion

Elderly populations are usually referred to as “digital refugees” or “digital immigrants”. They face the digital divide in the digital age. The Pandemic limited possibilities for them to receive healthcare services in hospitals. Under such a circumstance, digital healthcare service platforms become more important. In the smart healthcare service system, the platform is a core to connect older users and healthcare services. Although there are some digital healthcare service platforms, many older people do not know how to use them. The lack of digital skills may be an essential reason, and another important reason is that many digital healthcare service platforms are difficult to interact with and use. It is necessary to provide a design guideline for designers and policymakers to guide them to build an age-friendly platform. For those existing digital platforms for the elderly, the guidelines and checklist can be useful and valuable to help platform operators to evaluate and then improve their platform, finally making their digital healthcare service platform much age-friendly. The effectiveness of the design guidelines has also been validated through the empirical research.

Tab.9.1
Problems and
solutions

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Part IV Research answers

In order to answer RQ11 and RQ12, Chapter 9 provides a series of reference standard, design methods, tools and evaluation mechanisms based on theories from the scientific research and the experimental research. Finally, empirical research helps validate the effectiveness of these methods and tools.

●Answers to RQ11

In order to design an age-friendly digital health care service platform, some key design principles must be considered.

The Part 1 focus on the UI design, including understandable and perceivable information, the layout, and region's cultural norms. It requires digital healthcare platform to present information clearly and effectively.

The digital interaction includes motor control, navigation, physical limitations, and experience with technology. This part requires that there are not any barriers when elderly people interact with the digital platform.

The design patterns include responsive design, privacy and security of personal information, and elderly-oriented design. It means that the design of a digital healthcare service platform should be age-friendly.

The accessibility means a digital platform should offer additional aids and multiple interaction methods to assist older users who have cognitive, visual, motor or auditory disabilities in receiving digital healthcare services.

The service scenario means the platform should provide various scenarios to guide and help the elderly step by step.

Multi-channel learning means that designers or platform operators should provide elderly people with more opportunities to learn how to use a digital healthcare platform.

●Answers to RQ12

The evaluation mechanism consists of tools and a checklist. The tools include stakeholder map, wireframes, user journey map, system map,

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and evaluation matrix. These tools aim to help analyse stakeholders, pain points, the service process etc. The checklist includes all key design indicators. Every indicator can be evaluated as poor, medium, and good. The checklist can help stakeholders evaluate whether a digital platform is age-friendly, and find the weak points of a digital healthcare platform.

CONCLUSION

Research limitations

Future development

Conclusion

The doctoral research focuses on a smart healthcare service system for the elderly. It answers research questions and achieves research goals. The design guidelines provide designers and platform developers with the methods and tools to make their digital platforms more age-friendly. The research content can contribute to the development of a smart healthcare service system and provide a reference for relevant practitioners.

Chapter 1 introduces the research background, general and specific research objectives, considers the research question and methodology and describes expected results and research outputs. Chapter 2 is a theoretical study mainly focusing on the healthcare service systems in China, Italy and Japan. The research covers demographic trends, retirement ages, pension systems, social health insurance systems and related laws in the three countries. Through these fundamental studies, the healthcare service systems of the three countries can be demonstrated. Chapter 2 explores, classifies and summarises existing healthcare service models. The result of two-dimensional correlation analysis can help older people compare and choose the service models they want. Case studies describe details of the healthcare services provided by nursing homes or retirement communities in three countries. By comparing and analysing the above studies, the advantages, opportunities and challenges of China's healthcare service system can be obtained. This can provide references and suggestions for the future development of the healthcare service system in China.

Chapter 3 (User Research) describes the definition of the elderly and categorises them. Based on Maslow's Hierarchy of Needs, the characteristics and needs of different types of elderly people are analysed. These studies define the healthcare services that older people need. Chapter 4 discusses the relationship between ageing and digital technology, as well as the meaning of digital accessibility and inclusion. The case studies showcase some of the digital devices and technologies that older people currently use. Based on these studies, a research hypothesis that could help older people bridge the digital divide is proposed.

Experimental research helps verify the feasibility of this hypothesis and explore feasible solutions. Chapter 5 evaluates the feasibility of the digital platform through social innovation and verifies the architecture of the smart healthcare service system. Chapter 6 investigates the real needs of older people and defines the groups of older people who are most in need of digital healthcare services. They can be considered as the primary target users of the digital service platform. Chapter 7 describes the service processes of a typical Chinese hospital and online healthcare services provided by the digital platform, which provides a practical basis for the research output. In Chapter 8, expert interviews help define the scope of the research output and present actionable recommendations.

Based on scientific research and experimental Research, Chapter 9 proposes a design guideline for digital healthcare service platforms for the elderly. It can be used as a reference standard to evaluate the digital user experience for the elderly. Designers or platform developers can improve their digital healthcare service platform.

Overall, the research involves multiple disciplines (ergonomics, medicine, and computer science) and emphasises the value of interdisciplinary research. This research aims to use design and digital technology to help the elderly bridge the digital divide and have a safer, more comfortable, healthier, and happier retirement life.

