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Proposal for a Behavioral Transformative Digital Platform for Extending Healthy Life Expectancy Aimed at 2040

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Table of Contents

CHAPTER 1.　Foreword

1.1. Purpose of this Working Paper

Japan is currently a super-aging society, and the population of elderly people aged 65 years and above is anticipated to reach approximately 40 million in 2040[1]. In contrast, the working-age population is expected to decline rapidly owing to the declining birthrate, raising concerns regarding increasing social security costs. Considering the future, the extension of healthy life expectancy, which is "the period during which individuals can live without having their daily lives restricted by health concerns," has become an important issue, as it is essential for maintaining and improving the vitality of society and enriching the lives of individuals. Against this backdrop, the Ministry of Health, Labor and Welfare (MHLW) formulated the "Healthy Life Expectancy Extension Plan" in 2019, setting the goal of extending healthy life expectancy to 75 years or longer by 2040 for men and women, an increase of 3 years or more from 2016[2].

The "Healthy Life Expectancy Extension Project," a Keio Global Research Institute (KGRI) 2040 Aging Society Innovation Center, aims to design and propose a social system that inter-operably links multiple health services utilizing various research seeds to realize the extension of the healthy life span in a super-aged society in 2040. This working paper describes a study of new health services and social systems to realize the extension of healthy life expectancy in 2040 as part of the "Healthy Life Expectancy Extension Project." Based on the status of health in Japan and projections of future challenges, we focus on behavioral change for health maintenance and promotion as well as propose new health services and systems for service realizations that will contribute to solving health-related issues.

This paper is intended for health ministries and agencies; companies providing products and services related to health, diet, and exercise; insurance companies; Internet Technology (IT) and Artificial Intelligence (AI)-related companies; and digital healthcare researchers. Your participation, advice, and cooperation in the discussion of this proposal would be greatly appreciated.

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[1] [2020 edition, Health, Labor and Welfare White Paper] Reiwa 2-nen-ban Kousei roudou hakusho p.7
https://www.mhlw.go.jp/wp/hakusyo/kousei/19/dl/1-01.pdf
[2] Ministry of Health, Labor and Welfare ["Healthy Life Expectancy Extension Plan"] Kenko Jumyou Enshin plan p.1
https://www.mhlw.go.jp/content/12601000/000514142.pdf:
Healthy life expectancy in 2016: 72.14 years for men and 74.79 years for women.

1.2. Configuration of this Paper

Chapter 1	Foreword

Chapter 2	State of Health in Japan and Related Issues

Social Status

Current Status	Projection for 2040
2.1. Demographic Composition and Life Expectancy	2.3. Potential Impact on Medical Treatment and Long-term Care in 2040
2.2. Health Management	2.4. Importance of Personal Health Awareness

Solutions

Chapter 3 — Current Initiatives and Challenges in the Use of Digital Technology in Health Care	Chapter 4 — Toward 2040: A New Proposal
3.1. Current State of the Use of Digital Technology in the Medical and Health Care Industries (Japan and Overseas)	4.1. Proposal of a New Service Model
3.2. Analysis of the Health Promotion Mechanism by Digital Health Care using the Causal Loop Diagram	Introduction to Behavioral Change Ethics and Models
3.3. Structurization of the Promotion of Digital Technology in the Medical and Health Care Industries in Japan	4.2. Mechanisms Needed to Realize New Service Models
3.4. Summary of Chapter 3	4.3. Impact on Society of Implementation
Interviews with Leading Authorities on Current State of Digital Health Care	

Chapter 5	Role of the University

Chapter 6	Summary

Fig.1 Overall Configuration of this Paper

1.3. Terminology

● Health care

Health care currently has several definitions and often indicates a wide range of "health management," including medical and long-term care. The Japan Association of Health Care Initiative defines health care (simplified version) as "The creation of new value through cross-industry support to achieve freedom from illness and mental and physical infirmity by raising one's zest for living and various activities for this purpose." The detailed version of the report states that a total of 29 health care-related fields exist in the three areas of medicine, health, and daily life, including medical care, pharmaceuticals, home care, and care for the elderly, among others. Neither the Ministry of International Trade and Industry nor the MHLW provides a clear definition of health care, where its

scope can be interpreted in the above-mentioned sense. However, herein, we distinguished between those covered by the existing medical insurance and long-term care insurance systems and various other measures and devices related to health maintenance, and positioned the latter as "health care."

- Digital health care

  Digital health care refers to tools and services that utilize information and communication technologies to monitor and manage lifestyle habits affecting health by preventing, diagnosing, treating, monitoring, and managing health-related problems[3].

- Digital platform

  Although there is no unified definition of a digital platform, we defined a digital platform as "a platform that uses information, communication technologies, and data to provide an online service venue for third parties, forming a multifaceted market where multiple different user groups exist, and which is characterized by the so-called indirect network effect." The indirect network effect is a phenomenon that occurs in a multifaceted market, explained as, the more the number of users increase in one market, the more the utility of the service in the other market increases[4].

CHAPTER 2. State of Health in Japan and Related Issues

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[3] European Commission, eHealth: Digital health and care, Overview
https://health.ec.europa.eu/ehealth-digital-health-and-care/overview_en
[4] Fair Trade Commission ["Anti-Monopoly Act Policy Regarding Abuse of Dominant Position in Transactions between Digital Platform Operators and Consumers Who Provide Personal Information, etc. December 17, 2019, Revised April 1, 2022"] Digital Platform jigyousha to kojinjyouhou wo teikyousuru shouhisha tono torihiki ni okeru yuetsuteki chii no ranyo ni kansuru dokusen kinshihou no kangaekata p.2
https://www.jftc.go.jp/dk/guideline/unyoukijun/dpfgl_files/220401_dpfgl.pdf

Fig.2-1 Configuration of Chapter 2

In this chapter, the status and issues of the medical and long-term care systems and health care in Japan are extracted and discussed from the viewpoint of extending healthy life expectancy and living out one's life, rather than simply living longer, as the "100-year life age" is becoming a likely possibility. Additionally, the significance and potential of digital health care technology that allows us to observe our health through various daily numerical values will be discussed.

2.1. Demographic Composition and Life Expectancy in Japan

2.1.1. Demographic Composition

Japan's society will be greatly affected by changes in the composition of its population. First, let us look at Japan's demographic trends. Japan's population gradually increased after the end of World War II and has been decreasing since its peak in 2008, and the aging rate, which was 12.1% in 1990, reached 28.4% in 2019, indicating a rapid aging of the population over the past 30 years. A breakdown of the population structure shows a slowdown in the growth of the elderly population aged 65 years and above and a significant decline in the 20–64 years age group[5]. The situation is expected to change from a "rapid increase in the number of the elderly" to a "rapid

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[5]Ministry of Health, Labor and Welfare 2020 edition Health, [Labor and Welfare White Paper] Kouseiroudou Hakusho ["Thinking about social security and work styles in the Reiwa era"] "Reiwa jidaino shakai hoshou to hatarakikata wo kangaeru" p.4-5 https://www.mhlw.go.jp/wp/hakusyo/kousei/19/dl/1-01.pdf

decrease in the working-age population[6]." The percentage of children <15 years in the total population has been declining since 1975, and reached a record low in 2022[7].

2.1.2. Differences between the Average Life Expectancy and Healthy Life

It is estimated that approximately 40 and 20% of men and women who are aged 65 years in 2040 will live to be 90 and 100 years, respectively; thus the "100-year life expectancy era" is within reach[8].

However, although the World Health Organization proposed "healthy life expectancy" in 2000, and interest in life expectancy and healthy living has increased worldwide, there is still a prolonged "unhealthy period" that imposes restrictions on individuals in their daily lives. Data on the life expectancy of the Japanese people illustrate that Japan has one of the longest life expectancies worldwide and that the average life expectancy is increasing, however, as of 2019, healthy life expectancy is 8.73 and 12.07 years shorter than the average life expectancy for men and women[9]. The difference in life expectancy and healthy life expectancy is expected to lead to a sustainable increase in social security costs, including medical and nursing care costs for the elderly.

Additionally, the "Study Group of Experts on Healthy Life Expectancy" established by the MHLW proposed in its report, in March 2019, that "the goal is to increase healthy life expectancy by >3 years from 2016–2040." The report also states that the reduction of the period of unhealthy life expectancy will become an urgent issue from the perspective of suppressing medical costs and independent living for the elderly by 2040 when the above-projected life expectancy will reach the aforementioned level[10].

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[6] Ministry of Health, Labor and Welfare, 28th Social Security Council Meeting, ["Future Social Security Reform: Looking Ahead to 2040,"] Dai 28 kai shakaihoshou singikai siryou "Kongono shakai hoshou kaikaku ni tsuite", p.3 https://www.mhlw.go.jp/content/12601000/000474989.pdf

[7] Statistics Bureau, Ministry of Internal Affairs and Communications, ["Statistical Topics No.131 Number of Children in Japan - On the Occasion of Children's Day - (from Population Estimates)"] "Wagakunino kodomo no kazu – Kodomono-hi ni chinande- (Jinkou suikei kara)", p.3 https://www.stat.go.jp/data/jinsui/topics/pdf/topics131.pdf

[8] Ministry of Health, Labor and Welfare, ["White Paper on Health, Labor and Welfare, 2020 Edition: Social Security and Work in the Age of 2020,"] " Reiwa 2 nen ban Kousei roudou hakusho – Reiwa jidai no shakaihoshou to hatarakikata wo kangaeru" p.14 https://www.mhlw.go.jp/wp/hakusyo/kousei/19/dl/1-01.pdf

[9] Cabinet Office, ["White Paper on Aging Society, 2022 Edition,"] "Reiwa 4 nen ban Kourei shakai hakusho" p.27 https://www8.cao.go.jp/kourei/whitepaper/w-2022/zenbun/pdf/1s2s_02.pdf

[10] Ministry of Health, Labor and Welfare, ["Report of the Study Group of Experts on Healthy Life Expectancy, March 2019,"] "Kenkou jumyou no arikata ni kansuru yushikisha kenkyu houkokusho 2019 nen 3 gatsu," p.33 https://www.mhlw.go.jp/content/10904750/000495323.pdf
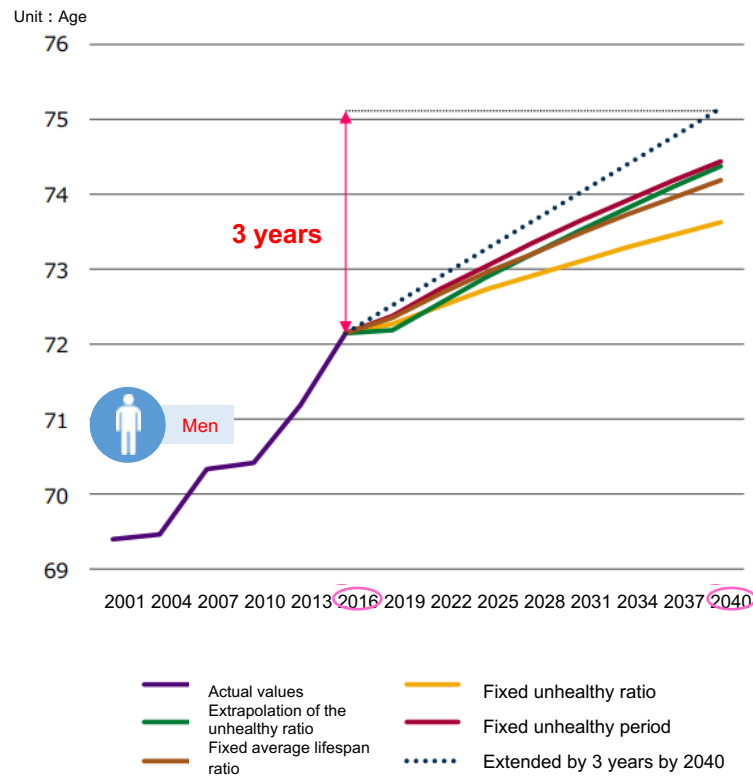
Fig.2−2 Projected Changes in Healthy Life by 2040 and Goals[11]

2.2. Health Management

2.2.1. Health Checkups by Companies and Local Governments

What is the status of personal health management, which is important for extending healthy life expectancy? We will discuss the current efforts by companies and local governments to support health management.

