DESIGN THINKING FRAMEWORK OF PERVASIVE GAME TO PROMOTE FITNESS AMONG OLDER ADULTS IN CHINA

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ABSTRACT

This study aims to develop and validate a design thinking framework for using pervasive games as a creative branding strategy on fitness among older adults in China. A provisional framework called GISE-B was developed through a systematic literature review to examine the relationship between game design and three domains of design thinking, i.e. interactive design, service design and experience design. A bespoke pervasive game titled Agoing was designed, developed and validated for use in this study to examine the behavioural intention (BI) of older adults, specifically to engage in fitness exercises. As an instance of the GISE-B framework of design thinking, the game was tested by adapting the Unified Theory of Acceptance and Use of Technology (UTAUT) model. The adapted version of UTAUT was named as the UTAUT-LK model, which consists of five independent variables: performance expectancy, effort expectancy, facilitating condition, social influence and hedonic motivation. A single-group pretest / posttest quasi-experiment was conducted with 378 participants using a 20-item questionnaire. Collected data were analysed using SPSS and AMOS, where nonparametric statistics and structural equation model (SEM) were run to test five hypotheses. After modifying the SEM, effort expectancy (EE, $b = 0.410$, $p = 0.033$), social influence (SI, $b = 0.500$, $p = 0.029$), and hedonic motivation (HM, $b = 0.539$, $p < 0.001$) significantly and positively affect behavioural intention, whilst the effect size of the UTAUT-LK model exceeds 80% ($R^2 = 0.827$). In conclusion, this demonstrates that with good design, older adults' behavioural intention toward pervasive games enhances significantly. Furthermore, the researcher proposed the Seven Guiding Principles of pervasive game design for older adult players. This study implies that a pervasive game designed and developed using the GISE-B design thinking framework can enhance older adults' intention to play the game and help them with fitness.

KERANGKA PEMIKIRAN REKA BENTUK PERMAINAN PERVASIF UNTUK MENGGALAKKAN KECERGASAN DALAM KALANGAN WARGA EMAS DI CHINA

ABSTRAK

Kajian ini bertujuan untuk membangun dan mengesahkan kerangka pemikiran reka bentuk permainan pervasif sebagai strategi penjenamaan kreatif dalam kalangan warga emas di China. Kerangka sementara yang dipanggil GISE-B, telah dibangunkan melalui kajian literatur sistematik untuk mengkaji hubungan antara reka bentuk permainan dan tiga domain pemikiran reka bentuk (interaktif, perkhidmatan dan pengalaman). Permainan pervasif dibangunkan untuk menghuraikan tingkah laku warga emas berfokuskan latihan aktiviti kecergasan. Teori Penerimaan dan Penggunaan Teknologi Bersepadu (UTAUT) diadaptasi dan dinamakan sebagai model UTAUT-LK telah dijadikan alat analisis data. Seramai 378 sampel telah menjalani pra ujian dan pasca ujian menggunakan satu soal selidik yang mengandungi 20 item. Data yang dikumpul telah dianalisis menggunakan SPSS dan AMOS yang melibatkan statistik non-parametrik dan model persamaan struktur (SEM) untuk menguji lima hipotesis. Setelah SEM dimodifikasikan, jangkaan usaha (EE, $b = 0.410$, $p = 0.033$), pengaruh sosial (SI, $b = 0.500$, $p = 0.029$), dan motivasi hedonik (HM, $b = 0.539$, $p < 0.001$) secara signifikan dan positif telah mempengaruhi niat tingkah laku, manakala saiz kesan model UTAUT-LK telah melebihi 80% ($R^2 = 0.827$). Secara kesimpulan, kajian ini membuktikan bahawa dengan reka bentuk yang baik, niat tingkah laku warga emas terhadap permainan pervasif dapat meningkat dengan ketara. Tambahan pula, kajian ini menghasilkan Tujuh Prinsip Panduan Reka Bentuk Permainan Pervasif untuk Warga Emas. Kajian ini memberi implikasi bahawa permainan pervasif yang direka dan dibangunkan menggunakan kerangka pemikiran reka bentuk permainan pervasif GISE-B boleh meningkatkan niat orang dewasa yang lebih tua untuk bermain permainan dan membantu kecergasan mereka.

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
AMOS	Analysis of Moment Structure
ANOVA	Analysis of variance
AR	Augment Reality
AVE	Average Variance Extracted
BI	Behavioural Intention
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CR	Composite Reliability
DDRI	Data-Driven Retrospective Interviewing
DSR	Desing Science Research
DSM	Domain-Specific Modelling
DPS	Dynamic Pervasive Storytelling
EBSCO	E.B.Stephens Company
EE	Effort Expectancy
FC	Facilitating Conditions
HM	Hedonic Motivation
MDD	Model-Driven Development
MOBAs	Multiplayer Online Battle Arenas

OPOS	Outdoor Play Observation Scheme
PE	Performance Expectancy
RLE	Real-World Events
RMSEA	Root Mean Square of Approximation
RMR	Root Mean Square Residual
RPG	Role-Playing Game
PRISMA	Pre-Recording Systematic Reviews and Meta-Analysis
SEM	Structural Equation Model
SI	Social Influence
SLR	Systematic Literature Review
SMC	Square Multiple Correlations
SSPS	Statistical Package for the Social Sciences
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UI	User Interface
UTAUT	Unified Theory of Acceptance and Use of Technology
VISOLE	Virtual Interactive Student-Oriented Learning Environment
VR	Virtual Reality

APPENDIX LIST

CHAPTER 1

INTRODUCTION

1.1 Overview

The construction of a ‘healthy China’ has risen to the national strategy, and the nation has set off a wave of fitness. Scientific fitness has gradually penetrated among the nationals. In the current rapid economic development, older adult groups join the wave of fitness to enhance their physical fitness and increase self-confidence, positive energy, and happiness.

Many years ago, China had not entered an ageing society. This situation has persisted for a long time. However, the rate of ageing in Chinese society has continued

to accelerate in recent years, leading to the older adult industry not being fully recognized. Older adult games are a relatively new concept in the older adult industry. As an emerging industry, older adult games are still in their infancy in China and are unknown to consumers. Therefore, this study aims to find ways to design the pervasive game for the older adults group and promote the concept of using the pervasive game in older adults.

The pervasive game relies on physical space, emphasizing the relationship between the outdoors and the public, which is suitable for older adults' active and healthy lifestyles (Malik et al., 2020). The interaction, immersion, and experience of the game brought to older adults by the pervasive game cannot be obtained in any other way. This also accords with older adults' pursuit of authenticity, living environment, and playing games at any time.

The researcher proposes some design ideas for games for older adults in this study. A theoretical study of the application in the older adult population, combined with technology, provides the basis for the most effective framework system at the most appropriate time. Against the background of detailed investigation and analysis, this study investigates the attributes and characteristics of experience design, interaction design, game design, and service design in pervasive games. This scientifically analyzes their influencing factors and development trends. Provides an accurate industry direction for using pervasive games as creative branding for older adults.

Meanwhile, this study will provide a framework and guiding principles for designing and developing pervasive games with older adults on fitness.

Firstly, the research aims to create a design thinking framework for designing and developing a pervasive game as a creative branding strategy among older adults on fitness. Secondly, the relationship of pervasive games as creative branding includes and integrates interactive design, user experience design, game design, and service design to suit older adults on fitness. Then, using a quantitative research approach to collect information about older adults' perceptions of pervasive games and analyze them. Finally, at the end of the study, the framework will be revisited and revised concerning the findings and contributions.