Research Limitations

The lockdown caused by the COVID-19 pandemic reduces the possibility of field research. I did not include many surveys on Italian older people and medical institutions. My research lacks an in-depth understanding of the needs of the elderly and medical institutions in Italy. I focus more on China's healthcare service system and hope to apply my research to Chinese scenarios.

Following the advice of professors and experts, I provide a design guide for a digital healthcare service platform. This guideline needs to be verified and iterated. Currently, I have not had an opportunity to test and verify the guideline. After returning to China in the future, I can cooperate with the hospitals I surveyed for verification and continuous improvement.

Future Development

In China, the smart healthcare service system has huge potential. The problems caused by ageing population are getting more and more serious. The number of elderly people is growing. The Chinese government has issued many national policies to encourage the development of smart healthcare service systems. Many cities are transforming into smart cities where the local government are building a smart healthcare system. My research can contribute to policymaking and system design.

Medical institutions can use my research to improve their existing digital healthcare service platform. In the application process, this guideline can be continuously iterated and improved according to new problems encountered. It can eventually become a more complete and scientific reference standard.

RESEARCH ACTIVITIES AND PUBLICATIONS

Publications

Research projects and activities

Invention patent

Publications

[1] **Liang, S.**, Zhou, M. (2019). Un sistema di servizi sanitari per anziani basato sul concetto di sostenibilità[C]. *FRID 2019 Confini e Contesti. Università Iuavdi Venezia.2020*, 387-396.

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[3] **Liang, S.**, Zhou,M., Zhou, C.M., Zhu, J.G. & Tosi,F. (2022). The healthcare service models and development in China based on literature review. *Packaging Engineering*, (11). *Chinese*

[4] **Liang, S.**, Zhou,M., Zhou, C.M., Zhu, J.G. & Xu,J. (2022). The seriousness and entertainment of the sustainable development of intangible cultural heritage.Furniture & Interior Design, 29(04):50-54. *Chinese*

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Research projects and activities

[1] 2019-2020 Scientific Research Project of Intangible Cultural Heritage, Henan Province, China

Title:

Digitization and Sustainable Development of ICH in Henan Province——Taking Traditional Furniture Craftsmanship as an Example

Project Number:

20HNFYA35

Institution:

Zhengzhou University of Light Industry

Role: Director

[2] 2021 Nanjing Forestry University International Education Project

Title:

2021 International Ecological Health Design and Engineering

Project Number:

2020138-02

Institution:

Nanjing Forestry University

Role:

Main organizer and participant

[3] 2020 International Smart Healthcare Furniture Design and Engineering Project Summer School

Title:

2020 International Smart Healthcare Summer School

Project Number:

20200227

Institution:

Nanjing Forestry University

Role:

Main organizer and participant

[4] 2020 Humanities and Social Sciences Project, Department of Education, Henan Provincial, China

Title:

Pre-Qin art research at middle course of the Yangtze River

Project Number:2020ZZJH0870

Institution:

Zhengzhou University of Light Industry

Role:

Main participants

[5] 2019 Scientific Research Project, Intellectual Property Office, Henan Province, China

Title:
Intellectual Property Research in Arts and Crafts Industry

Project Number:
20190106027

Institution:
Zhengzhou University of Light Industry

Role:
Main participants

Invention patent

Title:
A Smart Fall Detection Device For The Elderly

Application (patent) number:
CN202110373353.6.

The publication number:
CN113077608A

Inventors:
Shuang LIANG, Min ZHOU, Peian YAO, etc.

Institution:
Zhengzhou University of Light Industry

Website:
https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=SCPD&dbname=SCPD2021&filename=CN113077608A&uniplatform=NZKPT&v=OVMGEalE_5fgHzc6s6e_nuidXJgiHx3sIKhIUSVFAwq_eXouVvW9RGWWjdDjhmAl

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1 Project Description

In the era of the fourth industrial revolution, traditional models of production and consumption are evolving radically and rapidly. Big data, platforms, the Internet of Things, augmented reality and artificial intelligence are the keywords of a change that brings about profound social and cultural transformations, well beyond the sole technological dimension. In this unprecedented challenge, enterprises, organizations, and institutions across all sectors show the growing need to rely on new professional profiles to unleash diffused creativity and resilience, turning innovation into an open process of collective experience and connection across meanings, knowledge and know-how (ODM, 2019).

Based on the background, the faculty of Architecture and Design University of Florence, CSM (Centro Sperimentale del Mobile), and LAMA Agency (a consulting company and founder of the social innovation coworking space “Impact Hub” in Florence) organized the workshop (Fig.1).



Fig.1
Poster. From: <https://odmplatform.eu/design-driven-strategies-florence/>

This is a workshop on system thinking and design thinking in paradigm 4.0. The goal is to empower designers and professionals in using design as a strategic lever for shaping multi-sectoral, collaborative and distributed co-creation processes, going beyond the conception of innovation as a linear process. The workshop is dedicated to shaping 'Enablers of Innovation and Social Innovation' across diverse communities and stakeholders, facilitating horizontal collaboration and bridging around real challenges that take together both economics and society, through a design driven approach.