The Occupational Health and Safety Law requires employers to ensure that workers receive a medical examination by a physician annually.

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[11] Ministry of Health, Labor and Welfare, ["Report of the Study Group of Experts on Healthy Life Expectancy,"] "Kenkou jumyou no arikata ni kansuru yushikisha kenkyu houkokusho, p.32-34 "Constant unhealthy ratio" is a scenario in which the "unhealthy ratio" by sex and age group in 2016 is fixed. "Extrapolating the unhealthy ratio" is a scenario in which the trend of the "unhealthy ratio" by sex and age group from 2001–2016 is extrapolated to 2040 with a logistic curve. "Constant unhealthy period" is a scenario in which the difference in average life expectancy in 2016 is fixed, and "Constant life expectancy ratio" is a scenario in which the ratio of unhealthy to average life expectancy is fixed. The "unhealthy period constant" is a scenario in which the difference from life expectancy in 2016 is fixed, the "life expectancy to life expectancy ratio constant" is a scenario in which the ratio to life expectancy in 2016 is fixed, and the "3-year extension by 2040" is a scenario in which healthy life expectancy is extended by 3 years from 2016–2040. The "3-year increase by 2040" refers to a scenario in which healthy life expectancy increases by 3 years from 2016–2040. Reference] The ratio of "Yes" responses (non-responses are not included in the denominator) to the question "Do you currently have any health problems that affect your daily life?" in the health questionnaire of the National Survey of Living Conditions (Large-scale survey) is called the "ill-health ratio."

In 2008, a health checkup system was initiated to improve metabolic syndrome[12]. However, the "specific health checkups (metabolic syndrome checkups)" and "specific health guidance" provided by health insurance societies have not always been as effective as expected in terms of disease prevention. The "prevalence," or the percentage of those with findings among those who have undergone health checkups, has been increasing annually. According to the data from the 2021 MHLW periodic health checkups, 58.7% or approximately 60% of those examined had some findings[13]. The breakdown of findings is high in lipids, blood pressure, and liver function, in that order, suggesting that lifestyle factors such as eating habits, lack of exercise, and obesity may be influencing them. Should the abdominal circumference exceed the standard value in a specific health checkup, the patient must receive specific health guidance to improve lifestyle habits; however, the implementation rate of specific health guidance was only 23.0% in FY2020[14]. According to a study by a joint research group of Kyoto University, the Universities of California, Los Angeles, and Tokyo, weight loss among those who received health guidance was not clinically meaningful, and no improvement was observed in health indicators such as blood pressure, blood sugar, and lipids[15]. Although specific health guidance is expected to have a certain effect, there are still issues to be addressed in improving lifestyle habits, and some improvement is needed.

2.2.2. Investments in Health Management by Companies

The Ministry of Economy, Trade and Industry recommends "health management," in which health management of employees and others is considered from a managerial perspective and strategically implemented. Based on corporate philosophy, investment in the health of employees and others is expected to lead to increased vitality and productivity of employees and other organizational revitalization, resulting in improved business performance and stock price

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[12] Under the 2006 reform of the medical care system, health insurance societies and national health insurance companies have been required to conduct health examinations (specified health examinations) and health guidance (specified health guidance) focusing on metabolic syndrome (visceral fat syndrome) for enrollees aged ≥40 since April 2008.

[13] Ministry of Health, Labor and Welfare, ["Report on the Results of Periodic Health Examinations in 2021 (by year),"] Reiwa 3 nen Teiki kenkou shindan jisshi kekka houkoku (nenji betsu), https://www.e-stat.go.jp/stat-search/files?page=1&layout=dataset&toukei=00450211&tstat=000001018638&stat_infid=000032241014, 17.8% had blood pressure, 16.6% had liver function tests, 33.0% had blood lipids (HDL and neutral fat values), 12.5% had blood glucose levels, and 10.5% had electrocardiograms with findings.

[14] Ministry of Health, Labor and Welfare, ["Implementation Status of Specific Health Examination and Specific Health Guidance (FY2020),"] Tokutei kenshin・tokutei hoken shidou no jisshi jyoukyou ni tsuite (2020 nendo), p.1 https://www.mhlw.go.jp/content/12400000/001017830.pdf

[15] Shingo Fukuma, Toshiaki Iizuka, Tatsuyoshi Ikenoue, Yusuke Tsugawa. Association of the National Health Guidance Intervention for Obesity and Cardiovascular Risks With Health Outcomes Among Japanese Men. JAMA Intern Med. 2020;180(12):1630-1637. doi:10.1001/jamainternmed.2020.4334 https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2771507

performance[16]. According to a survey conducted by the University of Tokyo and others that analyzed questionnaires from the civil engineering and construction industries, the average annual medical expenses, the percentage of employees at risk for dyslipidemia, diabetes, smoking, weight gain, and metabolic syndrome were higher in large companies than that in low-scoring companies[17]. However, according to the survey of the White Paper on Human Resources 2020, few companies (approximately 30%) answered that they practice health management, and the implementation rate was higher in larger companies, clearly indicating that there is a significant difference between large and small companies[18]. Although health management is becoming more widespread, it is still insufficient.

2.3. Potential Impact on Medical Treatment and Long-term Care in 2040

2.3.1. Potential Impact of Demographic Changes on Medical Treatment and Long-term Care in 2040

An overview of the world's health care systems can be broadly classified into the following three systems:

(1) State-run system (British model)

(2) Social insurance system (Japanese model)

(3) Private insurance system (United States model)

While each system has its advantages and disadvantages, type (2) is superior in terms of access to medical treatment. Under the Japanese system, medical treatment is available anywhere and to anyone, and is relatively inexpensive. Moreover, when comparing Japan's medical treatment system with that of other countries, Japan has a universal health insurance system and is

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[16] Ministry of Economy, Trade and Industry, Health Care Industry Division, ["Promotion of Health Management,"] "Kenkou keiei no suishin nit suite," p. 11, June 2022. https://www.meti.go.jp/policy/mono_info_service/health_care/downloadfiles/kenkokeiei_gaiyo.pdf
Reference: Same document p.28-29. The specific content of health management can be easily understood by looking at the evaluation items of the health management survey.
1. Management philosophy (commitment from top management, communication internally and externally), 2. Organizational structure (building an organizational structure whereby top management participates, such as having the president and executives in charge of health promotion, and establishing an organization with specialized knowledge in the industry) participation of doctors, public health nurses, etc. in examining health measures, establishment of a collaborative system with health insurance associations), 3. Implementation of systems and measures (setting of initiatives to understand and solve health issues, clarifying target values and years) 4. Evaluation and improvement; and 5. Legal compliance and risk management.

[17] Tokio Marine & Nichido Risk Consulting ["Report on the 2016 Health Management Research Project (University of Tokyo Research Project) April 20, 2017"] "2016 nendo Kenko keiei kenkyu jigyou (Tokyo daigaku kenkyu jigyou) no gohokoku 2017 nen 4 gatsu 20 ka" p.16-18 http://dokenpo.or.jp/ckfinder/userfiles/files/toudaihoukoku_yoko.pdf2f

[18] [Japan's Human Resources Department] Nihon no jinji bu ["Human Resources White Paper Survey Report New HR Issues 'Health Management' is now attracting attention. Only 30% of companies are practicing it"] Jinji hakusho chousa report atarashii jinji kadai ima chumoku sareru kenkou keiei, jissen shiteiru kigyou ha 3 wari ni todomaru" September 29, 2020 https://jinjibu.jp/article/detl /hakusho/2350/

characterized by low out-of-pocket costs to medical institutions[19]. The annual number of medical examinations and average length of hospitalization (1–3 d for appendectomy in the US, 3 d in France, compared to 6–7 d in Japan) indicate that the environment is conducive to accessing medical facilities when one falls ill.

In contrast, the rising cost of medical care in Japan has become a social problem. According to data on changes in social security benefits in the Ministry of Finance[20] data for 2021, the total amount for budget-based medical treatment in 2020 was 40.6 trillion yen, accounting for 32.0% of the total social security benefits of 126.8 trillion yen. Data from the Social Security Council of the Ministry of Health, Labor, and Welfare[21], estimates medical expenses will amount to 66.7 trillion yen (35.4%) to 68.5 trillion yen (36.1%) of the 188.2–190.0 trillion yen in social security benefits in 2040, and medical expenses are expected to increase approximately 27–29 trillion yen from 2018–2040. Thus, Japan's medical expenses are expected to increase enormously with the arrival of a super-aged society, and a future where a smaller number of working individuals will have to cover these costs is anticipated.

2.3.2. Current State of the Long-term Care System and Potential Impact

With the aging of society, the number of elderly individuals requiring nursing care is increasing, and duration of long-term care is lengthening, resulting in an ever-increasing need for long-term care. The landscape surrounding the families that have supported the elderly requiring long-term care has evolved, as nuclear families have become more prevalent, the family members providing care have aged, and the conventional welfare and medical care systems for the elderly have reached their constraints. In response, the long-term care insurance system was established in 2000 to support elderly care. Under this system, the elderly who need long-term care are provided with services according to their physical and mental conditions as well as living environment, they can lead independent daily lives at home as much as possible. The system provides support for Category 1 insured persons (those aged ≥65 years who need long-term care or assistance in daily living) and premiums are paid by everyone (beneficiaries) beginning at 40 years old. Category 2 insured persons (those aged 40–64 years who need long-term care or daily life support owing to a specified disease) are certified by their municipality and can use the services.

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[19] Japan Medical Association website https://www.med.or.jp/people/info/kaifo/compare/
[20] Ministry of Finance Fiscal System Council Fiscal System Subcommittee Material ["Social Security, etc. (Reference Materials) April 15, 2021"] "Shakai hoshou tou (Sanko shiryou) 2021 nen 4 gatsu 15 nichi" p.3 https://www.mof.go.jp/about_mof/councils/fiscal_system_council/sub-of_fiscal_system/proceedings/material/zaiseia20210415/02.pdf
[21] February 1, 2019 Ministry of Health, Labor and Welfare 28th Social Security Council ["Future Social Security Reform - Looking to 2040"] "Kongo no shakai hoshou kaikaku nit suite – 2040 nen wo misuete-," p.4 https://www.mhlw.go.jp/content/12601000 /000474989.pdf

The long-term care insurance system is operated by municipalities as the insurer and is jointly supported by entities such as the national government, prefectures, medical insurers, and pension insurers. The system accounts for approximately 10%[22] of social security expenses in FY2023 (budget basis); however, there are concerns that the benefit rate will further increase owing to the expected increase in the elderly population. Thus, the long-term care insurance premium was 2,911 yen when the long-term care insurance system was established (2000); however, it tripled to 6,014 yen from 2021–2023[23]. In the future, raising the fee burden on citizens utilizing long-term care insurance has been proposed, and the MHLW's study group is discussing this issue on an ongoing basis.