1.2 Research Background

1.2.1 Older Adults

China has a large population. Another indisputable fact is that China's population ageing is accelerating. The Chinese government considers those over the age of 60 years to be defined as older adults. The National Information Office of the People's Republic of China held a press conference on the main data results of the seventh national population census on May 11, 2021. The population aged 60 years and above

was 264.02 million, accounting for 18.70%, among which the population aged 65 and above was 190.64 million, accounting for 13.50% (National Bureau of Statistics of China, 2021).

At the same time, during the 14th Five Year Plan period, China's older adult population will exceed 300 million, from mild to moderate ageing (National Bureau of Statistics of China, 2021). The ageing population is further deepening and will continue to face the pressure of long-term balanced development in the future. In Henan province, where the researcher lives, the ageing population continues to deepen. At the end of 2021, 13.830 million people aged 65 years and above lived in Henan province, accounting for 13.99% of the resident population (Henan Provincial Bureau of Statistics, 2022). According to statistics, in the city where the researcher lives, Zhengzhou, the proportion of people aged 60 years and above in the resident population is 12.8%. Among them, the proportion of people aged 65 and above in the resident population is 9.0% (Henan Provincial Bureau of Statistics, 2022).

Census data show: that first, the older adult population is huge. Second, the ageing process has been significantly accelerated. Third, there are obvious differences in ageing levels between urban and rural areas. Fourth, the quality of the older adult population continues to improve. The report shows that the ageing of the population is an important trend of social development and is also the basic national condition. This situation is both a challenge and an opportunity. Such changes will have a far-reaching

impact on economic and social development. Therefore, the Chinese government has established a national development strategy and will actively respond to the ageing population as a long-term strategic task (PR Newswire, 2021).

From the perspective of challenges, population ageing will reduce the labour force supply, increase the burden of family pensions, and pressure the basic public service supply. At the same time, the ageing of the population has promoted the development of the 'silver economy,' expanded the consumption of products and services for older adults and helped promote technological progress. All of this opens up new opportunities. Moreover, among the population aged 60 years and above in China, older adults aged 60-69 years account for 55.83%. Most of these older adults have the advantage of knowledge, experience, and skills. Their physical condition is good, and they have great potential to play with the residual heat fully.

In 1970, Japan officially entered the ranks of ageing countries when the percentage of people over 65 reached 7%. However, during the 1960s-1980s, China was amid a baby boom and seemed far from an ageing society. Official data predicted that in 2022, China would enter an 'aged society,' in which the proportion of the aged population exceeds 14 per cent (see Figure 1.1). Therefore, improving the working system and mechanism for older adults, strengthening the construction of the health and old-age service system for older adults, and building an age-friendly society should focus on the work of the national and local governments.

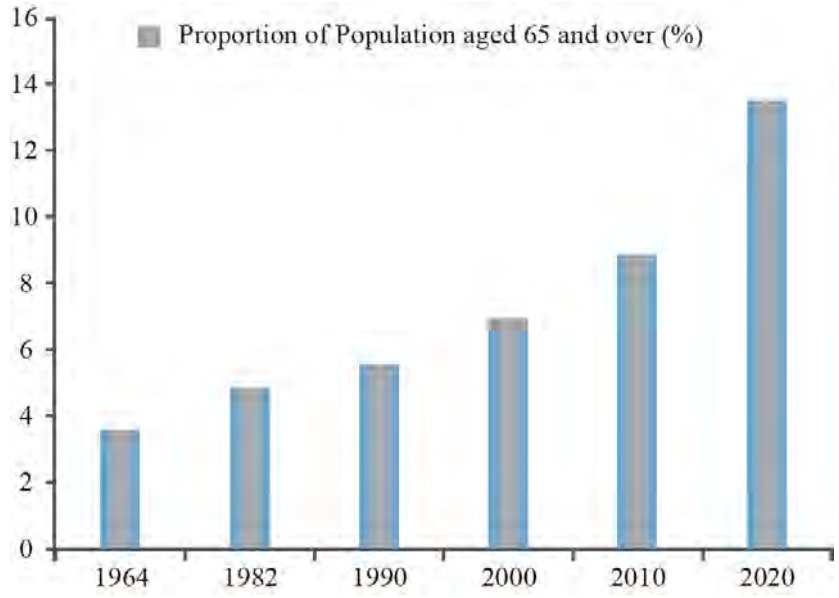

Figure 1.1. The Proportion of the Older Adult Population in China

The State Council of the Central Committee of the Communist Party of China promulgated the Opinions on Strengthening the Work on Ageing in the New Era at the end of 2021. Effectively responding to the ageing of the population is a matter of national development, the well-being of hundreds of millions of people, social harmony, and stability, and it is of great significance to the overall construction of a modern socialist country. In order to implement the national strategy to cope with the ageing population actively, strengthen the work of older adults in the new era, and enhance the sense of access, happiness, and security of most older adults, the following views are presented. All places should support street communities to actively provide cultural and sports activities for older adults by revitalizing vacant houses, parks, shopping malls, and other resources. Organize cultural and sports activities to combine entertainment, fitness, culture, learning, consumption, and communication for older adults. Cultivate a grassroots cultural and sports backbone to serve older adults, improve the

participation rate and quality of cultural and sports activities for older adults, and work with culture, tourism, sports, and other departments to do a good job of regulation and management. Develop senior tourism products and lines, and improve the quality and level of senior tourism services. Counties (cities, districts, banners) should integrate existing resources to set up suitable education, culture, fitness, and communication places for older adults (CPC Central Committee and State Council, 2021).

1.2.2 Health Demand

In 2016, the General Administration of Sport and the State Council promulgated the 'National Fitness Program (2016-2020) .' In 2018, the number of people who regularly participated in physical exercise reached 650 million, accounting for 48.3% of the national population (State Council, 2016). In 2020, the number of people participating in physical exercise once a week or more will reach 700 million (State Council, 2019). The number of people who regularly participate in physical exercise will reach 435 million. The total sports consumption is 1.5 trillion yuan, and the goal is to turn national fitness into a national card. The large fitness population has brought vast demand to the fitness industry (XinHuaNet, 2016).

In contrast, the fitness problems of older adults are often overlooked. Such a large older adult population in China faces a rather disappointing situation. After

retirement, older adults, driven by the traditional Chinese family concept, will contribute their final energy to the next generation of children and devote themselves to their grandchildren and granddaughters, spending a lot of time and energy. If they want to participate in fitness activities actively, they will also be bound by traditional Chinese culture and the real environment. The older adult female group only dances in the square near the community and becomes the noise of others. The older adult male group only pulls a horizontal bar in the park near the community, suffering from contempt. The older adult group needs a fitness method to develop psychologically and physically. With the continuous upgrading of the healthy consumption demand of older adults in the modern era, the traditional sports style has become more challenging to meet the new self-consciousness, the upgrading of consumer quality, and the pursuit of individuality (Bonus et al., 2017; Koivisto et al., 2019; Wei & Wang, 2019).

In order to implement the national strategy of actively coping with population ageing and promote the coordinated development of the ageing business and industry, the '14th Five Year Plan for the Development of the National Ageing Industry and the Senior Care Service System' has been formulated (State Council, 2022). The Plan sets the development goals for the 14th Five Year plan period. This goal is to continuously expand the supply of older adults' services and improve the health support system for older adults. At the same time, the development of innovative and integrated multi-industry services for older adults, the continuous enhancement of the ability to guarantee the elements and a more livable social environment for older adults. It

promotes the whole society to cope with the pattern of population ageing's initial formation actively, and the older adults' sense of access, happiness, and a sense of security significantly improved.