2 Social cooperation and innovation

This smart healthcare service system needs to be composed of many small service systems. In this workshop, I thought about how to improve the social participation of the elderly and help the elderly overcome loneliness and achieve self-actualization. In other words, this is a pilot study to evaluate the feasibility of a digital platform to help the elderly overcome loneliness by organizing stakeholders to provide short-term social care activities. Participants of this project are ODM, UniFi, Caravan design manufacturers. Our team members proposed an innovative education services platform. Elderly people usually feel lonely and hope to have social activities to overcome loneliness and achieve self-actualization. Children in remote areas lack skills and education resources. This platform integrates the elderly, these children and caravan manufacturers. The camper van can become a modular warehouse of informal educational activities targeting children in rural and remote areas. Several retired older adults can drive RVs (or with a driver) to remote areas and teach their knowledge or skills to the children in those areas. Through this activity, the elderly can not only enjoy the journey, but they can also enhance their sense of accomplishment.

In the digital service platform, elderly people can register as service providers, and local educational institutions can apply for informal education services (Fig.2). This digital platform can connect the elderly and children, plan these activities, and provide support.

By brainstorming and group interviews, key stakeholders should include family numbers, children's parents, caravan companies, local

governments, and social organizations. The value proposition gives older people and children opportunities to participate in informal education activities (Fig.3).

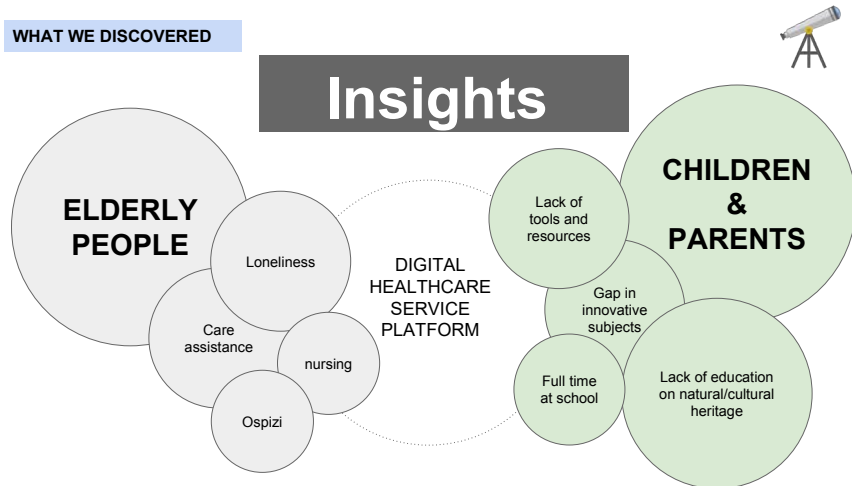


Fig.2
Elderly people and children



Fig.3
Brainstorming and group interviews

It is important to create a business model canvas. In the process, we consider and define the customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships & cost structure (Fig.4).

Then, we thought about the service process and scenario prototyping. Based on the health status of the elderly, this informal educational event will last up to 7 days. On the first day, the elderly and children were organized through the intelligent system, and on the second day, all the elderly set off to the local community. From the third day to the fifth day, the elderly can interact and stay with their children. On the sixth day, the children showed their learning results. Finally, the older adults returned from the local area on the last day (Fig.5).

I went to Poggibonsi to visit the EURODUE company and learned about the RV's production process and internal structure. In order to make the RV meet the needs of our activities, I designed a 3D model, and used a 3D printer and laser cutting machine to make prototypes of this RV and some furniture (Fig.6). The name of the RV is Care You.

For evaluating the feasibility of the digital service platform, we did much work. We investigated the views of many older adults and went to Casentino to communicate with local education institutions about the feasibility of the plan, I also discussed with the directors of some social organizations and communicated the platform with professors. Finally, they think it is feasible, and the outwork was displayed in an exhibition in Florence (Fig.7). I tried to organize a social innovation activity to connect lonely older people with children in remote areas throughout the workshop. These experiences help verify the research and have a positive effect.



Fig.4
The business model canvas

Per prima cosa dobbiamo informare che Carriù sta per arrivare...



Carriù è arrivato in città, è l'inizio di una divertente attività!



Vecchi, grandi e bambini del posto rurale racconteranno tutto ciò che lo rende speciale.



Vogliamo fare ne abbiamo molta... così costruiamo i giochi di una volta!



Diventiamo anche attori ed entriamo in azione, inscenando le storie della tradizione.



E oltre al passato guardiamo al futuro, imparando il codice di un web sicuro.



Quello che abbiamo fatto con creatività, è giusto che ritorni in mano alla città.



Soddisfatto del lavoro meritorio, Carriù va a valorizzare un altro territorio!