Twenty years have passed since the establishment of the long-term care insurance system. During this time, the number of insured persons aged ≥65 years has increased by approximately 1.6 times, whereas the number of service users has increased approximately 3.3 times[24]; with the system becoming an indispensable component of long-term care for the elderly.

Under these social conditions, the number of people leaving the workforce owing to long-term care has become an issue for consideration. In a 2012 "Worker Questionnaire Survey on Balancing Work and Nursing Care" conducted by a private company commissioned by the MHLW, it was revealed that >50% of male and female workers who left their jobs due to long-term care answered that they "wanted to continue (working)" and approximately 20% answered that they "did not," indicating that many of the respondents wanted to continue working[25]. There is concern that the number of workers leaving to provide long-term care will continue to increase in the future, potentially leading to a decline in the overall economic strength of the industry.

Furthermore, when we consider the workforce required to provide long-term care, we are confronted with a major challenge. Based on the projected volume of long-term care services in the 8th Long-Term Care Insurance Business Plan, prefectures in Japan are estimated to require an additional 690,000 long-term care workers by FY2040 when compared to the number of care workers in FY1990[26]. Briefly, it will be necessary to "increase the total number of workers" and "realize medical and welfare facilities that can operate with fewer workers."

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[22] Ministry of Health, Labor and Welfare website [About benefits and burdens] Kyuhu to futan ni tsuite https://www.mhlw.go.jp/stf/newpage_21509.html

[23] Ministry of Health, Labor and Welfare, Elderly Health Bureau ["Summary of Nursing Care Insurance System May 2021"] "Kaigo hoken no gaiyou Reiwa 3 nen 5 gatsu" p.17 https://www.mhlw.go.jp/content/000801559.pdf

[24] Ministry of Health, Labor and Welfare, Elderly Health Bureau ["Summary of Nursing Care Insurance System May 2021"] "Kaigo hoken seido no gaiyou Reiwa 3 nen 5 gatsu" p.15 https://www.mhlw.go.jp/content/000801559.pdf

[25] Mitsubishi UFJ Research & Consulting Co., Ltd. ["Worker Survey on Balancing Work and Nursing Care FY2012"] "Shigoto to kaigo no ryoritsu ni kansuru roudousha ankeeto chousa Heisei 24 nendo" p.28 https://www.mhlw.go.jp/bunya/koyoukintou/dl/h24_itakuchousa05.pdf

[26] Ministry of Health, Labor and Welfare, Social Relief Bureau, ["Required number of nursing care staff based on the 8th Long-Term Care Insurance Business Plan, July 9, 2021"] "Dai 8 ki kaigo hoken

To ensure prolonged active and healthy lives for all citizens, we must pursue efforts to (1) create an environment for diverse employment and social participation, (2) extend healthy life expectancy, (3) enhance productivity through reforming medical and welfare services, and (4) ensure the sustainability of social security by reviewing benefits and burden sharing.

In addition, the younger generation needs to be health-conscious to minimize their duration of required long-term care and there are high expectations to develop health care services that can provide support at the individual level while conserving manpower.

	Demographic Composition and Life Expectancy	Health Management	Impact on Medical Treatment and Long-term Care System
Current Status	• The birthrate is declining, and the population is aging yearly. The increasing medical care costs for the elderly must be covered by the rapidly declining working population.	• Companies and local governments provide health checkups and cancer screenings. • The government is working on specific health checkup and specific guidelines for people aged 40–74 years. • Companies are investing in "health management."	• The total amount spent on medical care accounts for approximately 30% of the total social security benefit costs, although further increases are expected. • The number of people requiring long-term care is increasing.
Issues	• The "100-year life expectancy era" is within reach. Meanwhile, the gap between the average life expectancy and healthy life expectancy (unhealthy period) is becoming longer.	• Specific health guidelines does not yield the expected effect. • Although corporate health management has been effective, its implementation has been limited to only some companies, mainly large corporation, have implemented corporate health management systems.	• Medical and long-term care insurance rates are high. • The shortage in the number of caregivers will increase. • The number of family care leavers is increasing, leading to a decline in economic strength.

Fig.2-3 State of Health in Japan and Related Issues

The above-mentioned table summarizes the "current status" and future "challenges" for extending healthy life expectancy. The importance of lifelong health management emerges from these perspectives.

2.4. Importance of Personal Health Awareness

2.4.1. Individual Health Management and Expectations for Digital Technology

It is difficult to artificially change the composition of the population and life expectancy, and sustainability of social security is under threat owing to escalating costs of medical and long-term care. The effectiveness of health management led by local governments and companies is limited. Therefore, in the future, individuals will be required to "improve their health awareness as a

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jigyou keikaku ni motoduku kaigo shokuin no hitsuyou suu nit suite Reiwa 3 nen 7 gatsu 9 ka
https://www.mhlw.go.jp/content/12004000/000804129. pdf

personal responsibility," prioritizing their health before receiving medical and long-term care services.

Severity (Level)

Social healthcare costs

Period

No. of patients (No. of people)

Digital healthcare reduces severity, duration, and patient numbers, lowering social healthcare costs.

Social healthcare costs
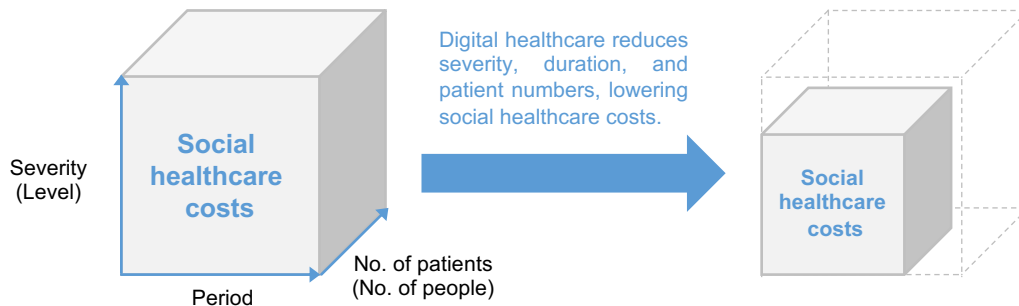
Fig.2-4 Model of the Configuration of the Cost of Social Healthcare

Figure 2-4 shows a model of the composition of social healthcare. To reduce the volume of the social healthcare cost box, it is essential to reduce one or more of the following three factors: "reducing the level of severity of illness," "shortening the duration of medical treatments," and "reducing the total number of patients." Reducing the severity of illness and duration of medical treatment can, to some extent, be achieved by improving health awareness through self-reliance.

It is anticipated that individuals will rely on the universal health insurance system to maintain their health and digital technology for daily health management. Digital data offers distinct advantages such as cost-effectiveness, high processing speed, seamless integration with other data, immediate responses, and personalization of services, making it easy to provide high-quality health services. Therefore, in the future, utilizing digital health care to shift people's awareness to "optimize their health" and prevent the progression of lifestyle-related diseases will be recommended, especially through self-management.

Regarding self-management capabilities, Hasebe[27] states, "It is important for people to effectively manage their health concerns and stress while improving their quality of life (QOL) to achieve a sense of well-being." It is because adolescents and mature adults are the generations that particularly require self-management skills (Figure 2-5) and services making good use of digital technology.

In contrast, Hasebe also pointed out that "it is difficult for infants and the elderly to control their health and stress." However, as adolescents and mature adults become more proficient in digital technology, support for infants and the elderly will become more widespread. For example, digital technology will support the health and development of young children, improve the

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[27] Masahiko Hasebe, Norimasa Sugiyama, Shizuyo Takaishi, Sachiko Nakamura, Ayako Nishida, ["Proposal of new services in the field of mental health care,"] Mental healthcare ryoiki ni okeru shinki service no teian" [Information Science and Technology,] Jouhou no Kagaku to gijyutsu, Vol. 70 (2020), No. 2, p. 90-95

convenience of childcare, and prevent illness. In particular, the spread of digital services to adolescents and mature adults will provide seamless digital services to all generations.
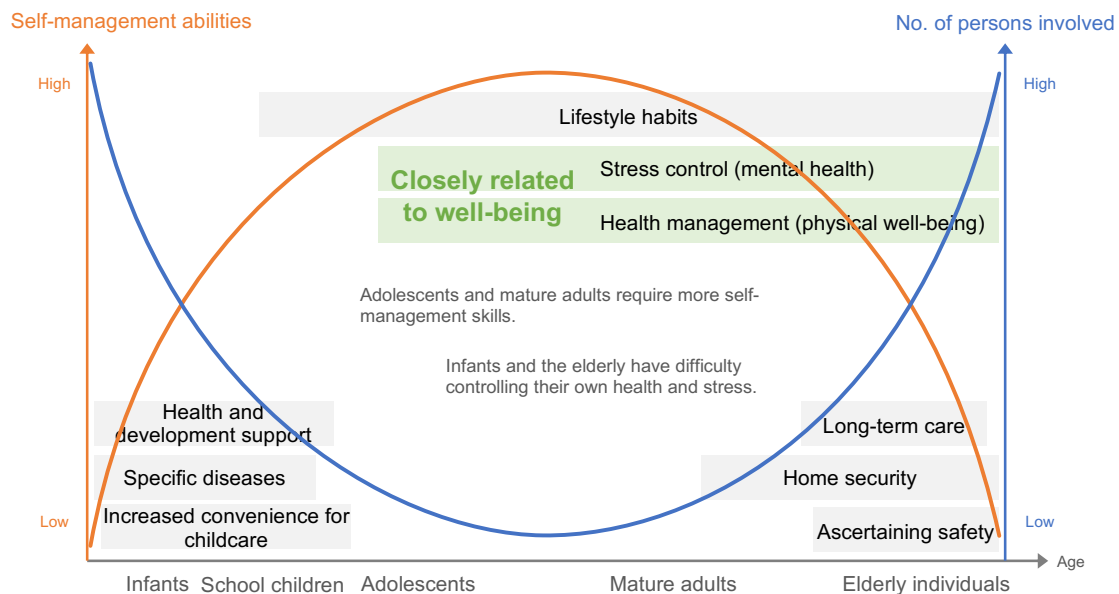
Fig.2-5 Overview of Social Needs for Health care[28]

2.4.2. Use of Digital Technology in Medical Treatment, Health Care, and Long-term Care

In the medical field, digital technology is being used to accumulate patient data, improve the efficiency of hospital administrative procedures, standardize electronic medical records, and facilitate remote diagnosis, treatment, and regional medical collaboration. Challenges in this field include the standardization of electronic medical records and reimbursement costs. In health care, digital devices are used for self-measurement, such as Apple Watch, and many applications are provided to support health. Furthermore, since the spread of coronavirus disease (COVID-19), digital technology has been used for contact tracing of infected individuals and vaccination certification. However, popularizing the use of digital services, changing lifestyle behavior by utilizing advice and guidance provided by applications, and to link this to care continuity remains a challenge. In the long-term care field, digital technology is used to support the daily lives of those who require long-term care, to assist caregivers in monitoring those who need long-term care, and to improve the efficiency of nursing care administrative tasks. Similar to the medical care field, challenges include the issues of reimbursement costs and the need for IT literacy to

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[28] Quoted and added from above

effectively utilize digital technology.