Following the '14th Five Year Plan' on February 2021, the State noticed the '14th Five Year Plan for Healthy Ageing.' Health is the basic condition for the ageing group to continue their good lives and is also an important symbol of the country's wealth and national revitalization. The plan noted that promoting healthy ageing can synergistically promote the Healthy China strategy and the national strategy of actively coping with population ageing, and a good job may be 'doubly rewarded'. In contrast, a poor job may cause a 'double loss.' Therefore, the Plan deserves 'double attention.' Around the development goals, the 'plan' proposed that by 2025, the allocation of resources for older adults' health services be more reasonable. Health services for older adults should be integrated and continuous, and the nation should establish a health service system for older adults covering both urban and rural areas. The health protection system for older adults is sound, and the social environment for older adults is friendly. The health needs of older adults are better met, their health level continues to improve, and their healthy life expectancy continues to increase. The Plan ranks strengthening health education at the top of all tasks and proposes to expand the content of health education for older adults. At the same time, a diversified pattern of supply of health education services for older adults is formed. Furthermore, to innovate in providing health education services for older adults. Finally, implement special projects

for older adults' health education (National Health Commission, 2022).

From a worldwide perspective, chronic diseases in older adults are a global problem. A new American Cancer Society study shows that older adults with higher physical activity and shorter sitting times have better overall physical and mental health. The study, published in Cancer, suggests that regular moderate-to-vigorous physical activity and shorter sitting times are associated with higher overall physical and mental health for older cancer survivors and older adults (CPC Central Committee and State Council, 2019; Rees et al., 2020). In the summer of 2021, the State Council issued a notice on the National Fitness Plan (2021–2025). In order to promote a higher level of national fitness development and better meet the fitness and health needs of the people, according to the 'national fitness regulations,' the development of the plan is "To improve the fitness facilities for the ageing, research and promote physical fitness and leisure projects suitable for older adults, and organize events suitable for older adults." (State Council, 2021)

In China, the most populous province is Henan. Henan Province Government released the "special research report on the situation of the national fitness movement." which mentioned that during the '13th Five Year Plan' period, the total size of the province's sports industry in 2019 was 123.24 billion yuan, with an average annual growth of 16.2% from 2017 to 2019. By the end of 2020, the number of sports venues in the province was 275,000, and the per capita area of sports venues reached 2 square

meters. Henan Province has a total of 16,700 legal entities in the sports industry, employing 174,700 people, and the number of people who regularly participate in physical exercise in the province reaches more than 35 million, accounting for 31% of the total population. The province's existing 7396 various types of sports social organizations, 2086 sports clubs, 45,000 mass fitness sites and social sports instructors, 292,000 people, respectively, than the end of the '12th Five Year Plan' by 79%, 112%, 88%, and 79% (The People's Congress of Henan Province, 2021).

1.2.3 Relevant Policy

At the end of 2020, the Ministry of Human Resources and Social Security issued the Implementation Plan on Further Optimizing Public Services of Human Resources and Social Security to Effectively Address the Difficulties of Using Smart Technologies for Older Adults. The plan covers pensions, social security cards, health insurance cards, and all aspects of life for middle-aged and older adults (Ministry of Human Resources and Social Security of the People's Republic of China, 2020). The General Office of the State Council issued a notice on November 24, 2020, on the implementation plan to effectively address the difficulties of using smart technology for older adults (The General Office of the State Council, 2020). The text mentions that with the rapid development of the Internet, big data, artificial intelligence, and other information technology in China, intelligent services are widely used, profoundly changing the

mode of production and life and improving social governance and service effectiveness. Nevertheless, at the same time, China's ageing population is growing rapidly. Many older adults cannot access the Internet, use smartphones, travel, medical care, consume, and other daily life inconveniences, and cannot fully enjoy the convenience of intelligent services. Older adults face the 'digital divide' problem, which is increasingly prominent. To further promote the solution to the difficulties encountered by older adults in the use of intelligent technology, the older adults better share the fruits of information technology development and the development of this implementation plan (Ministry of Industry and Information Technology, 2021a).

The government requires adhering to people-centred development thinking, meeting the people's growing needs for a better life, and promoting the construction of a wisdom society that fully considers the needs of older adults. This adheres to the traditional service methods and intelligent service innovation in parallel and effectively solves the difficulties encountered by older adults in intelligent technology (Ministry of Industry and Information Technology, 2021c). According to integrated epidemic prevention and control promotion and economic and social development work requirements. It focuses on the high-frequency matters involved in the daily lives of older adults. It does a solid job of serving older adults to enhance the well-being of all people, including older adults, so that older adults in the development of information technology have a greater sense of access, happiness, and security (Ministry of Industry and Information Technology, 2021b).

The work effectively solves the difficulties older adults encounter in intelligent technology under policies and society's joint efforts. Most older adults can better adapt to and integrate into the fashionable society. The government requires steady progress on related work plans: By the end of 2020, focus on promoting the traditional services to protect the bottom in place, and urgently introduce and implement several effective measures to solve the most pressing problems of smart technology for older adults and effectively meet the basic needs of the older adults; By the end of 2021, around the high-frequency matters and service scenarios such as travel, medical care, consumption, recreation, and business for the older adults, the traditional service methods are perfect for promoting the older adults to enjoy intelligent services more generally; By 2022, the level of intelligent services for older adults will significantly improve, and the convenience will be continuously improved. Therefore, the online and offline services will be more efficient and coordinated, and a long-term mechanism to solve the 'digital divide' faced by older adults will be established.

In particular, the policy pointed out to facilitate the older adults' cultural and sports activities and enrich the intelligent channels for them to participate in cultural and sports activities. Public cultural and sports institutions, cultural, sports and tourism enterprises are guided to provide more age-appropriate intelligent products and services while carrying out rich traditional cultural and sports activities. Develop and design age-appropriate intelligent applications for square dancing and mass singing for common cultural needs and provide convenience for social entertainment for older

adults. Explore virtual reality, augmented reality, and other technologies to help older adults enjoy online tours, games and exhibitions, physical fitness, and other intelligent services (Ministry of Industry and Information Technology, 2021d).

The government requested especially facilitating intelligent products and service applications for older adults. Expand the supply of ageing-appropriate intelligent terminal products. Promote the ageing-appropriate transformation of smartphones and other intelligent terminal products. They have a large screen, large font, large volume, large battery capacity, simple operation, and other more convenient characteristics for older adults. Develop intelligent terminal products such as intelligent assistive devices, intelligent homes, health monitoring, and older adult care. Release the promotion catalogue of intelligent health and older adult care products and services, pilot demonstrations of applications, and promote the continuous optimization and upgrading of intelligent terminals under ageing requirements. Build a public service platform for standard intelligent, healthy older adults' care terminal equipment and enhance age-appropriate product design, testing, and certification capability.

1.2.4 Design Trends

At present, intelligent technology is changing daily, greatly changing human lives. The emergence of fast payment makes people’s travel lighter; the rise of online ticketing

has solved difficult queuing and ticketing; the platform of 'Internet + government' is also more conducive to building a communication bridge between the government and the public.

However, many older adults do not have smartphones and are not familiar with intelligent devices leading to many difficulties and troubles. During the epidemic, older adults were repeatedly blocked from accessing various public places because they could not show their 'health codes.' The older adults could not say their destinations on public transport and could not register online or purchase tickets, facing new 'difficulties in seeing a doctor' and 'difficult to travel'; do not understand the APP reservation and a series of problems. The ageing population situation is serious and should attract the attention of all aspects of society. Protecting older adults' legitimate rights and interests is a major national policy. Therefore, design for them is a common responsibility of society.