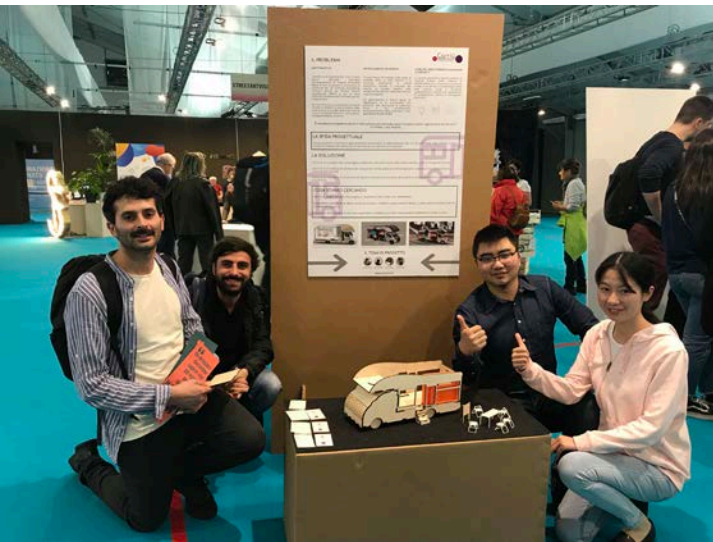


Fig.5 Service process

Fig.5.6
Product prototyping



Fig.5.7
Exhibition



3 Digital technology research

In order to further my research, I need to have a deeper understanding of digital technologies and to evaluate the architecture of IoT. In this workshop, Polish OD&M can provide excellent students with an opportunity to learn IoT, robot creation, and programming at Lodz University of Technology, Poland. Fortunately, as our team did excellent work, the organizer provided me with this opportunity. In Poland, I worked with students from the UK and Spain to create prototypes for meeting a social challenge (Fig.8).

In the Lodz University of Technology, I took some lessons about digital technologies and acquired basic knowledge of IoT, ICT, cloud computing and programming with the help of a researcher from the IoT and robotics laboratories (Fig.9). These lessons helped me understand the information architecture for the digital healthcare service platform. In the course, I discussed my research ideas with researchers and the laboratory director. They gave me some suggestions to help improve the architecture of IoT for the smart system. As a result, the system is based on the architecture of IoT with four layers.

This is just theoretical research. In order to help me have a deeper understanding, the director introduced their research projects on smart devices and digital platforms (Fig.10). The researcher described the design process and digital technologies they use. The design of digital devices requires interdisciplinary knowledge. It is crucial to understand how to choose development boards, information communication modules, and different sensor modules. Their research team designed robotic arms and robots to help people improve work efficiency in different scenarios. I manipulated these digital devices through a controller to understand the logical structure.

At WSB University, after learning the above technologies, I developed a small smart device based on Arduino. I assembled a wireless control car prototype and completed the design and control of this car prototype by uploading the code (Fig.11).



Fig.5.8
The team number
from different
universities

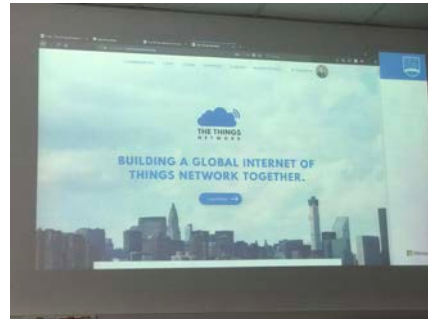
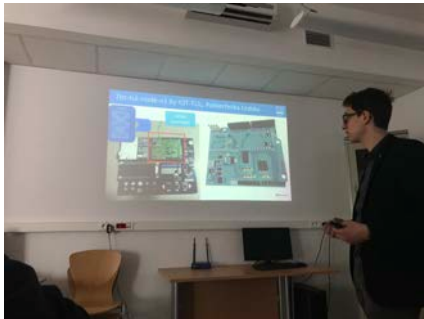
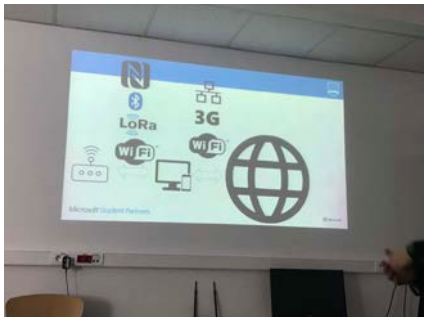


Fig.5.9
Digital technologies

Appendix 1: Investigation 1



Fig.5.10 IoT and Robotics laboratories



Fig.5.11 A prototype of small car

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Appendix 2: Test guide (In English)

Introduction

Digital healthcare services have become more popular in the recent years. Especially during the epidemic, an increasing number of older people start to receive healthcare services through digital healthcare service platform, where older people can communicate and make videocalls with a doctor or a medical expert. At the end of the consultation, the elderly can also receive a prescription from the doctor. These services are easily accessible and timesaving.

The test aims to find out what problems older people encounter when using the digital healthcare service platform. Older people can say whatever comes into their mind as they complete a task. This might include what they are looking at, thinking, doing, and feeling. This gives observers insight into the participant's cognitive processes. In a usability testing context, observers are asked to take notes of what participants say and do, without attempting to interpret their actions and words, and especially noting places where they encounter difficulty. Tests may be completed on participants own devices or in a more controlled setting. Tests need to be video recorded so that developers can go back and refer to what participants did and how they reacted.