	Medical Treatment	Health Care	Long-term Care
Current State	**Data building** Accumulation of diverse data **Clinical** Introduction of online medical care, medication guidance, and robot-assisted surgery using information terminals (PC, tablet, or mobile) that transmit test results (images, pathology specimens, etc.) to remote locations for diagnosis. **Hospital administration** Building a system to improve efficiency **Communication** Establishment of regional medical coordination (EHR) **Standardization of standards** Standardization for sharing of electronic medical records and other patient information	Commercialization of **health care domain companies** (fitness-related) Commercialization of **companies outside the health care** domain (e.g., life and non-life insurance industry) Acceleration of dissemination of **mobile health care apps as PHR** ✓ Introduction of the COVID-19 Infection Contact Notification App ✓ Digital vaccination certificates ✓ Insomnia relief app ✓ Ambulatory ability measurement app, etc. Lifestyle improvement using **IoT devices and mobile apps** (behavioral change through character-based advice)	Products for **long-term care recipients** ✓ Robots to relieve loneliness ✓ Mobility assistance ✓ Excretion support, etc. Long-term care support products for **long-term carers** ✓ Remote monitoring ✓ Alarm function by sensor detection and PC controlled excretion alarm ✓ Mealtime asphyxiation calls ✓ GPS calls, etc. Products to **improve long-term care provider administration** ✓ Long-term care records app ✓ Care plan creation AI system ✓ Preparation of nursing care fee applications, etc.
Issues	**Remuneration** Low reimbursement relative to costs	**Behavioral Changes** Creating mechanisms to expand dissemination and sustain behavioral changes	**Remuneration** Low reimbursement for long-term care relative to cost **IT Literacy** Improve staff IT literacy as well as design apps and guides that consider diverse generations and functional disabilities.

Regulations & Privacy — Balance between data sharing, privacy protection, and legal regulations

Management — Difficulty with safety and maintenance due to lack of defined management bodies, management methods, etc.

Fig.2-6 State of Medical Treatment, Health Care, and Long-term Care and related Issues

2.4.3. Impact of Digital Technology on Society

According to estimates made by the Mitsubishi Research Institute, if preventive medical technologies, which are expected to be utilized practically in the future, are adopted across eight preventive domains—diabetes, nicotine dependence, dementia, depression, high blood pressure, physical inactivity, obesity, and bone fractures caused by muscle weakness—they could reduce medical treatment and long-term care costs by approximately 1.5 trillion yen by 2030 (approximately 0.3 trillion yen in medical expenses, including medication costs, and 1.2 trillion yen in long-term care expenses). Although these technologies are not limited to digital technologies like digital devices, it is assumed that some form of IT-based healthcare will be utilized, given today's widespread use of IT.

The report also states that although overall life expectancy may not be significantly extended, the duration of a healthy life will be prolonged. Specifically, preventive medical technologies may extend the period of good health, consequently, medical treatment costs will be somewhat reduced.

In the area of long-term care, it is expected that improvement in the QOL will reduce the number of elderly patients who need long-term care by approximately 720,000 individuals and that the increase in the number of elderly who can live independently will reduce the burden of care on their families[29]. It is estimated that a reduction in the number of elderly individuals who require long-term care will have the effect of reducing the cost of long-term care[21].

Digital health care will not only reduce social security costs but will also enhance the QOL and well-being of individuals.

Estimating the Effectiveness of Preventive Medicine

Preventive medicine dissemination rate

×

Effects of preventive medicine

Target diseases

- Hypertension
- Diabetes
- Coronary artery disease
- Strokes
- Dementia
- Cancer
- Bone fractures, etc.

Outcomes

- Morbidity rate decrease
- Decrease in the rate of serious illness
- Lower mortality rate
- Improved QOL for families (caregivers)

Improvement of healthy life expectance and QOL

Impact on Medical Treatment and Long-term Care

- Reduction of about 1.5 trillion yen (0.3 trillion yen for medical expenses and about 1.2 trillion yen for long-term care expenses)
- Improve quality of life around the 75-80 age group, the volume zone for long-term care

Fig.2-7 Impact of Preventive Medical Care in 2030[30]

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[29] Michio Fujii ["Impact of preventive medicine in 2030"] "2030 nen no yobou iryou no impact" "Mitsubishi Research Institute Monthly Review" October 2021 issue
[30] Created based on the above materials.

CHAPTER 3. Current Status of Digital Technology Use in the Medical and Health Care Industries

After organizing the current status of the digital utilization in the medical and health care industries, we will analyze the mechanism of health promotion through digital health care using the causal analysis method and attempt to structure the challenges related to the promotion of digital health care in Japan. Finally, we will introduce the contents of interviews with experts regarding ongoing efforts to digitalize medical and health care aimed at addressing these challenges.

Chapter 3	Current Initiatives and Challenges in the Use of Digital Technology in Health Care
3.1. Current Status Regarding Using Digital Technology in the Medical and Health Care Industries (Japan and Overseas)	
3.1.1.Use of Digital Technology in the Medical and Health Care Industries in Japan	3.1.2. Development of Services and Products and Services using Digital Technology and Examples for Overseas
3.2. Analysis of the Health Promotion Mechanism by Digital Health Care using the Causal Loop Diagram	
3.3. Structurization of the Promotion of Digital Technology in the Medical and Health Care Industries in Japan	
3.3.1. Data Management	3.3.3. Intergenerational Management
3.3.2. Regional and Sectoral Management	
Interviews with Leading Authorities on Digital Health Care	

Fig.3-1 Configuration of Chapter 3

3.1. Current Status Regarding Using Digital Technology in the Medical and Health Care Industries (Japan and Overseas)

3.1.1. Use of Digital Technology in the Medical and Health Care Industries in Japan

To shorten the period of unhealthy life, which is the difference between the average and healthy life expectancy, awareness of the prevention of physical and mental illnesses, including lifestyle-related diseases must be raised through individual health management. Thus, "implementation of primary, secondary, and tertiary prevention" becomes a key concept.

Primary prevention includes a well-balanced diet, exercise habits, smoking cessation, moderate alcohol consumption, adequate sleep, and stress reduction (Figure 3-2). The key to secondary

prevention is to promote early detection and treatment of diseases to prevent them from becoming severe. Tertiary prevention aims to minimize disease progression after treatment, while also reducing the risk of complications and long-term effects. For example, should diabetes be diagnosed and left untreated, there is a high likelihood of it progressing to the three major complications: neuropathy (numbness, pain, and dullness of the senses in the feet, urinary problems, and eye problems); visual impairment and blindness owing to retinopathy; and dialysis owing to decline in kidney function.

Currently, however, approximately 50 and <20% of men and women in their 20–70s are strongly suspected to have "metabolic syndrome (MetS)[31]." Approximately 55 and 17% of men and women aged 40–74 years fall into this category, making lifestyle improvements an urgent necessity[31]. Moreover, this situation has continued for at least a decade since 2008, when MetS checkups were incorporated into general health examinations. The major risk of MetS is accelerating arteriosclerosis, which triggers the onset of stroke and myocardial infarction, two of the three major diseases.

Therefore, it has been pointed out that it is necessary to incorporate an awareness of prevention in daily life. Figure 3-2 shows the relationship between these preventive measures as a "hierarchical structure of factors to extend healthy life expectancy." Based on this figure, let us consider the use of digital technology for disease prevention.

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[31]   Ministry of Health, Labor and Welfare ["Results of the 2019 National Health and Nutrition Report" Part 2 Physical Condition Survey Results 2020], "Reiwa gannen Kokumin Eiyou houkokusho no kekka, Dai 2 bu shintai joukyou no kekka 2020 nen", p.156 https://www.mhlw.go.jp/content/000711007.pdf

Life expectancy layer: reduction of long-term care period and extension of healthy life expectancy

Health Layer: prevention of diseases prior to an increase in their severity

Health Care layer: activities for maintaining and improving health

Hierarchy of Factors that Increase Healthy Life Expectancy
- Life expectancy layer
- Health layer
- Health care layer

Health Data
- Health checkup results
- Health care devices

Preventive Medicine
Primary prevention (disease prevention)
Lifestyle improvement (sleep, exercise, diet, smoking, alcohol consumption, and stress management), vaccinations
Secondary prevention (early detection of disease)
Initiation of early (in stage) treatment through physical examinations and cancer screenings
Tertiary prevention (recovery from disease, maintenance of remission, and prevention of recurrence)
Rehabilitation

Healthy life expectancy

Unhealthy period (period of withdrawal, hospitalization, long-term care, etc.)

*Middle-aged adults (40–64) , older adults (65+)

Health — Health Maintenance (Middle and older adults*, obesity) — Illness (Middle and older adults requiring support) — Severe illness (Long-term care required)

Primary prevention   Secondary prevention   Tertiary prevention

Target areas discussed in this paper

Exercise | Improved diet | No smoking | Work–life balance | Moderation in drinking alcoholic beverages | Relaxation

Insufficient exercise | Diet | Smoking | Overwork | Alcohol consumption | Stress

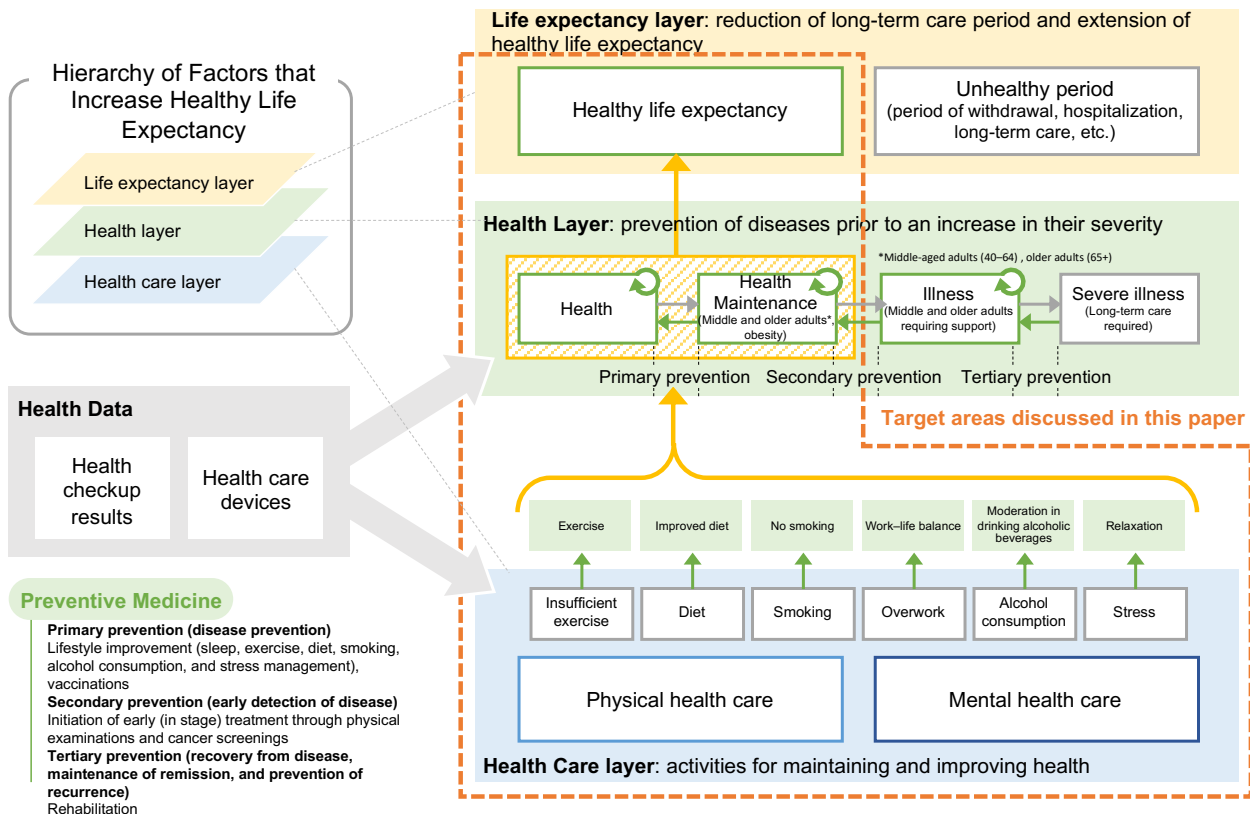Physical health care | Mental health care

_ **Fig.3-2** Hierarchical Structure of Elements to Extend Healthy Life

Recently, we have seen an advancement regarding using "mobile health apps." In primary prevention, in addition to daily step counts, vaccination records for prevention of COVID-19 can be managed to track doses and timings, sleep conditions can be monitored and analyzed to improve sleep quality, and daily blood pressure measurement records can be continuously analyzed to track one's health condition.