The 'digital social ageing' issue must be put on the agenda, and the 'digital divide' needs to be crossed urgently. This is necessary to effectively solve the difficulties of using intelligent technology for older adults and improve ageing-friendly Internet applications and accessibility. By the end of 2022, the level and convenience of smart services for older adults will be significantly improved, online and offline services will be better coordinated, and long-term mechanisms bridging the digital divide will be established, according to the plan.

In China, the Ministry of Industry and Information Technology has recently organised a one-year special action for Internet application ageing and accessibility transformation nationwide from January 2021. The special action focuses on the information life needs of older adults and the disabled, extensively mobilizes all social forces and favourable factors, and integrates administrative guidance, technical promotion, credit evaluation, and other means. The special action promotes the ageing and accessibility transformation of Internet websites and mobile applications. The special action focuses on solving the difficulties older adults encounter in the face of intelligent technology and promotes information technology that fully considers the needs of older adults. The special action also promotes the construction of an information-based society that fully considers the needs of older adults. The special action significantly improves the level of ageing-appropriate Internet applications and the accessibility rate and enhances the welfare of all people, including older adults (The General Office of the State Council, 2020).

Technological progress is for the people, and the increasingly large group of older adults must not be ‘forgotten in the corner.’ Developing ageing-appropriate technical products and improving ageing-appropriate technical services are inevitable requirements for building a civilized society and a silver hair industry with great development prospects. The opportunity to meet the demand and promote the ageing-appropriate transformation of smart terminal products such as smartphones; develop smart assistive devices, smart homes, health monitoring, older adults care, and other

smart terminal products. At the same time, it promotes the ageing-appropriate transformation of Internet websites and mobile applications such as government services, community services, news media, social communication, life shopping, and financial services. These are closely related to the daily life of older adults. Ageing-appropriate technical products and services could strengthen the cultural care of mobile games for older adults so that more of them can share the technological dividends brought by the progress of the times (Chin et al., 2017).

In terms of product development, developing products suitable for older adults and promoting the development of the silver hair economy. Considering the living habits of older adults and developing new smart home appliances that are convenient, simple, and fashionable to improve the degree of 'ageing appropriateness.' For example, augmented reality games increase the design of voice prompts, timely reminders, and various thoughtful service functions for older adults - a more intelligent and interesting life for older adults in old age (Lim et al., 2019).

In recent years, one of the hottest Internet developments has been the 'digital revolution', especially with the new epidemic that swept the world in 2020, accelerating digitalization. The design of an age-appropriate user experience became one of the hot points of discussion. "Promote intelligent services to adapt to the needs of older adults and to do so without allowing intelligent tools to cause obstacles to older adults in their daily lives." (Premier Li Keqiang of The State Council, 2021). Ageing design, or digital

ageing, seems to be a kind of social care for older adults. People will inevitably go senile. Digital ageing is to solve the current ageing problem and explore the future digital life of everyone. Life is destined to age, but the pace of technological progress is unlikely to slow down. Designing games for older adults with digital thinking is an important direction of today's game design thinking (Foo et al., 2018).

1.2.5 Games for Older Adults

The concept of pervasive games has been popular abroad for a long time, but its acceptance in China is disappointing. In China, the design development and implementation of pervasive games are rare. There is little research on pervasive games, and almost no pervasive games were developed and properly implemented for older adults. As a result, there is a gap in the market for older adult games in China (InvestGame, 2021).

The pervasive game is a pursuit of the player's real experience. This game can be played anywhere based on the real world and partners. This kind of game evokes people's freedom of gameplay. The pervasive game is a type of game with great potential. Combining real-world games with high and new technologies will bring players from the virtual world into real life and a different game experience (Kopeć et al., 2017; Malik et al., 2020).

The characteristics of the pervasive game are suitable for the healthy living concept of older adults. With the rapid development of the older adult consumer market, the older adult group game industry will also have a vast market as part of the older adult industry (GameLook, 2015). For many new things, older adults have changed from bystanders to active participants (GameLook, 2016). Understanding older adults' health needs and designing games that match their fitness goals is of tremendous social and practical significance.

This study proposes a framework for designing and developing pervasive games for older adults. At the same time, the older adult group in Chinese cities, combined with their fitness and entertainment needs, based on research and development, to create a pervasive game for the older adult group. Then, the target population was invited to play the game, and many questionnaire data were collected. Based on data analysis, the research finding is put forward. Finally, study the relevant characteristics and principles using the pervasive game in older adults, discuss various factors affecting the user in older adults and explore the development trend using the pervasive game in older adults.

1.3 Problem Statement

Although China is a big game industry, this status is limited to video games such as

online games and mobile Internet games. Understanding the game is also the traditional game type that uses the electronic screen as the game interface and only needs input through the mouse and keyboard or finger swipe. However, Chinese people's cognition level of the pervasive game is generally low or absent. The older adult group is even more scornful about the game concept, not to mention contact with the pervasive game.

The pervasive game is an integral part of ageing development and is an important trend in the future development of the fitness industry. How to combine the older adult group to develop a pervasive game suitable for its application is imminent.

1.3.1 Design Perspectives

There is much research on the pervasive game itself but rarely looks at them from design perspectives. The most well-known games among pervasive games are Ingress and Pokémon Go. In this case, most studies on Pokémon focus on its social attributes (Evans & Saker, 2019; Wang et al., 2018), while most studies on Ingress focus on spatial attributes (Laato, Inaba, & Paloheimo, 2020; Sengupta et al., 2020). These studies rarely explore pervasive games from the perspective of design attributes.

Social changes are happening all the time in the context of China's rapid development. New things like the creative branding of games, which are highly

dependent on economic development, are constantly impacted by technology and art. 5G, big data, cloud computing, artificial intelligence, virtual reality, hologram, and other high-tech factors control interactive media of various games. In the meantime, user experience, service design, game thinking, physical interaction, likewise control different expressions of games. Interactive design principles and art design aesthetics all constrain interactive media development. Under the influence of many factors with the development of society, designing games suitable for the older adult population and how to grasp the development trend for games suitable for the older adult population are the focus of this study.

1.3.2 Game Atmosphere

Video games were a popular way to take a break during the COVID-19 pandemic. Video games helped build connections and communities when people needed them most. According to a survey conducted by the Entertainment Software Association in 2021, gamers agreed that video games bring together different types of people (89%) and make experiences accessible to people of all abilities (88%). In China, Tencent's Honor of Kings has become the largest mobile game in the world, generating USD 10 billion in revenue to date. As with other mobile game markets, the global New Crown virus pandemic and blockade triggered a surge in global MOBA player spending, with average monthly revenue up 43% year-over-year in 2020. Revenues in the subgenre

continue to grow, driven by King's Quest, with average monthly revenue up 14% through 2021 to more than USD 300 million per month. Known as 'Arena of Valor' in the West since its release in 2015, 'Glory of Kings' has become the highest-grossing mobile game on the App Store and Google Play worldwide, with total player spending exceeding USD 10 billion. The game continues to be a huge success and will have more than USD 2 billion in revenue by 2021 (Sensor Tower, 2021).

Even though China has an extensive gaming industry, there needs to be more work on the pervasive game atmosphere. Successfully pervasive games like Pokémon Go and Ingress have been popular in other countries for years (Cerezo et al., 2022). But China doesn't have a mature, large-scale commercial game like Pokémon Go or a mature, large-scale social game like Ingress that is popular in society (Shang et al., 2015). The key is the lack of actual examples of successful pervasive games in China. Therefore, let alone a pervasive game developed specifically for older adults that even represents the idea of fitness.

1.3.3 Empirical Studies

There are few empirical studies have been conducted on pervasive games for older adults. Among some studies, there are empirical studies on players' motivations to use (Zsila et al., 2018), some empirical studies on players' intention to continue using (Jang

& Liu, 2019), and some empirical studies on players' traits and gratifications (Dunham et al., 2021). However, they have rarely conducted empirical studies on older players of pervasive games.