Notes

1. Please use your mobile phone or camera to record the whole process.
2. Mainly recording the interaction between older people with digital platforms. For example, how older people operate on their mobile phones.
3. If the older person encounters problems and cannot continue to complete the task. We can help them, but it is better to allow older people to complete tasks independently.

Privacy notice

We will go through some questions, where your answers will be recorded. All tests will be recorded on video. You are completely anonymous. If you feel uncomfortable for answering any of the questions, you don't need to answer. The data collected will be only used for academic purposes.

A Brief Interview:

Age: _____ Gender: Male Female

1. Which kind of digital tools do you have?

Smartphones Laptops Computer Ipad
Other _____

2. Where do you usually receive healthcare services?

Family doctors Hospitals Clinics Pharmacies Digital platforms
Other _____

3. Have you ever received healthcare services through a digital healthcare platform?

Yes The name of the platform is _____

_____ Which kind of healthcare services? _____

No

4. Do you think you have enough knowledge to use digital healthcare platforms?

Yes No I am not sure.

5. Do you want to receive digital healthcare services?

e.g., remote medical care, Internet hospitals, buying medicines online, electronic medical records, wearable devices, disease management, etc.

Yes No I am not sure.

6. If you need to use digital healthcare services, which form of communication do you prefer?

Video Chat Phone Voice Other _____

Usability testing

Goals

The goal of this test is to find out what problems older people encounter when using the digital healthcare service platform, and to think how to enhance elderly people's experiences by improving the design and service of the digital platform.

Task

According to the services provided by a digital healthcare service platform, you can choose any of them to experience. We hope you can complete it. During the process, you can say anything you want, about your thoughts, feelings, difficulties, etc. You can express any discomfort you have.

Questions

1. What problems did you encounter with the experience you just had?

- a. Could you understand icons and its functions?
- b. Could you read text/information without difficulty?

2. Do you think the platform is easy to use?

3. User satisfaction: What score would you give this platform?

Score (1-10) _____

4. Would you like to continue using the platform to receive services next time?

5. Do you feel as if you can use a digital platform in an independent way?

6. How do you think this digital platform could be improved to make it easier for you to use?

介绍

近年来，数字医疗服务变得越来越流行。尤其是在疫情期间，越来越多的老年人开始通过数字医疗服务平台接受医疗服务。老年人可以在这个平台上与医生或医学专家进行交流和视频通话。在咨询结束时，老人还可以从医生那里得到处方。这些服务易于访问且节省时间。

该测试旨在了解老年人在使用数字医疗服务平台时遇到的问题。老年人在完成一项任务时可以说出他们想到的任何东西。这可能包括他们正在看、想、做和感受的东西。这使观察者可以深入了解参与者的认知过程。在可用性测试环境中，观察者被要求记录参与者所说和所做的事情，而不是试图解释他们的行为和言语，特别是注意他们遇到困难的地方。用户测试可以在参与者自己的设备上或在更受控的环境中完成。测试过程可以用视频录制，以便方便未来参考测试者所做的事情以及他们的反应。

注意

1. 请用手机或相机记录整个过程。
2. 主要记录老年人与数字平台的互动。例如，老年人如何使用手机进行操作。
3. 如果老人遇到问题，无法继续完成任务。我们可以帮助他们，但最好让老年人独立完成任务。

隐私声明

我们将询问一些问题，您的答案将被记录下来。所有测试都将记录在视频中。您是完全匿名的。如果您对任何问题感到不舒服，则无需回答。收集的数据将仅用于学术目的。

简短的问卷:

年龄: _____ 性别: 男 女

1. 您有哪些智能设备?

智能手机 笔记本电脑 台式电脑 平板电脑
其他 _____

2. 您通常在哪里接受健康关心服务?

家庭医生 医院 诊所 药店 数字健康关心服务平台
美容院 其他 _____

3. 您是否通过数字医疗平台接受过医疗服务?

是的 平台名称是 _____
哪种类型的医疗服务? _____
没有

4. 您认为您有足够的知识使用数字医疗平台吗?

是的 没有 我不确定

5. 您想接受数字医疗服务吗?

例如, 远程医疗、网络就医、线上购药、电子病历、可穿戴设备、疾病管理等
是的 不想 我不确定

6. 如果你需要使用数字医疗服务, 您更倾向哪种形式的交流?

视频通话 文字交流 电话交流 语音交流
其他 _____

可用性测试

目标

本次测试旨在了解老年人在使用数字医疗服务平台时遇到的问题，思考如何通过改进数字平台的设计和服务来提升老年人的体验。

任务

根据河南中医药大学第一附属医院微信公众号提供的健康关心服务，您可以选择其中任何一种进行体验。我们希望您可以完成它。在这个过程中，您可以表达任何您的想法、感受、困难、甚至抱怨等。您也可以表达您的不适。

问题

1. 您刚刚在使用数字平台时，遇到了哪些问题？
 - a. 您能理解图标及其功能吗？
 - b. 您能毫无困难地阅读数字平台中的文本和信息吗？
2. 您觉得这个平台好用吗？
3. 用户满意度：您会给这个平台打几分？