In secondary and tertiary prevention, we have been developing personal health records (PHR), enabling individuals to conveniently access their medical data. These data include (1) medical information (medication information, adverse medication reactions, test results, and other medical institution information in the electronic medical records); (2) general health examination and check-ups (medical examinations at schools and companies, immunization history, cancer screenings, and osteoporosis screenings); and (3) health information (life log data such as exercise, sleep, diet, and blood pressure).

Currently, the services provided by PHR providers are broadly classified into three types: (1) recording and managing personal health and medical information; (2) displaying personal health and medical information in an easy-to-understand manner, and presenting lifestyle improvement

methods and effects after analysis; and (3) using and providing personal health and medical information to research institutions and companies for research and development[32].

Additionally, the "personal data trust bank" initiative is attracting attention in the industrial world. A "personal data trust bank" generally refers to a business that manages and operates personal data for individuals based on a contract with them. Currently, various business models that exist are as follows: (1) the user's data can be managed safely and securely, and should the data owner desire to show it to someone, they can freely retrieve it (the aforementioned PHR-type service) and (2) should the user answer a questionnaire survey from a company, a gift or benefit will be provided.

Particularly, personal data trust banks in the medical, nursing, and health care fields are attracting attention because utilizing this data is expected to lead to improved health and extended healthy life expectancy for individuals, and the benefits are direct and simple. Regarding the aforementioned type (1) service, SMBC Group's Sumitomo Mitsui Banking Corporation, Osaka University Hospital, and the Japan Research Institute have been promoting a verification project of an "personal data trust bank for medical data" (detailed in the interview on p. 31) since March 2019. This is a service that allows patients to check their medical data via smartphone.

In 2022, the world's first application for treating hypertension (handling medical devices), Cure App HT, was approved by the MHLW for manufacturing and marketing (pharmaceutical affairs approval). Until now, medication and therapeutic applications have been prescribed as a set for smoking cessation treatment, whereas the application for hypertension treatment does not use medication but sends advice and messages to patients daily to encourage behavioral changes for blood pressure control.

Thus, we can grasp the current use of digital services for primary, secondary, and tertiary prevention at the individual level, mainly through mobile health apps and PHR.

3.1.2 Development of Services and Products Using Digital Technology in Japan and Overseas

This section focuses on digital utilization services and products outside of hospitals, such as

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[32] Ministry of Health, Labor and Welfare ["Study Group on Promoting PHR for National Health Promotion, Private Utilization Working Group Direction of Study (Draft)" Material] "Kokumin no kenkou dukuri ni muketa PHR no suishin ni kansuru kentoukai minkan riyou sagyou han kentou no houkousei (an) shiryou" https://www.mhlw.go.jp/content/10904750/000595942.pdf

fitness and wellness, for health care companies as well as life insurance and non-life insurance companies entering the market to develop digital-based services and products, leading to ongoing competition. When health condition is classified along the axis of "healthy → unwell → sick," services and products have already been launched in all these categories (Figure 3-3). Many individuals still face challenges in understanding and managing their health conditions.
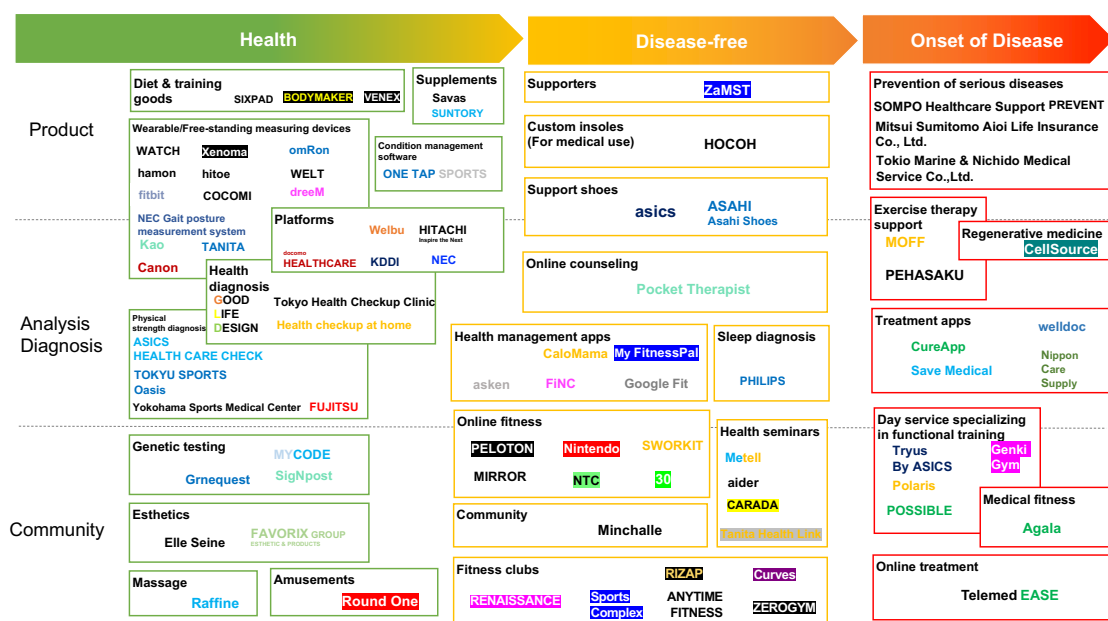

Fig.3-3 Examples of Domestic Digital Health Care Services and Products[33]

According to the study by Nakagawa et al., overseas health care cases utilizing digital technology include the following[34].

Denmark (government-led data utilization): Denmark introduced personal identification numbers in 1968 and has been using them >40 years. It is characterized by the government's centralized management of medical and health-related data, including personal medical record information and information from health care applications. The government's medical portal site allows individuals and registered family members to view this data, and is capable of raising health awareness among individuals, thereby leading to health management and preventive medicine. In Japan, this field is just beginning to take off, and benchmarking Denmark could be beneficial.

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[33] The logo images of the companies are not used, but the name of the companies were used instead rather than the logo.

[34] Atsuhiro Nakagawa et al. ["Efforts to change people's behavior using digital ICT: infrastructure, methods,"] "Digital ICT wo mochiita hitobito no koudou henyou ni kansuru torikumi: Infra, method," Operations Research, Vol. 64, No. 7, 2019, p. 413-418 https://orsj.org/wp-content/corsj/or64-7/or64_7_413.pdf

The Netherlands (private sector-led extension of healthy life expectancy): The Netherlands is promoting using data to extend healthy life expectancy, with three steps: Electronic Health Records within institutions, Health Information Exchange between institutions, and PHR exchange between patients and professionals. Moreover, since 2016, the country has launched the MedMij project to promote PHR, a lifelong electronic health record that collects data throughout a person's life, enabling individuals and professionals to use it to improve health. A distinctive feature of this initiative in Japan is that it encourages individuals to participate in health promotion through self-help efforts, and the government only provides major policies (enactment of laws, creation of guidelines and rules). By entrusting the development of PHR platforms to the private sector, the government aims to improve the quality of medical treatment through market principles and to enhance the quality of services while reducing costs through competition principles.

Singapore (medical institutions also contribute to the improvement of convenience and quality): In Singapore, public and private hospitals have been introducing healthcare-related applications since 2016. These applications enable patients, their families, and health professionals to share information seamlessly, improving service quality and increasing efficiency in the healthcare sector. The background of this trend is said to be the "Smart Nation Concept" that started in 2014. As Society 5.0 and the smart city concept are gaining momentum in Japan, it will be valuable to refer to Singapore's efforts.

Israel (utilization of medical information and promotion of innovation led by medical institutions): Israel, with its world-class technology and experience in cybersecurity, has been promoting a data-oriented approach, which focuses on collecting and sharing data in the medical and health care fields. It has established a highly secure system with robust privacy protection. This initiative started by collecting and accumulating patient data through regional hospitals capable of handling such tasks and has since been rolled out nationwide, creating a system that enables data sharing among hospitals. Consequently, patients can receive medical treatment at any hospital based on their medical records and data, and that data can be shared with research institutions, leading to new technologies and commercialization. For users, the fact that their health care data is protected by strong security is a source of reassurance, further promoting using digital health care. Security is a fundamental prerequisite for digital health care promotion.

While the main actors involved in initiatives in each country vary from government organizations, private sectors, and medical institutions, in each case, it is evident that they are progressing with the use of data that transcends organizational barriers. In Japan too, progress is being made with diverse initiatives, and the challenges are described in detail in Section 3.3.

3.2. Analysis of the Health Promotion Mechanism by Digital Health Care using the Causal Loop Diagram

We analyze how digital healthcare affects health outcomes using a causal loop diagram (Figure 3-3). A causal loop diagram is an analytical tool that helps visualize complex systems by mapping out cause-and-effect relationships between different elements. In this diagram, green boxes represent key variables in the system, while arrows connect these variables to show their relationships. The relationships between elements are marked with either positive or negative signs. A positive sign indicates that the connected elements change in the same direction - as one element increases, the other increases as well. Conversely, a negative sign indicates an inverse relationship, where an increase in one element leads to a decrease in the other. Through these relationships, the diagram illustrates the interconnected pathways through which digital healthcare influences health outcomes.