As mentioned in the previous section, few games are designed for older adults, and almost no pervasive games are designed for older adults (Laato, et al., 2020). In such a context, empirical studies on pervasive games for older adults are rare. Designing questionnaires, collecting data, analyzing data, and so on are the main empirical research methods that rarely appear in studies of games for older adults. There are few quantitative methods for analyzing games for older adults, let alone actively applying these methods to pervasive games developed specifically for older adults.

1.3.4 Ageing-Friendly

There is insufficient research on creative branding design for ageing, especially on pervasive games. Many scholars study the famous Pokémon Go game, but most research subjects are young people, children, and a few older adults (Gervasoni, 2018). Although many studies are aimed at older adults in some other fields, most are in product or environmental design, and few are in game design (Sanahuja, 2019). In Japan, Luciano scholars' study pervasive game design to evaluate social interaction effects on physical activity levels among older adults (Santos et al., 2019). Nevertheless,

there are no such studies in China.

Creative branding design research in China has grown significantly, and academia has paid much attention to creative branding research. However, creative branding design concepts and creative branding thinking to pervasive games for older adults are relatively rare. As a result, there is relatively little academic research on pervasive games (Marchessault, 2020). Brand research articles on pervasive games are still relatively few, and brand research on pervasive games integrated with older populations is almost non-existent. Therefore, no detailed or comprehensive research results on creative branding for pervasive games for older adults exist. Understanding the brand concept of pervasive games and clearly defining the brand characteristics of pervasive games for older adults need to be addressed.

1.4 Research Objectives

Under the background of China's 'big health' industry, this study examines creative branding through a pervasive game from the perspective of the urban older adult group in China. First, the primary task of this study is to identify and develop a design framework for pervasive games. Second, according to the problem statement, this framework contains relevant design thinking aspects of pervasive games, which is an important area in this study. And then, this framework must be based on pervasive

games as a creative branding strategy. Thus, the RO1 follows:

RO1: To identify and develop a design thinking framework for pervasive games as a creative branding strategy on fitness among older adults in China.

The research must have an instance of pervasive games for validating the design thinking framework. Therefore, the researcher designed a pervasive game for older adults based on the proposed design thinking framework (see Chapter 3). The purpose of this pervasive game instance, which includes five types of design thinking, is to a creative branding strategy on fitness among older adults. These older adults would enhance their behavioural intention after playing this instance of the pervasive game. Thus, this leads to the formation of RO2, as shown below:

RO2: To design an instance of pervasive games on fitness for older adults to enhance their behavioural intention.

This instance of pervasive games should be used to validate this design thinking framework, specifically by examining whether the older adults would enhance their behavioural intention or not after playing the pervasive game. If this instance could enhance older adults' behavioural intention, the pervasive game must have some good design. According to the problem statement, a good pervasive game is reflected in game design, interactive design, service design, experience design, and branding design.

These designs correspond to some variables: hedonic motivation, effort expectancy, facilitating conditions, performance expectancy, and social influence. For example, if the pervasive game has a good experience design, older adults' performance expectancy positively affects their behavioural intention after playing it. The same is true for the remaining four design domains. So, validate that older adults' performance expectancy positively affects behavioural intention after playing pervasive games with good experience design, and so on. Therefore, the validating considerations have five variables: performance expectancy, effort expectancy, social influence, facilitating condition, and hedonic motivation. Furthermore, the validating considerations have five good designs: experience design, interactive design, branding design, service design, and game design. Thus, the RO3 and sub-objectives are listed below:

RO3: To validate whether five specific constructs can positively affect the behavioural intention of older adults after playing a pervasive game on fitness.

RO3.1： To validate whether older adults' performance expectancy positively affects or not behavioural intention after playing a pervasive game with good experience design.

RO3.2： To validate whether older adults' effort expectancy positively affects or not behavioural intention after playing a pervasive game with good interactive design.

RO3.3： To validate whether older adults' social influence positively affects or

not behavioural intention after playing a pervasive game with good branding design.

RO3.4：To validate whether older adults' facilitating condition positively affects or not behavioural intention after playing a pervasive game with good service design.

RO3.5：To validate whether older adults' hedonic motivation positively affects or not behavioural intention after playing a pervasive game with good game design.

After testing these good designs on the pervasive game and confirming that the older adults enhance their behavioural intention after playing, the researcher had experience designing a successful pervasive game. The researcher summed up this successful experience and proposed guidelines and principles for designing a pervasive game for older adults based on it. Thus, the RO4 follows:

RO4： To propose design guiding principles for using pervasive games as a creative branding strategy to influence the behavioural intention of older adults.

To sum up, this study identifies the future development trend of pervasive games for older adults through the creative branding factors that influence older adults' use of pervasive games. Therefore, the researcher explained older adults' behaviour patterns using pervasive games from the height angle of view under design thinking.

Moreover, from the perspective of interactive, service, experience, and games fit into the creative branding characteristics of the older adults group using the pervasive game.

1.5 Research Questions

Based on the research objectives of this study, the research questions for this study were generated smoothly. They are one-to-one correspondence, so the research questions are presented as follows:

RQ1：How to identify and develop a design thinking framework for pervasive games as a creative branding strategy on fitness among older adults in China?

RQ2：How to design an instance of pervasive games on fitness for older adults to enhance their behavioural intention?

RQ3: What are the constructs that can positively affect the behavioural intention of older adults after playing a pervasive game on fitness?

RQ3.1： Is there a significant positive effect of performance expectancy on the behavioural intention of older adults after playing a pervasive game on fitness with good experience design?

RQ3.2： Is there a significant positive effect of effort expectancy on the behavioural intention of older adults after playing a pervasive game on fitness with good interactive design?

RQ3.3： Is there a significant positive effect of social influence on the behavioural intention of older adults after playing a pervasive game on fitness with good branding design?

RQ3.4： Is there a significant positive effect of facilitating conditions on the behavioural intention of older adults after playing a pervasive game on fitness with good service design?

RQ3.5： Is there a significant positive effect of hedonic motivation on the behavioural intention of older adults after playing a pervasive game on fitness with good game design?

RQ4： What are the guiding principles for using pervasive games as a creative branding strategy to influence the behavioural intention of older adults?

1.6 Research Hypotheses

This study uses a quantitative research approach. In a quantitative research design, it is common for research hypotheses to be developed. A hypothesis implies a proposition or a set of propositions formulated as an explanation for the occurrence of some

particular phenomenon, either as a tentative conjectural assertion to guide the investigation only or as something accepted as highly probable based on facts. Therefore, based on the identified research objective 3 and the corresponding research question 3, the researcher developed the research hypothesis for this study.

First, mature facts do not require hypothesis testing and can be called null hypotheses (H_0). In this case, when there is any new statement that is not well established in the real world, the null hypothesis can be considered the default state of the statement. Therefore, according to research question 3, the null hypothesis should be that no constructs can positively influence older adults' behavioural intention after playing the pervasive game on fitness. Besides, follow the corresponding sub-null hypotheses are demonstrated below:

H_0: The behavioural intention of older adults shows no significant difference after playing a pervasive game on fitness.

$H_0$1: There is no significant positive effect of performance expectancy on the behavioural intention of older adults after playing a pervasive game on fitness with good experience design.

$H_0$2: There is no significant positive effect of effort expectancy on the behavioural intention of older adults after playing a pervasive game on fitness with good interactive design.

$H_0$3: There is no significant positive effect of social influence on the behavioural intention of older adults after playing a pervasive game on fitness with good branding design.