得分 (1-10) _____

4. 下次您还想继续使用这个平台接受服务吗？
5. 您觉得您可以独立使用这个数字平台吗？
6. 您认为如何改进这个数字平台可以更方便您的使用？

Appendix 3: The checklist and the evaluation result

Indicators	Evaluation standard		
	Poor (0)	Medium (1)	Good (2)
Part 1:	61/80		
User interface with understandable and perceivable information			
1.1 Understandable information	23/30		
1.1.1 Readable	12/16		
(1) Digital healthcare service platforms need to be easy for elderly users to understand and operate, with simple functions. The page can directly show what healthcare services the elderly can get.			2
(2) The expression of medical information should be simple, do not require the elderly to have background knowledge, do not use technical jargon (medical terminology) and system-oriented terms, and use understandable and readable text content.			2
(3) On the digital platform, the elderly can choose the language they are familiar with.	0		
(4) Captchas should be simplified to avoid characters and graphics that are difficult for the elderly to understand. Effective alternatives (such as repeatable audio captcha) can be used. It should also be designed according to the ability of the elderly.			2
(5) Information needs to be presented in a predictable order.		1	
(6) When elderly people use digital platforms for the first time, the beginner's guide is important and can help older people learn how to use main functions.			2
(7) All medical information needs to avoid the possibility of causing psychological stress to older people.		1	
(8) Digital platforms should provide labels or instructions when older users are required to input contents.			2

Indicators	Evaluation standard		
	Poor (0)	Medium (1)	Good (2)
1.1.2 Consistent identification	11/14		
(1) A digital platform's overall look and feel should be similar across all pages, but this does not mean every page follows the same layout.			2
(2) All the repeating elements keep the same. Typefaces, backgrounds, colour schemes, and encouraging tone can be consistent, which can positively impact older people's experiences.			2
(3) Visual consistency: all visual elements stay the same throughout the digital platform.			2
(4) Functional consistency: components with the same function keep the same form.		1	
(5) Internal consistency: the visual and functional elements are shown in the same place.			2
(6) External consistency: icons should follow the existing platforms and cultural conventions.		1	
(7) Real-world consistency: icons, words, and pictures should keep consistent with real-world experiences, observations, and perceptions. Older people can feel it is easier to understand and find the healthcare services they need.		1	
1.2 Perceivable information	18/28		
1.2.1 Text style	4/8		
(1) Larger sans-serif fonts are recommended. Condensed fonts should be avoided.			1
(2) Do not use too many font types. The number of font types is limited to two at most. If there are two fonts on a web page, the two fonts must be in harmony.	0		
(3) Using all capital letters can lead to higher levels of eyestrain and decreased readability.			2

Appendix 3: The checklist and the evaluation result

Indicators	Evaluation standard		
	Poor (0)	Medium (1)	Good (2)
(4) Fonts too similar can make text illegible, so each letter should have a distinctive shape. Letters that are airy and open are less likely to blur into closed shapes. Distinguishable beginnings and endings of letters help the eye recognize individual forms. Body text requires some contrast within letterform stroke width but should not go too far where certain strokes begin to disappear		1	
1.2.2 Font size		1/6	
(1) The font size depends on the distance between the reader and the screen. The font size in the main function and the main interface should be larger than 30 dp/pt. The font size of the main content area of a page should be not less than 18 dp/pt. This can ensure that older people have a pleasant and legible reading experience.	0		
(2) If possible, older people can adjust text size themselves	0		
(3) The number of letters on a line can contribute to the reader's fatigue, making sure line lengths are no more than 65 characters per line.		1	
1.2.3 Colour		9/14	
(1) According to recommendations from the handbook of computer-human interaction, digital platforms can use a maximum of five (plus or minus two) different colours.			2
(2) Older users can have a better reading performance, if the platform uses black texts on a white background.			2
(3) The movement and stroboscopic rate of dynamic visual elements should also be appropriately reduced.			2

Indicators	Evaluation standard		
	Poor (0)	Medium (1)	Good (2)
(4) According to the order of physical memory, colours take precedence over graphics. Using the same colour for the same service can make services easier to identify. By adding attributes of colour, elderly people can easily have access to services every time.		1	
(5) Textual explanations are helpful as a supplement of colour coding, as older people with colour blindness could understand.		1	
(6) The colour sensitivity of older people experiences a decline with age, and they become worse at distinguishing between similar colours, especially in the blue and green range. Important interface elements should avoid using the two colours. Warm colours are better choices than other colours.	0		
(7) High contrast can make the text much more readable on a device. The contrast ratio between text, images, icons and other elements is at least 4.5:1. It would be best to stay over 6.7:1. If the font size is larger than 18 dp/pt, the contrast is at least 3:1. The line spacing in a paragraph is at least 1.5 lines.		1	
1.3 Layout		10/18	
(1) In the layout of digital platforms, the functions that the elderly frequently use should be given priority. All information should maintain high discoverability. A practical layout can avoid dividing users' attention between multiple tasks or parts.			2
(2) The layout should use flat design, be as simple as possible, and avoid complicated decorative designs such as shadows, perspectives, and textures.			2
(3) Undo and return buttons should be available and easy to access.		1	
(4) A search bar near the top of a digital platform is helpful.			2