First, note the pink loop (health promotion loop with digital health care) and blue loop (digital health care diffusion loop) in Figure 3-4. In the pink loop, health is improved by digital health care. The blue loop, which is part of the pink loop, connects the factors for the diffusion of digital health care. The structure of the blue loop is such that health promotion will be improved should the blue loop for digital health care dissemination be successfully implemented. Additionally, the vertical line connects the flow of the blue loop to the pink loop (the "behavior change only through one's awareness" line). In the gray line in the middle, from the bottom to the top, the "degree of visualization of one's activity and physical condition" is increased using self-data from digital health care, and awareness of one's own life is raised. This is anticipated to motivate individuals to change their behavior for better health, however this is the bottleneck of the line. Therefore, it was necessary to strengthen the right-side route ("behavior change through intervention from the external environment" line) to cause an intrinsic change in the user's own life and change in the environment. This means controlling the living environment digitally as well as motivating and intervening in the environment to change behavior.
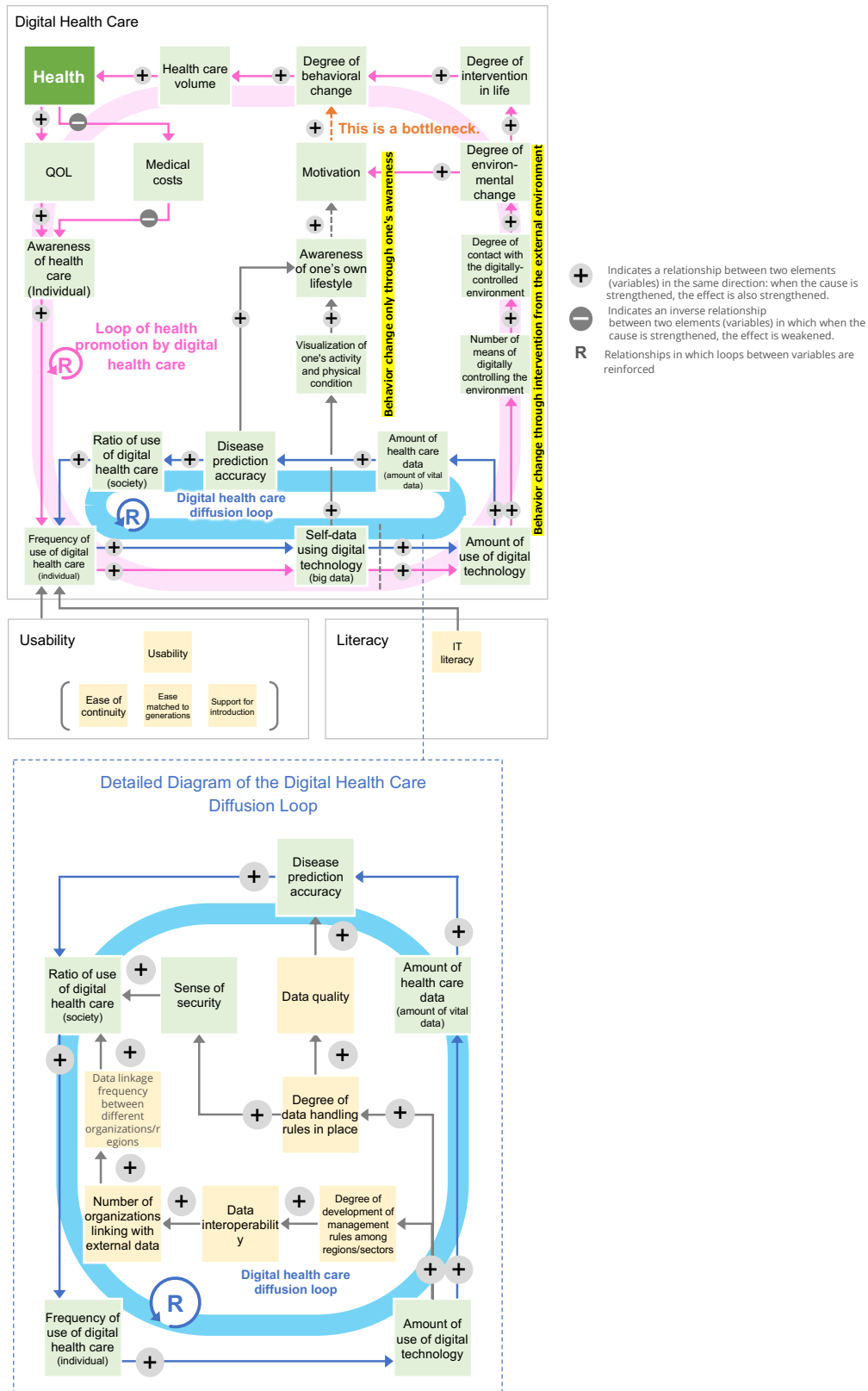
Digital Health Care

Health ← + Health care volume ← + Degree of behavioral change ← + Degree of intervention in life

This is a bottleneck.

QOL — Medical costs

Motivation ← + Degree of environmental change

Awareness of health care (Individual)

Awareness of one's own lifestyle

Degree of contact with the digitally-controlled environment

Loop of health promotion by digital health care **R**

Visualization of one's activity and physical condition

Number of means of digitally controlling the environment

Behavior change only through one's awareness

Behavior change through intervention from the external environment

Ratio of use of digital health care (society)

Disease prediction accuracy

Amount of health care data (amount of vital data)

Digital health care diffusion loop **R**

Frequency of use of digital health care (individual)

Self-data using digital technology (big data)

Amount of use of digital technology

Usability

Usability

Ease of continuity | Ease matched to generations | Support for introduction

Literacy

IT literacy

Indicates a relationship between two elements (variables) in the same direction: when the cause is strengthened, the effect is also strengthened.

Indicates an inverse relationship between two elements (variables) in which when the cause is strengthened, the effect is weakened.

R Relationships in which loops between variables are reinforced

Detailed Diagram of the Digital Health Care Diffusion Loop

Disease prediction accuracy

Ratio of use of digital health care (society)

Sense of security

Data quality

Amount of health care data (amount of vital data)

Data linkage frequency between different organizations/regions

Degree of data handling rules in place

Number of organizations linking with external data

Data interoperability

Degree of development of management rules among regions/sectors

Digital health care diffusion loop

Frequency of use of digital health care (individual)

R

Amount of use of digital technology

Fig. 3-4 Relationship between Health Promotion and Digital Health Care

Collecting and using individual information is changing the environment around us. An increase in an individual's "frequency (number of times) of using digital health care" and the "amount of self-data using digital technology" leads to an increase in the frequency of contact with the digitally controlled environment. A similar trend can be seen in e-commerce entities such as Amazon and Rakuten. E-commerce uses big data and AI to transmit personalized information that introduces products and services that satisfy the needs of each customer. Contact with this personalized information (digitally controlled environment) has brought about an increase in convenience and utility. Consequently, the frequency of contact with the digitally controlled environment has increased, leading to an increase in online shopping, an intervention in people's lives, and a change in people's (purchasing) behavior. Similar developments are highly anticipated in the health care field. As Amazon announced Amazon Halo, a wristband-type wearable device service, in 2020, the connection of e-commerce and wearable devices will accelerate the creation of environments that respond to individual health conditions and frequency of contact with such environments. Although these are examples of IT environments, should the physical living environment be further interconnected to IT, our living and working environments will become digitally personalized, influencing our behavior. This will lead to an increase in the degree of intervention in our lives and the degree of behavioral change, such as exercise and health care behavior, which will eventually lead to improved health. Once the effect of improved health is realized, it is expected to further raise awareness of health care and increase the frequency of using digital health care, forming a virtuous loop (pink: health improvement loop through digital health care).

In contrast, "improvement of IT literacy and ease of use (usability)" is one of the conditions for increasing the frequency of digital health care use by individuals, which is different from this loop. For individuals to use digital health care, it is necessary to form a dissemination loop (blue: digital health care dissemination loop) in which using digital health care is more common in society owing to the increase in health care data and the resulting improvement in the accuracy of disease predictions. Namely, social diffusion is indispensable to promoting individual-level use of digital health care. This "digital health care dissemination loop" includes issues such as the development of rules for management and data handling among regions and sectors, as well as the degree of dissemination of data linkage among different organizations and regions (details are described in the next section).

Currently, neither the "health promotion loop with digital health care" nor the "digital health care diffusion loop" has been realized. It cannot be said that the "increase in self-data using digital

technology" and "relationship with the amount of use of digital technology" are connected. No matter how much self-data is collected, it is not effectively utilized. One of the major issues for the future is successfully linking the two. Should this connection be achieved, the "health promotion loop through digital health care" and "digital health care dissemination loop" will overlap, it is expected to significantly accelerate the spread of digital health care. As mentioned above, a few ideas are to promote environmental changes digitally, encourage behavioral changes, and create a virtuous circle loop.

Recently, the government and companies have rapidly developed digital utilization of health and medical information. In contrast, using digitalization remains insufficient regarding diffusion, and various challenges.

3.3. Structurization of the Promotion of Digital Technology in the Medical and Health Care Industries in Japan

We analyze and structure the factors hindering digital healthcare adoption in Japan by building upon our examination of digital healthcare utilization in Japan and other countries (Figure 3-5). To extend the healthy life expectancy of the population, it is necessary to set goals related to healthy life expectancy based on the analysis of health risks and establish the design and evaluation of systems that align with these goals in an effective cycle. However, the current situation is that such a platform has not yet been built. We categorized the main challenges of digital health care platforms into "data management," "regional/sectoral management," and "intergenerational management." The details are described below.

Digital Platform Linking Fields, Regions, and Generations

Data Management
- Technology for data acquisition and data quality management
- Integration of multiple types of data
- Data standardization for sharing of PHR
- Balancing between personal information, protection for data standardization, and legal regulations.

Regional/Sectoral Management
- Public EHRs that link medical information on a national scale
- Data linkage between insurance-covered medical institutions and private companies
- Safety and maintenance management for which data management entities are not defined

Intergenerational Management
- Creating mechanisms to expand the dissemination ratio and sustain behavioral change
- Design of apps and guides that consider diverse generations and functional disabilities
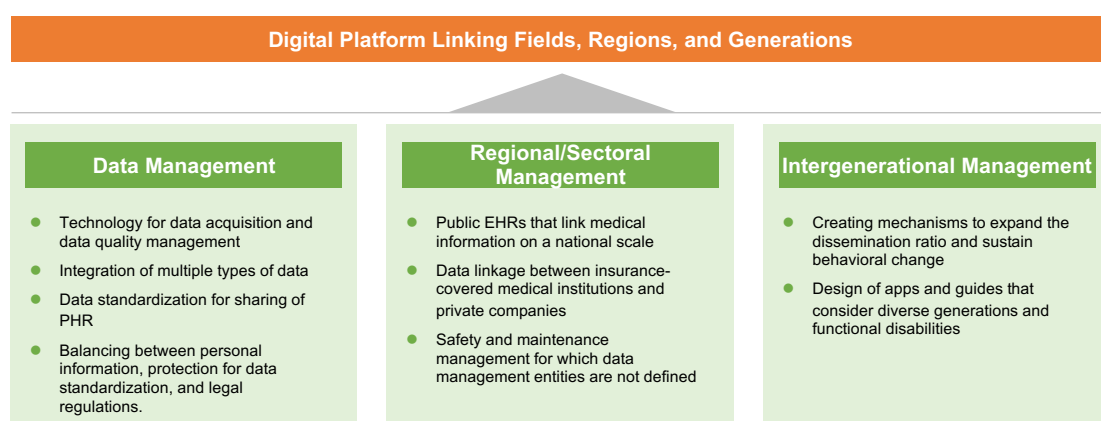
Fig. 3-5 Issues relating to the Digital Health Care Platform

3.3.1 Healthcare Data Management

Currently, multiple types of PHR collect personal information related to health care, and data linkage between them has not progressed. When users of PHR service have multiple types of PHR and use multiple services, data interoperability is required; however, such interoperability has not yet been established[35]. Since users may switch services for their own reasons or change data-handling service providers due to consolidation or closure of service providers, it should be possible to switch PHR providers (also known as "portability"), but such data linkage has not yet been established. One major factor is the lack of data standardization for integrated PHR utilization.

Another critical aspect to consider is personal information protection. PHR contains not only personal health data but also numerous types of personal information such as name, age, sex, and lifestyle. Thus, to utilize PHR as standardized data, data linkage must account for the balance between data convenience and personal information protection. While this data linkage requires discussion from a legal perspective to ensure personal information protection, the current discourse on legal regulations concerning PHR remains insufficient[36].

3.3.2 Regional and Sectoral Management

The aforementioned PHR-based services should be widely provided and operated regardless of an individual's specific living environment and lifestyle. However, this universal availability has not yet been achieved. The main reasons for this are the barriers between "regions" and "sectors." Regarding regions, the management of personal information is entrusted to local governments (municipalities) and medical institutions. Concerning "sectors," a major factor is the lack of data linkage between hospitals and private companies. Hospitals primarily focus on providing medical services, while the main purpose of private-sector businesses is to pursue profits by providing products and services. Due to these different perspectives, data linkage remains challenging.