$H_0$4: There is no significant positive effect of facilitating conditions on the behavioural intention of older adults after playing a pervasive game on fitness with good service design.

$H_0$5: There is no significant positive effect of hedonic motivation on the behavioural intention of older adults after playing a pervasive game on fitness with good game design.

Second, in response to the third research objective and research question, this study required a series of tests and expected that older adults have significantly enhanced their behavioural intention after playing a pervasive game created under the design thinking framework. Through these tests and propositions, the study naturally derived an alternative hypothesis (H_a), and subsequently subdivided the hypotheses into five sub-hypotheses as follows:

H_a: The behavioural intention of older adults shows significant improvement after playing a pervasive game on fitness.

H_a1: There is a significant positive effect of performance expectancy on the behavioural intention of older adults after playing a pervasive game on fitness

with good experience design.

H_a2: There is a significant positive effect of effort expectancy on the behavioural intention of older adults after playing a pervasive game on fitness with good interactive design.

H_a3: There is a significant positive effect of social influence on the behavioural intention of older adults after playing a pervasive game on fitness with good branding design.

H_a4: There is a significant positive effect of facilitating conditions on the behavioural intention of older adults after playing a pervasive game on fitness with good service design.

H_a5: There is a significant positive effect of hedonic motivation on the behavioural intention of older adults after playing a pervasive game on fitness with good game design.

Last, the researcher summarizes a table that shows how problem statements, research objectives, research questions, and research hypotheses all relate to each other. This table made understanding and comparing their relationships easier (see Table 1.1). It is a core of this study that complete, accurate, and comprehensive representation of essentials for subsequent research. At this point, the above elaboration demonstrates the fundamental elements of this research direction clearly and logically.

Table 1.1

A research summary of the relationship between problem statements, research objectives, research questions, and research hypotheses

Problem Statements	Research Objectives	Research Questions	Research Hypotheses	
			Null Hypotheses	Alternative Hypotheses
1. There are many empirical studies on pervasive games but most of them rarely looks from the perspective of design.	RO1: To identify and develop a design thinking framework for pervasive games as a creative branding strategy on fitness among older adults in China.	RQ1: How to identify and develop a design thinking framework for pervasive games as a creative branding strategy on fitness among older adults in China?		
2. Although the volume of the games industry is large, there is a lack of examples of pervasive games, especially in fitness for older adults.	RO2: To design an instance of pervasive games on fitness for older adults to enhance their behavioural intention.	RQ2: How to design an instance of pervasive games on fitness for older adults to enhance their behavioural intention?		
3. As of today, few empirical studies were conducted in relation to pervasive games for older adults.	RO3: To validate whether five specific constructs can positively affect the behavioural intention of older adults after playing a pervasive game on fitness.	RQ3: What are the constructs that can positively affect the behavioural intention of older adults after playing a pervasive game on fitness?	H_0: The behavioural intention of older adults shows no significant difference after playing a pervasive game on fitness.	H_a: The behavioural intention of older adults shows significant improvement after playing a pervasive game on fitness.

Table 1.1 (*continue*)

Problem Statements	Research Objectives	Research Questions	Research Hypotheses	
			Null Hypotheses	**Alternative Hypotheses**
	RO3.1： To validate whether older adults' performance expectancy positively affects or not behavioural intention after playing a pervasive game with good experience design.	RQ3.1： Is there a significant positive effect of performance expectancy on the behavioural intention of older adults after playing a pervasive game on fitness with good experience design?	H_01: There is no significant positive effect of performance expectancy on the behavioural intention of older adults after playing a pervasive game on fitness with good experience design.	H_a1: There is a significant positive effect of performance expectancy on the behavioural intention of older adults after playing a pervasive game on fitness with good experience design.
	RO3.2: To validate whether older adults' effort expectancy positively affects or not behavioural intention after playing a pervasive game with good interactive design.	RQ3.2: Is there a significant positive effect of effort expectancy on the behavioural intention of older adults after playing a pervasive game on fitness with good interactive design?	H_02: There is no significant positive effect of effort expectancy on the behavioural intention of older adults after playing a pervasive game on fitness with good interactive design.	H_a2: There is a significant positive effect of effort expectancy on the behavioural intention of older adults after playing a pervasive game on fitness with good interactive design.
	RO3.3： To validate whether older adults' social influence positively affects or not behavioural intention after playing a pervasive game with good branding design.	RQ3.3： Is there a significant positive effect of social influence on the behavioural intention of older adults after playing a pervasive game on fitness with good branding design?	H_03: There is no significant positive effect of social influence on the behavioural intention of older adults after playing a pervasive game on fitness with good branding design.	H_a3: There is a significant positive effect of social influence on the behavioural intention of older adults after playing a pervasive game on fitness with good branding design.

Table 1.1 (*continue*)

Problem Statements	Research Objectives	Research Questions	Research Hypotheses	
			Null Hypotheses	**Alternative Hypotheses**
	RO3.4: To validate whether older adults' facilitating condition positively affects or not behavioural intention after playing a pervasive game with good service design.	RQ3.4: Is there a significant positive effect of facilitating conditions on the behavioural intention of older adults after playing a pervasive game on fitness with good service design?	$H_0$4: There is no significant positive effect of facilitating conditions on the behavioural intention of older adults after playing a pervasive game on fitness with good service design.	H_a4: There is a significant positive effect of facilitating conditions on the behavioural intention of older adults after playing a pervasive game on fitness with good service design.
	RO3.5: To validate whether older adults' hedonic motivation positively affects or not behavioural intention after playing a pervasive game with good game design.	RQ3.5: Is there a significant positive effect of hedonic motivation on the behavioural intention of older adults after playing a pervasive game on fitness with good game design?	$H_0$5: There is no significant positive effect of hedonic motivation on the behavioural intention of older adults after playing a pervasive game on fitness with good game design.	H_a5: There is a significant positive effect of hedonic motivation on the behavioural intention of older adults after playing a pervasive game on fitness with good game design.
4. These studies were inadequate for examining aging-friendly digital design, specifically on pervasive games.	RO4: To propose design guiding principles for using pervasive games as a creative branding strategy to influence the behavioural intention of older adults.	RQ4: What are the guiding principles for using pervasive games as a creative branding strategy to influence the behavioural intention of older adults?		

1.7 Research Scope and Limitations

In terms of the research scope, this study was conducted as academic research under the field of applied arts. In particular, it is an empirical study on branding that involves the deployment of pervasive games as a creative branding strategy (Valente et al., 2017). It is worth stressing that this is not a social study, although human beings are recruited as research participants; and this is not an applied science study, although scientific research methods are applied to collect and analyze data for answering specific research questions.

Nowadays, technology is developing the society rapidly. Every now and then, there would be new technological breakthroughs. Today is also an age of integrated design, where theories and techniques intersect (Tichkiewitch & Brissaud, 2013). Nowadays, a thing's current situation or development trend can no longer be judged by a single aspect (Norman, 2005). A designer may need to consider various aspects, such as design thinking, Internet thinking, computational thinking and technical thinking. In this study, these four aspects of thinking are further explored, deconstructed and re-constructed as an approach for pervasive game design and development, named the 4T-PGCB (see Figure 1.2). This study considers the pervasive game as a brand and considers four aspects of its design. These four aspects are design thinking, Internet thinking, computational thinking, and technical thinking. It can be referred to for the development, design, production, operation, and evaluation of pervasive games.