Appendix 3: The checklist and the evaluation result

Indicators	Evaluation standard		
	Poor (0)	Medium (1)	Good (2)
(5) Each information area of a digital platform introduces healthcare service types and content gradually over time instead of all at once.		1	
(6) Each service is distinguished by different colours and provides corresponding voice.	0		
(7) Concrete icons or realistic pictures are easier to understand for the elderly than abstract icons. An icon should be accompanied by descriptive text as much as possible. Verb phrases are easier to understand than noun phrases.		1	
(8) Small buttons should be avoided. There should be sufficient spacing between buttons to prevent accidental presses and touches.		1	
(9) Due to spatial and working memory decline, elderly people are more likely to get lost while navigating, so a digital healthcare service platform should avoid a very deep hierarchy. The structure of primary navigation keeps simple.	0		
1.4 Region's cultural norms		1/4	
(1) Cultural inclusion is critical, and all information should not discriminate and urge the elderly.		1	
(2) Each digital platform can choose a suitable information presentation method to highlight the local cultural characteristics and norms.	0		
Part 2: Digital interaction		29/64	
2.1 Motor control		15/22	
(1) Important reminders or icons should be enlarged proportionally. Clicking is the most straightforward operation for the elderly and is better than sliding.			2

Indicators	Evaluation standard		
	Poor (0)	Medium (1)	Good (2)
(2) For elderly people with relatively normal manual dexterity, a button size of 16.51 mm square and spacing of 3.17 mm to 6.35 mm are acceptable. For elderly people with poor manual dexterity, a button size should be at least 19.05 mm square and a larger spacing, from 6.35 mm to 12.7 mm, are appropriate. Buttons to be clicked should be at least 9.6 mm diagonally (40×40 dp/pt). Interface elements should be at least 11 mm diagonally (60×60 dp/pt).			2
(3) For older users, tabbing is better design than drag and drop actions, voice call, slow motion interface		1	
(4) The slow movement and shakes of fingers could reduce the success of gesture interaction, so gestures with multiple fingers should be avoided			2
(5) The digital platform can provide a large cursor for older people with low vision.	0		
(6) In touch screens, an option of zooming or magnification is not the best solution, because elderly users need to use two fingers.			2
(7) The audio or video on a digital healthcare service platform should include clear and familiar playback controls to allow older users to understand how to control it.			2
(8) For the elderly, inputting is a complicated operation, and it is better to provide more default options. In each step, it just needs to focus on one chief function.	0		
(9) Typing was a source of difficulty for many older users. Alternative methods should be provided. If an older adult has to type, a touchscreen keypad may be a better choice.	0		
(10) When elderly people log in to digital platforms, fingerprint login or face login are better methods, which can prevent them from forgetting the account and password.			2

Appendix 3: The checklist and the evaluation result

Indicators	Evaluation standard		
	Poor (0)	Medium (1)	Good (2)
(11) If older users need to submit information, some methods of error prevention need to be used. For example, submissions are reversible; Information should be checked for input errors and older users can have an opportunity to correct them; A mechanism is available for reviewing, confirming, and correcting information before submission.			2
2.2 Navigation		4/12	
(1) The navigational structure and menu headings of digital platforms should be simple. Designers should minimize sublevels in navigation and keep menus to a single function.			2
(2) Breadcrumb navigation is a way for older users to visualize their location on a digital platform, and it should be clear and prominent on every page so that elderly users can navigate easily back and forth or return to a page they are familiar with.	0		
(3) It is necessary to include a search bar with voice search so older people can search by voice. The exact keywords related to the search query should be provided.		1	
(4) When elderly people focus on each functional module through the mouse, keyboard or other means, the module should have noticeable changes.	0		
(5) Before the next step, elderly users need to be given effective prompts. When elderly people use contextual or other related functions, the digital platform should have significant operation guidance with text or picture, introduce these functions and services.		1	
(6) Use the home screen menu as a safe point of return.	0		

Indicators	Evaluation standard		
	Poor (0)	Medium (1)	Good (2)
2.3 Physical Limitations	7/20		
(1) The cognitive ability, vision, and hearing of elderly people become weaker than before, and the speed at which they process information and perform tasks slows, so they need more operation time without the time limit of server timeouts and inactivity warnings.			2
(2) Gradually introducing healthcare services can help prevent cognitive overload from slower mental processing speeds in the elderly population.	0		
(3) Clear feedback on progress and reminders of the end goal can help older users overcome memory issues.	0		
(4) Healthcare service processes should be completed within the same screen as much as possible, rather than multiple screens.		1	
(5) Reminders and tooltips can make some actions more age-friendly.		1	
(6) Procedures can be simplified by reducing unnecessary steps and minimizing the number of actions.		1	
(7) Avoid using only colour as a means of reminder. Text or voice are also effective alternatives.		1	
(8) Emotional support based on patience, praise, encouragement and comfort can help the elderly avoid anxiety and stress from digital devices or services.	0		
(9) After each step is completed, the system should encourage the elderly to have a positive attitude and confidence to complete the remaining steps.	0		
(10) In healthcare service platforms, elderly people can establish contact with family doctors, adult children, hospitals, community care workers, etc.		1	