Another factor is that medical information used to be considered "the property of only hospitals." However, the current perspective is that "medical information is the property of hospitals and patients." Following this shift, the focus moved toward the significant benefits of collaboration

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[35] Japan Business Federation ["Health care in the Society 5.0 Era II - COVID-19 response using DX and the future beyond - July 14, 2020"] "Society 5.0 jidai no healthcare II ~DX ni yoru COVID-19 taiou to sono saki no mirai ~ 2020 nen 7 gatsu 14 ka" https://www.keidanren.or.jp/policy/2020/ 062_honbun.pdf

[36] Yasuko Kamikawabe ["Domestic Health care Service Trends and PHR Utilization" "JIPDEC Electronic Information Utilization Research Department Report 2021"] "Kokunai healthcare service doukou to PHR rikatsuyou nit suite" "JIPDEC denshi jyouhou rikatsuyou kenkyu bu report 2021 nen" https://www.jipdec.or.jp/library/report/20210706.html

between hospitals and private companies to enable patients to utilize the information at their disposal. For example, Keiju Medical Center (Ishikawa Prefecture) collaborated with Medical Data Vision (other examples are mentioned in the next section of the interview) to provide services such as easy access to fetal ultrasound images at any time and management of medical records in a mother-child health handbook for children >6 years[38].

Thus, the challenge is in aligning the data from hospitals and private companies to link them.

Management arising from inter-regional/inter-sectoral data linkage is also necessary. Issues such as determining who will be the management entity of the linked network, how it will be managed, how to ensure security and safety, and who will maintain and manage the network must be solved.

3.3.3 Intergenerational Management

To extend healthy life expectancy, health care for each citizen must be promoted over several decades. Behavioral change at the short-term level, from a few months to a few years is not sufficient. Continuous behavioral change that seamlessly supports the transition of individual life stages is necessary; however, such a system has not been established.

To sustain the promotion of behavioral change spanning several decades, there is a need for purposes and incentives that support these changes. However, currently, incentives have not been designed for each generation or category of users. Examples of incentives include "improving the efficiency of medical practices at medical institutions," "simplifying the process of purchasing insurance and reducing its cost," and "giving back in the form of money or goods when health is improved." Medium-to-long-term incentive design in line with generations and user categories is required.

This chapter describes the current status of digital health care in Japan and challenges to its promotion. Our analysis highlights the importance of increasing self-collected health data, implementing data-driven behavioral interventions, and creating a virtuous cycle where these changes enhance health management. In the future, the spread of digital services that effectively change behavior is expected. Diverse efforts are being made to solve the mentioned issues, "data management," "regional/sectoral management," and "intergenerational management", and continued efforts are required to realize a platform that provides digital services to promote behavioral change.

We will propose a specific "digital service platform for behavior change" in the next chapter.

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[38] Keiju General Hospital. Efforts in Carteco and Medical Collaboration. NewMed.
https://www.newmed.co.jp/gakkai/4591

Interviews with Leading Authorities with a Focus on the Current State of Digital Health Care and Related Topics

Yasushi Kimizuka, Public Relations Office, Medical Data Vision Co., Ltd.

●**Collecting medical treatment data for use in patients' lives and regional liaison**

Our company aims to "realize a society where people can choose their medical care" and "build a society that can utilize medical data." Our primary service is the provision of management support systems to medical institutions nationwide. We collect medical information after anonymous processing that has been licensed for secondary use by such institutions (44.25 million individuals as of the end of July 2023), create a database, and provide it to pharmaceutical companies, academia, and others. Additionally, we provide a PHR service for individuals called "Karteco" (a coined word combining the Japanese terms for "electronic medical record" and "warehouse"). Patients can store medical information from hospitals in their applications. Daiyukai Social Medical Corporation (Aichi Prefecture) allows patients who have undergone health checkups or cancer screening to keep their results and share them with those around them, facilitating information sharing between medical and nursing care providers. In a case involving data linkage between hospitals and clinics in the community, Jiseikai Social Medical Corporation (Adachi-ku, Tokyo) shares information among Tojun Hospital, Joraku Medical Office, and Irua Casa (a geriatric health care facility), and utilizes it for health management, including prevention of serious lifestyle-related diseases in patients and users.

●**PHR changes the concept of "Smart Patients"**

When patients were surveyed regarding which items they checked daily from "Karteco," the following items were listed in order: (1) blood tests and other laboratory tests (25.5%), (2) results of physical examinations (12.7%), and (3) images from examinations (11.8%). They also looked at medication information (7.3%) and health condition records (5.5%).

Based on the results of this survey, we feel that the concept of an "informed patient" has changed in recent years. An informed patient means not only taking tests and medications as directed by a physician but also actively participating in their medical care. To achieve this, it is essential to create an environment in which people can make choices regarding their medical care by carrying their medical and health information and checking it at any time.

For instance, should a patient be undergoing artificial dialysis owing to chronic kidney failure caused by diabetes, there are dietary restrictions such as the intake of potassium contained in raw vegetables and fruit. One man tried eating raw vegetables and fruit at each meal, checking the data in his Karteco to see how it affected his test results. Consequently, he could control his test

data while still enjoying the foods he liked.

Therefore, this illustrates how valuable data can be when used effectively. In the future, we intend to develop systems that allow individuals to link their health and medical information for personalized disease prediction using AI.

Taku Iwami, Representative Director of the General Incorporated Association PHR Council (Graduate School of Medicine, Kyoto University, Master of Public Health, Professor and Physician in the Field of Preventive Medical Care)

●Providing Experiences Where PHR Benefits Health

The basic philosophy of PHR is "health and medical data are sensitive; however, it is data generated by the individual and is valuable. We strive to manage it by ourselves and utilize it for to promote physical and mental health and disease prevention." Currently, the progress of promotion is at stage 2 or 3 out of 10 to reach the goal. The key point is "to convey to society that the utilization of data can make us healthier and that the main actors in data utilization are the individual themselves."

We are promoting initiatives to allow people to experience how PHR contributes to health promotion and how data sharing among multiple PHR services enhances the value of data. These experiences are being offered at venues such as the Digital Garden City (a national concept promoted by the Cabinet Secretariat, Cabinet Office, and Digital Agency) and the Expo 2025 Osaka, Kansai, Japan. For example, by accumulating step counts and health data in a PHR 6 months before the Expo, a shoe manufacturer can aid you in making healthy shoes at the Expo site's pavilion, you can access recommendations when you look at a menu for a meal, and you can access information regarding your health when you sit in a chair at a housing manufacture's pavilion.

Moreover, you choose where to provide this information. This will encourage people to think about how to increase the value of their data and help them improve their health. In collaboration with local governments and pharmacies, we are also training "health promoters," specialists who support health promotion using data.

●The key to the implementation of PHR is not holding on to data

Data should be acquired and utilized throughout a lifetime. Therefore, data linkage and interoperability, especially data standardization, are urgent issues. To ensure citizens can comfortably utilize data, they should move and share data (also known as "data distribution") as they wish when selecting services; thus, service providers should not hold onto data. We plan to begin standardization of data exchange protocols starting with evidence-based data related to

lifestyle diseases, such as weight, blood pressure, step counts, and hemoglobin A1c, which reflects blood sugar levels, information related to medication which is useful in emergency and disaster situations, and information on severe allergies.

As a cardiologist, I have focused on the promotion of cardiopulmonary resuscitation and automated external defibrillator (AED) in emergency medicine. In the past, it was considered that only physicians could perform medical acts, similar to AED electric shocks. However, since many sudden cardiac deaths occurred outside of hospitals, the government began to entrust some of the medical treatment to the public in the interest of saving lives. Some doctors were opposed to the idea at first; however, since then, many people have been saved thanks to AEDs, and they have become generally recognized and widely used.

To date, health and medical data were also limited to management and utilization in hospitals because it was believed that leaving it to doctors and other medical professionals would lead to better medical care. However, we are entering an era in which the owners of data, that is, the public, will manage the data and choose its recipients. I believe that health care providers will be required to play a supporting role. The key to the significant development of this kind of PHR business is to "increase the number of colleagues who agree with the basic philosophy of PHR." Companies that will be the pillars of PHR services in the future must collaborate with medical professionals and academia to create rules for data standardization. Local governments will also play an important role in delivering PHR services, and I believe that many local governments will join.

Kentaro Sakata, Digital Strategy Department, Sumitomo Mitsui Financial Group, Sumitomo Mitsui Banking Corporation

●**Managing the most valuable and sensitive data as an information bank for individuals**

Data utilization is required as we advance toward the realization of Society 5.0, a data-driven society. However, "concern" regarding personal data being used and "dissatisfaction" about benefits and benefits not being provided are issues that need to be addressed. The SMBC Group believes that one of the new social missions required of financial institutions in the future is to realize enriched lifestyles for individuals by utilizing the social trust they have cultivated as financial institutions to store and promote the use of personal data safely and securely.

Based on this policy, Sumitomo Mitsui Banking Corporation, a member of the SMBC Group, together with Osaka University Hospital, and the Japan Research Institute, has been working since March 2019 on a verification project for an "information bank for medical data" that will enable patients to check their medical data using their smartphones. Medical data is one of the most valuable and sensitive personal data for individuals; this is a field in which the SMBC Group's

credibility can be most fully utilized. We have received strong support, endorsement, and expectations from patients and their families for this project.

Although various explanations and approaches to information banking have been attempted, the SMBC Group considers this to be a service that realizes self-management of personal data in accordance with the concept of data portability. It is a "service from the individual's point of view," with the focus being managing personal data securely and utilizing data for the benefit of the individual based on their choices, and not primarily for buying and selling data.

● Growing Recognition of the Value of Personal Medical Data Ownership

The specific service content of the "Information Bank for Medical Data" provided in the verification project is that "users can view, manage, and utilize their medical data (allergies, test results, drug prescriptions)" managed in electronic medical records at medical institutions, using their smartphones. We understand that this is the same type of service as what is called a PHR, and one of its features is that it is centered on medical data that has been conventionally managed by medical institutions.

At the beginning of the verification experiment in March 2019, the service was targeted only at pregnant women; however, the comments we received during the experiment included the following: "I want to know about myself through medical data," "I want people to know about me when necessary through medical data," and "I want the service to be available to other medical departments besides obstetrics." These were the great expectations for this initiative.

In response to these expectations, we have been offering the smartphone application "decile" for all patients since July 2021. The name of the application, "decile," was coined based on the essential need of patients to "know themselves and have them known to others through data."

The SMBC Group aims to realize affluent lives for patients and to solve social issues, such as reducing social security costs, by spreading what it has learned through this verification project throughout society.

Former Board Chairman of the Japan Association for Medical Informatics
Naoki Nakajima, Professor and Physician, Kyushu University, Medical Information Center

●Toward Establishment of a Data-Driven Learning Health System

Since November 2021, I have been serving as the lead chairperson of the "Working Group on Infrastructure of Medical Information Network (WG)" of the Study Group for Utilization of Health, Medical, and Nursing Care Information, Ministry of Health, Labor and Welfare. In accordance with the Ministry's roadmap for data health reform, the WG is to investigate and study the ideal infrastructure of the medical information network (main constituents, relationship between the online eligibility confirmation system and the government common infrastructure,

and timing of the operation) and the technical requirements, and to reach a conclusion while reporting to the relevant councils.