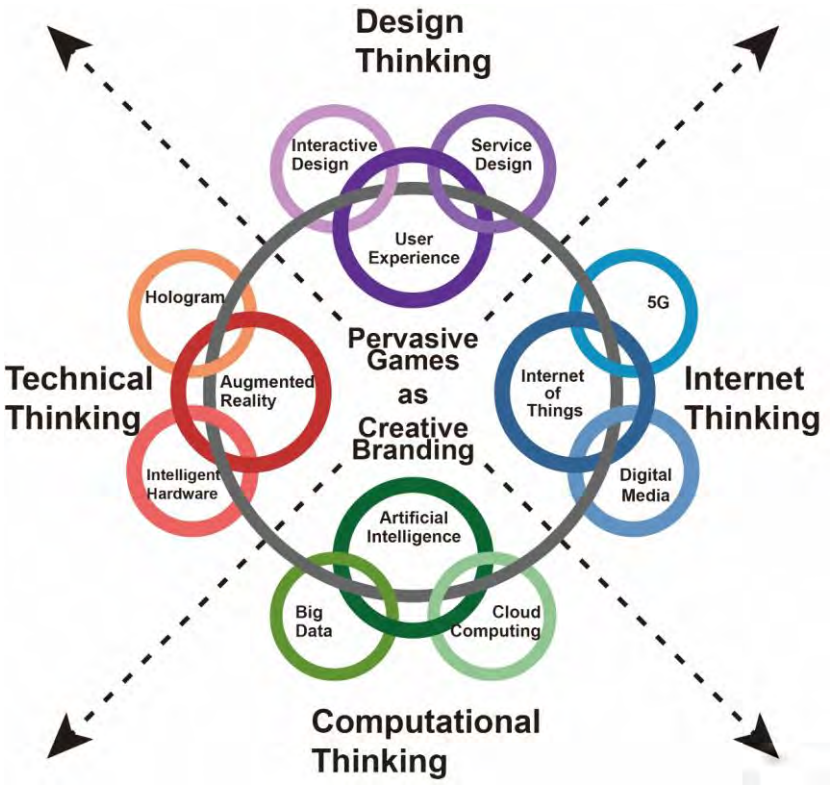

Figure 1.2. Four Thinking's of Pervasive Games as Creative Branding (4T-PGCB)

When developing pervasive games, designers should treat games as a brand. Such as Figure 1.3, pervasive games and creative branding must have overlapping fields. If taking a pervasive game as an isolated game to develop, that will inevitably be short-sighted and lose the long-term development goal. If taking the pervasive game as a brand to develop and design from the beginning, this is a development strategy with a strategic vision. From the smallest logo to the game's production framework; from a simple interface to the overall visual style; from the concept of virtual games to related derivative objects, all things should be done at the beginning of development and design to treat pervasive games way of a brand. Secondly, consider pervasive games from design, technology, the Internet, and computing when taking pervasive games as a brand.

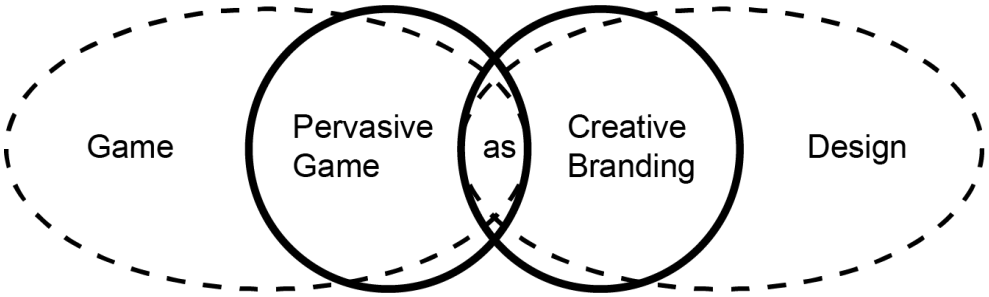

Figure 1.3. Creative Branding and Pervasive Games Relationships

In the Internet thinking aspect, there are also three directions to consider. They are 5G, Internet of things, and digital media in Figure 1.2. The 5G network has been fully rolled out in mainland China, and all major cities are fully covered and enjoying the high-speed 5G technology. Communication technology is important in the pervasive game; high-speed networks mean agile game feedback. Embodying 5G network technology in pervasive games will enhance its good interactivity and increase its smooth experience. In the context of high-speed network development, the Internet of things must be the trend of future social development. Under the premise that many objects can be linked to the network, they can provide inspiration and elements for pervasive games. When the pervasive game is designed and developed, the ability to incorporate the Internet of things, use them, and interact with them expands the infinite possibilities of the pervasive game. Because pervasive games are physical location-based games, the mobile nature of pervasive games is reflected here in the mobile Internet. In the information age, digital media has become so advanced and powerful that become an important field. Suppose a pervasive game can be developed and designed with digital media, seamlessly integrated with digital media, and even infiltrated into each digital media. In that case, the unimaginable prospect of the

development of pervasive games. The Internet Thinking aspect is necessary for pervasive game development and design and will also bring players a better experience.

The computational thinking aspect is the inevitable result and trend of the development of times and computing. This is an important element that should be deployed at the beginning of the development and design of pervasive games. Big data, computing, and artificial intelligence（AI） are in the computational thinking aspect shown in Figure 1.2. Big data can be combined with pervasive games in the field of big data. If the data is analyzed properly and used correctly, this positively affects the pervasive game. Therefore, the designer should consider the data's security, storage, analysis, utilization, and redevelopment when designing the pervasive game. Cloud computing enhances the characteristics of pervasive games, which generate much information in the form of files when players play the game, and this data needs to be saved in the cloud so that not a burden to the players. Cloud computing technology is mature and popular, so the attributes of cloud computing can be considered at the beginning of pervasive game development and design to be fully utilized. Artificial intelligence has been a popular research field recently, and the application of algorithms is gradually becoming popular. Adding artificial intelligence to pervasive games will make the game diversified and fun for the players while enriching gameplay. Reflecting artificial intelligence in pervasive games is a major problem. Intelligent hardware, which is gaining popularity, is a technological concept that refers to the intelligent transformation of traditional devices by combining hardware and software.

The technical thinking aspect stimulates players' interest in exploring pervasive games and experiences more joy in in-game computing and great computing power. There is a deep connection with pervasive games in the technical thinking aspect. This relationship is shown in Figure 1.2, and the three most popular technologies are hologram, augment reality and intelligent hardware. Holographic projection technology (front-projected holographic display) is a kind of 3D technology that originally refers to the use of interference principles to record and reproduce the real three-dimensional image of the object technology. With the guidance of science fiction movies and commercial promotion, the concept of holographic projection was gradually extended to stage performances, exhibitions, and other commercial activities. The hologram can be well combined with pervasive games to enhance their modernity and value. There are many different kinds of intelligent hardware. If they are well integrated with pervasive games, that will greatly expand spatial and physical properties. Augmented Reality (AR) is a technology that cleverly integrates virtual information with the real world. AR uses various technical means, such as multimedia, 3D modelling, real-time tracking, intelligent interaction, and sensing. AR simulates computer-generated text, images, 3D models, music, video, and other virtual information simulations applied to the real world. The two kinds of information complement each other to achieve the 'enhancement' of the real world. This technology is especially suitable for pervasive games, and there are already relevant pervasive games using this technology.

Nonetheless, since this study is positioned under the field of applied arts, design thinking would be the focus, as opposed to Internet thinking, technical thinking, and computational thinking, as shown in Figure 1.4. Design thinking became a popular approach in applied arts after Brown (2009, 2019) promoted how his company used this approach to transform organizations and inspire innovation worldwide. With reference to this approach, the researcher developed three core domains of design thinking, i.e. interactive design, service design and user experience (see Figure 1.4), as creative branding strategy. In relation to the research scope and limitation, these domains become the basis for establishing a bespoke framework for designing pervasive games as creative branding strategy on fitness among older adults. Therefore, these design thinking domains set the direction and scheme of reference in the applied arts. In other words, this study focuses on three domains of design thinking, while the pervasive game would be seen as a creative branding strategy, and would be examined from the perspective of design thinking.