Appendix 3: The checklist and the evaluation result

Indicators	Evaluation standard		
	Poor (0)	Medium (1)	Good (2)
2.4 Experience with technology	1/6		
(1) Timely information feedback is essential because it can increase user stickiness and retention.	0		
(2) Smart wearable devices of older people can be connected to the digital platform, which can collect and analyse data and provide some health advice. These suggestions are helpful to the elderly.	0		
(3) Haptic, visual, and aural feedback can help older people confirm whether the operation is completed successfully.		1	
2.5 Distractions	2/4		
(1) Unnecessary design elements could overwhelm older people and make it more challenging to accomplish what they are trying to accomplish.		1	
(2) Graphics can be added only to help elderly users complete a task.		1	
Part 3: Design patterns	15/30		
3.1 Responsive design	2/8		
(1) Contents of digital healthcare service platforms can be automatically resized and reshuffled to fit the dimensions of different devices. It can be accomplished with HTML templates or a mobile site.	0		
(2) It is essential to test the website's cross-cross browser compatibility.	0		
(3) The hamburger menu in the top corner is helpful for a mobile site.	0		
(4) Illustrations or icons should use scalable vector graphics (SVGs).			2
3.2 Privacy and security of personal information	3/6		
(1) Security issues cause anxiety to elderly users. Digital healthcare service platforms should guarantee data security and protect the privacy of elderly people.			2

Indicators	Evaluation standard		
	Poor (0)	Medium (1)	Good (2)
(2) Elderly people may be more cautious than younger people about whom they share data with, and they need to choose which organizations and individuals they want to share information with.	0		
(3) Privacy and security settings should be easy to manage. How information is used should be transparent.		1	
3.3 Elderly-oriented design		10/16	
(1) Do not make assumptions about prior knowledge.		1	
(2) The digital platform should provide the elderly with staff service or other easier-to-understand ways to help them access healthcare services.	0		
(3) Advertisements and pop-up windows will interrupt the operation process of the elderly and should be avoided as much as possible.			2
(4) Older people are prone to read all the lines on the digital platform. Long lists should be avoided.			2
(5) When older people face problems, they are more likely to turn to online tutorials for help. It is necessary to explain how to use these functions.		1	
(6) After an update, it is better to keep healthcare services in the same position. Otherwise, older people may be hard to find a new position.		1	
(7) Older people can perform better when using touchscreen interfaces and tablets.			2
(8) Co-design: The elderly should be included in the design process. User participation can contribute to the improvement of service. Some research methods, such as observation, thinking aloud, and scenario, can be used in the process.		1	

Appendix 3: The checklist and the evaluation result

Indicators	Evaluation standard		
	Poor (0)	Medium (1)	Good (2)
Part 4: Accessibility	5/20		
4.1 Additional aids	0/4		
(1) Digital platforms can provide a screen reader to help older people with decreased vision hear text content. Voice readers require high voice clarity, slow speech speed, and repeatability.	0		
(2) Screen readers cannot interpret images, artwork, drawings and other graphic elements, so adding text alternatives can be an easy way to make digital platforms accessible to people with specific disabilities.	0		
4.2 Multiple interaction methods	2/10		
(1) The use of the keyboard should be minimized.	0		
(2) Mis-clicks happen very frequently for older people. Error tolerance needs to be applied to form fields and search engines.		1	
(3) Multiple interaction methods are necessary for older people with different disabilities, such as physical interaction, virtual interaction, and voice interaction.	0		
(4) Platform operators can provide subsidies or incentives targeting specific digitally disadvantaged segments to encourage the elderly to use the platform.		1	
(5) Tabbing with audio confirmation can help older people with reduced vision.	0		
4.3 Robust	3/6		
(1) A screen-reading software is effective.	0		
(2) Input assistance can help reduce errors that older adults make.			2
(3) Maximize compatibility with assistive technologies.		1	

Indicators	Evaluation standard		
	Poor (0)	Medium (1)	Good (2)
Part 5: Service scenario	17/18		
(1) The digital platform should provide common service scenarios so that the elderly can understand how to use these healthcare services in scenarios			2
(2) These service scenarios should be displayed in the form of texts, pictures, or video.			2
(3) The elderly can make appointments for the hospital's department on a digital healthcare service platform.			2
(4) Elderly people can pay online for their registration and medical costs.			2
(5) Digital medical card			2
(6) Navigation map		1	
(7) Home delivery service			2
(8) Medical report online			2
(9) Follow-up consultation online			2
Part 6: Multi-channel learning	5/8		
(1) It is crucial to provide older users with enough information and tutorials on digital platforms for helping them get healthcare services.			2
(2) In addition to online tutorials, platform operators can provide coaching services, community classrooms, and user manuals for elderly people to help them understand and learn how to use these service platforms.		1	
(3) Designers need to help the elderly build usage habits. If it is easy to access digital platforms and services, elderly people have more opportunities to build habits.		1	
(4) Digital platforms need to help the elderly build usage habits. If it is easy to access digital services, elderly people are more willing to build habits.		1	

Appendix 3: The checklist and the evaluation result