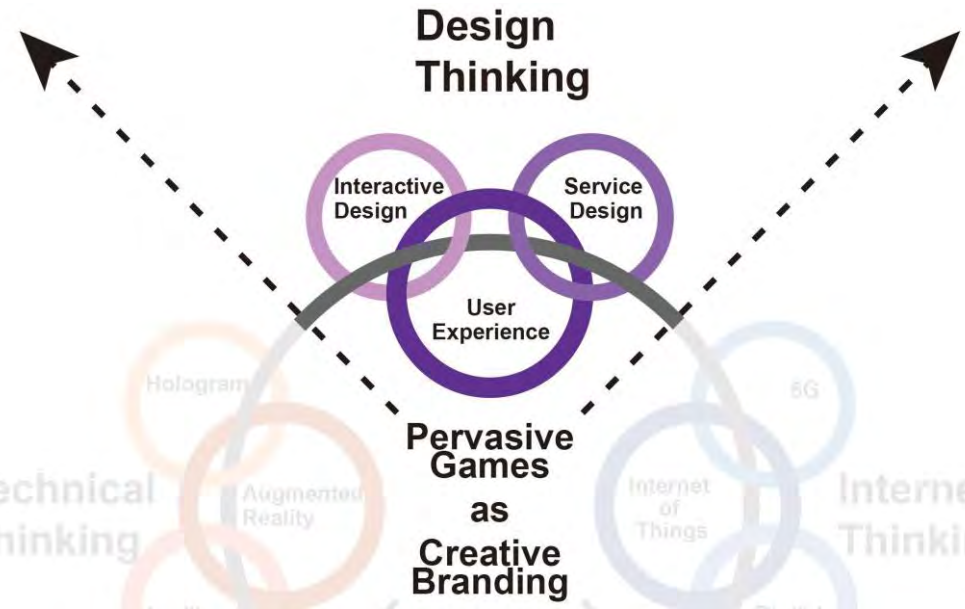

Figure 1.4. Three Core Design Thinking Domains

In Figure 1.4, user experience is the core, which connects interactive design and service design. The interactive design and user experience have some intersections, and the service design and user experience also have some intersections. The relationship between them can also be seen from the colour shades: user experience is the darkest colour, interactive design is the middle colour, and service design is the lightest colour, which expresses the order of importance between them in turn. Interactivity is the main characteristic of a game. A good game should at least have good interactive characteristics, and pervasive games are the same. The interaction between people, the interaction between people and machines, and the micro-interaction of many game interfaces, these ideas or qualities must always be consistent throughout the design and development of pervasive games. If a pervasive game only has a nice interface design without a good user experience design, that is also bad. Only by designing and developing the game from the point of view of the application objects of the game and considering the details of good experience everywhere can meeting the basic requirements of a pervasive game. Pervasive games are a brand, so running the game is equivalent to running a brand. At this time, start considering service design. In service design, relevant issues such as stakeholders, user journey, and service blueprint need to be considered, which are exactly the issues that need to be considered when implementing a pervasive game. In addition to the game's design, consider its related service attributes. Only in this way can running a pervasive game well. Design thinking is the primary consideration in developing and designing a pervasive game, which is the basis and foundation of other aspects.

Towards the end of this thesis, the characteristics of pervasive games are juxtaposed in three domains of design thinking, particularly the relationship between experience design and pervasive games; the relationship between interactive design and pervasive games; and the relationship between service design and pervasive games. Understanding these relationships is crucial to deploy pervasive games as a branding strategy.

1.8 Importance of the Research

This study integrates older adults and the pervasive game seamlessly and proposes the research field of creative branding for older adults using the pervasive game. The study comprehensively sorts out the design domains of older adults using pervasive games and aims to reveal the various concepts of attributes and characteristics of the use of pervasive games in older adults. This involves constructing a design thinking framework of creative branding using the pervasive game in older adults, solving various problems using the pervasive game in older adults, and providing the pervasive game to move toward specialization. Therefore, three points of this study are important in terms of research value.

First, this study proposes a design thinking framework for designing and developing pervasive games on fitness for older adults. The framework was developed

to set the basis for pervasive game design and development, hence the most important contribution of the thesis. Second, the researcher designed a pervasive game for older adults based on the design thinking framework, in which the five design thinking domains: game design, interaction design, experience design, service design, and branding design were considered. This game can relieve the fatigue of exercise, increase the fun of exercise, prolong the exercise time for the older adult groups, and improve the health of the body and mind. Whether the game is to meet older adults' physiological, psychological, and social needs, broaden the development direction of the pervasive game, or use the pervasive game to enhance older adults for fitness, that has crucial reference guidance and practical value. Third, this study presents guiding principles for developing and designing pervasive games as a creative branding strategy for fitness among older adults in China. These design guiding principles explain the ageing-friendly of the pervasive game. Therefore, the research results of this study to improve pervasive game design for older adults are important for practical significance.

1.9 Operational Definitions

1.9.1 Behavioural Intentions

The measurement of the strength of an individual's intention to carry out certain behaviour is classically referred to as behaviour intention (Fishbein and Ajzen, 1975).

It is often used as a proxy or correlate of actual behaviour. Traditionally in consumer research, behavioural intention focuses on consuming, purchasing, or willingness to purchase. Within the technology adoption literature, it focuses on adopting the technology.

1.9.2 Performance Expectancy

Venkatesh et al. (2003, p.447) define Performance Expectancy as "the degree to which an individual believes that using a system will help him or her to attain gains in job performance." Venkatesh et al. (2003) also pointed out that age and gender are moderators of the relationship between intention and Performance Expectancy. In terms of gender, men tend to accept a new technology more quickly than their female counterparts. For age, prior studies have demonstrated that age plays no significant role in IT usage, although older users are generally less accepting of new information systems and do not have the same perception of use when using them.

1.9.3 Effort Expectancy

Venkatesh et al. (2003) define Effort Expectancy as "the degree of ease associated with the use of the system" (p.450). If it becomes too difficult to use a particular technology,

users might simply decide not to use it. This relates to the user-friendliness of the product. Effort expectancy is similar to perceived ease of use, reflecting users' perceived difficulty with the information system and positively influencing behavioural intention.

1.9.4 Facilitating Condition

Facilitating Conditions are defined by Venkatesh et al. (2003) as "the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of a system" (p.453). This factor relates to whether the user has the resources, skills, and knowledge to complete the tasks at hand. Facilitating conditions include the compatibility of the product with other geospatial technologies and data (i.e., interoperability).

1.9.5 Social Influence

Social Influence has been defined as "the degree to which an individual perceives that important other believe he or she should use the new system" (Venkatesh et al., 2003, p.451). This construct highlights the important role that people who are important to us (e.g., family, colleagues, or friends) play in our decision to accept a certain technology.

Interestingly, the literature suggests that as the familiarity and experience with technology increases, the social influence reduces over time.

1.9.6 Hedonic Motivation

Hedonic motivation is defined as "the fun or pleasure derived from using a technology, and it has been shown to play an important role in determining technology acceptance and use" (Venkatesh et al., 2012, p. 161). Hedonic motivation is one of the constructs added to the UTAUT2 model by Venkatesh, who argued that intrinsic utilities (i.e., joy, fun, playfulness, entertaining, and enjoyment) play a crucial role in accelerating the adoption of a new technology.