The MHLW is promoting "HL7 Fast Health care Interoperability Resources (FHIR)" as a standard, and it has been specified that each of the rules for specific health checkups/health examination data, discharge summary, and patient medical information forms will be compliant to it. In the future, with the establishment of the information exchange infrastructure using Open FHIR on the online eligibility verification network infrastructure, it will be possible to link data among regional core hospitals, clinics, pharmacies, and health examination organizations. Additionally, patients and healthy individuals can primarily utilize PHR data in devices such as smartphones. The involvement of PHR providers will enable them to make secondary use of the information quickly and easily via registering for utilization with anonymous or explicitly named data by themselves or by outsourcing secondary use of the data to information banks.

Randomized controlled trials with a high level of evidence have been criticized as being "too time-consuming and costly" and "inaccurate in reflecting the real world" because of the many restrictions on research participants. Data-driven clinical research using accumulated real-world data, medical big data research, is expected to address these challenges.

●**Connecting to Societal Improvements by Implementing Layer-specific PDCA**

Furthermore, a new concept of secondary data usage is the construction of a "Learning Health System (LHS)," which is a rapid PDCA cycle between "clinical sites" and "data-driven research analysis sites." Until now, explanatory variables in clinical practice have been the tacit knowledge of physicians. However, recently, explanatory variables have been increasingly visualized and structured, as seen in the efforts of the Japanese Agency for Medical Research and Development to standardize the clinical path system (a standard medical plan that includes evaluation and recording of patient conditions and medical actions).

LHS can be understood in terms of three layers: "the societal," "medical institution," and "individual layers." In the societal layer of LHS, evidence is derived from the accumulation and analysis of clinical data and incorporation into research papers and guidelines. LHS of the medical institution layer will seek to provide optimal medical care for individual medical institutions based on clinical paths and regimens. Individual-tier LHSs can provide personalized services, such as "This new medication is right for you," "New research shows these results," or "should you provide this data, you will receive these benefits." If medical services like Google's recommendations become possible, the feedback information will enable a series of PDCA cycles.

Japan's medical expenses are approximately 40 trillion yen, while the US expenses are 12 times that amount (approximately 500 trillion yen); however, the two countries have been competing for first and second place in the world for average life expectancy for many years. Japan's health and medical care system is excellent, efficient, and the best worldwide, which is supported by the

medical information system. The stage we should aim for in the future is "extension of healthy life expectancy," that is, lengthening the period during which individuals can work in good health and solve the challenges of aging, something that no country has yet achieved. While Japan's digitalization is lags behind, there is still great potential for medical Digital Transformation (DX) . We need to lead the world in medical DX by quickly advancing the digitization and standardization of medical care, creating a world in which a wholesome LHS thrives.

CHAPTER 4.   Towards 2040: A New Proposal

Chapter 4	Toward 2040: A New Proposal

4.1. Proposal of a New Service Model

    4.1.1. Overview of Environmental Change Type Digital Service Platform for Behavioral Change   `Introduction to Behavioral Change Ethics and Model`
    4.1.2. Examples of Environmental Change Type Digital Services for Behavioral Change
    4.1.3. Proposition for Value of Environmentally Transformative Digital Service Platform for Behavioral Change

4.2. Mechanisms Needed to Realize New Service Models

    4.2.1. Platform System to Enable Environmental Change Type Digital Services for Behavioral Change
    4.2.2. Governance of Environmental Change Type Digital Services for Behavioral Change

4.3. Impact of Implementation on Society

Fig.4-1 Chapter 4 Configuration

4.1. Proposal of a New Service Model

For individual health management, it is important to manage lifestyle habits such as exercise, diet, rest, smoking, and alcohol consumption. However, lifestyle, or behavioral changes, ultimately depend on the efforts of the individual. Digital utilization using wearable devices, for example, is currently limited to monitoring and advising on health conditions. Therefore, it is unlikely to have a significant impact on the ultimate goal of health maintenance and improvement. We believe that this is a major issue.

As a solution, we propose a new system that utilizes digital technology to actively intervene in the user's living environment to promote behavioral change aimed at extending healthy life expectancy. This system aims to provide support for behavior and lifestyle habit change by intervening with individuals who tend to give up on changing their lifestyle habits (such as the

inability to maintain exercise habits, overeating, overdrinking, or the inability to quit smoking). This intervention targets the user, individuals, and the living environment surrounding the user. It is a "digital service platform for behavioral changes" that allows participation from various industries. In particular, the platform we propose is a mechanism that improves the personal awareness of individual users and changes their living environment, including the physical living environment and attitudes of individuals around the user, to promote behavioral change; thus we named it "Environment-Transformative Digital Service Platform for behavior change." Using this platform, companies will provide their intervention services to users and accumulate data on the results of behavioral change. This is envisioned as a mechanism to improve services and create new businesses, ultimately, entire cities can intervene in the users' behavior to aid them in achieving their goals.

4.1.1. Overview of Environment-Transformative Digital Service Platform for Behavioral Change

Our proposed digital service platform has the following six features.

1. Behavioral Change by Intervention from the Life Environment

Various smartphone applications are currently available to support behavioral change, by visualization of data analysis on behavior and health conditions as well as the creation of push notifications to create awareness of and triggers for behavioral change. However, there are limits on how far behavioral change can be maintained only by encouraging the individual. In our proposed system, we envision support for behavioral change that does not rely solely on the will of the individual by combining mechanisms that work on the user's cognition and directly intervenes in their behavior. As an example of a highly coercive intervention from the living environment, a system that forcibly locks a computer per hour and requires the user to do push-ups to unlock it has been developed[39]. As an example of a gradual intervention from the living environment, a university cafeteria increased the number of vegetarian meals from one to two out of the four recommended menu items, and consequently, the number of purchases increased among those who had not previously chosen vegetarian meals[40]. However, while there are several individual life environment intervention schemes and experiments, currently no platform connects multiple intervention methods.

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[39] Unlock your PC with a pushup or two, Raspberry Pi website
https://www.raspberrypi.com/news/unlock-your-pc-with-a-pushup-or-two/
[40] Garnett EE, Balmford A, Sandbrook C, et al. Impact of increasing vegetarian availability on meal selection and sales in cafeterias. Proc Natl Acad Sci USA. 2019; 116: 20923–20929. https://pubmed.ncbi.nlm.nih.gov/31570584/

2. Continuous Provision of Multiple Intervention Services

To fulfill the behavioral change objectives set by the users themselves (to lose 3 kg of weight in 3 months), multiple intervention services such as the examples introduced above should be provided. Should users become bored with one service and discontinue their efforts, different services should be provided successively to support the achievement of the objective. Additionally, since unhealthy behaviors such as poor diet and lack of exercise often occur simultaneously, targeting multiple behaviors may have a greater effect than individual interventions[41].

3. Platform to Facilitate Participation of Multiple Service Providers

A platform should be built that allows multiple service providers to enter and offer intervention services. By lowering the entry barrier for service providers, we can support the participation of small and medium-sized businesses and startups in the market.

4. Feedback on Service Effectiveness to Service Providers

Feedback on "service effectiveness = results" should be provided to users and service providers by utilizing data analysis. By supplying service providers with information on what types of users and intervention services are most effective, the platform will encourage market entry by small and medium-sized companies that have difficulty conducting marketing and data analysis on their own. Furthermore, the data that will be sequentially accumulated in this platform is expected to be significantly utilized to provide society with new knowledge on behavioral change.

5. Service Improvement and New Service Creation Through Learning

In addition to giving feedback to individual service providers, the system can accumulate data on what types of individuals were successful in changing their behavior when intervention services were provided to them, extracting knowledge to supply to service providers in improving individual services. By accumulating data on the results of multiple services, the entire system can learn and evolve. Furthermore, by prototyping intervention services and sharing the learning results before service implementation, it potentially contribute to the efficient creation of new service models.

6. Mechanism for Not Providing Personal Information to Service Providers

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[41] Prochaska JJ, Spring B, Nigg CR. Multiple health behavior change research: An introduction and overview. Prev. Med. 2008; 46: 181–188. https://pubmed.ncbi.nlm.nih.gov/18319098/

The system will be implemented with a specification that does not provide the personal information of users to service providers. Since the system proposed in this study assumes the provision of services that monitor the behavior and health of individuals and intervene in the lives of users through various methods, the possibility that users may feel uneasy about using the system cannot be denied. To resolve users' concerns regarding the handling of personal information and to lower the hurdle for using the system, it is necessary to consider a system that enables service providers to provide services without obtaining users' personal information. Therefore, we would like to realize appropriate matching between users and service providers by keeping user's personal information only within this platform. One example is the anonymous shipping service of Mercari, a free-market platform that allows individuals to buy and sell goods. When buying or selling goods using normal shipping methods, the sender and receiver must disclose personal information such as addresses, names, and phone numbers. However, Mercari acts as an intermediary, creating a mechanism whereby the source and recipient can buy and sell anonymously without disclosing their respective information. The idea is that by constructing and operating such a system in which personal information is not provided, users can receive intervention services without disclosing their information.

The possible mechanisms to realize a system with these features are discussed below in 4.2.

4.1.2. Examples of Environment-Transformative Digital Services for Behavioral Change

The notional intervention services provided via the platform can be organized in the following categories, for example, referring to the Transtheoretical Model of Stages of Change (please look at the next column, Introduction to Behavioral Change Theories and Models). The examples of possible intervention services that we provided are limited, and it is up to the market to decide what kind of intervention services can be developed. Should the market develop it, it may lead to the creation of a new industry, the intervention service industry.

Table 4-3 Examples of Envisaged Intervention Services for Behavioral Change

Target		Examples of Intervention (image)	Types of Behavioral Change Process
Physical	Exercise	• Do not use escalators or elevators • Forced to walk • Provision of exercise in a way that suits the individual • Good things happen simply by exercising • You cannot purchase it unless you exercise.	Counterconditioning Counterconditioning Reinforcement management Reinforcement management Reinforcement management.
	Dietary improvements	• Blood glucose levels can be measured at various locations • Highly satisfying low-calorie foods are offered • Low-sugar satisfying foods are offered • The appropriate food for your body's condition will be recommended to you • Serving foods that produce laxative effects.	Self-reassessment Counterconditioning Oppositional conditioning Helping Relationships Reinforcement management.
	Smoking	• Cigarettes will not be sold and alternatives are recommended. • Every time you resist smoking a cigarette, you save money or earn more points • Paying to use smoking areas.	Counterconditioning Reinforcement management Reinforcement management.
	Alcoholic consumption	• Low-alcohol beverages are provided • Opportunity to speak with members of a self-help group are provided • Natural connections with professionals and people who understand.	Counterconditioning Helping relationships Helping relationships.
Mental	Overwork (depression)	• Being told that you are in danger • You are prompted to meditate, e.g., in a restroom • Alarms are issued to remind you and your supervisors to think about your work assignments.	Self-reassessment Counterconditioning Helping relationships.
	Stress	• Stress conditions are visualized and shown • Forced to take a break • Invited to go for a walk • Receiving a phone call from a specialist.	Self-reassessment Counterconditioning Helping relationships Helping relationships.

To effectively promote behavioral change, it is important to provide intervention services that correspond to the behavioral change stage of each target user (Figure 4-2). Therefore, it is ideal

to detect which behavioral change the user is at through some means, such as surveys or behavioral observation, and provide corresponding services.

Introduction to Behavioral Change Theories and Models

To change and sustain people's behavior, it is necessary to incorporate marketing elements for the development of intervention programs, in addition to efforts from physiological, biochemical, and psychological perspectives[42]. Intervention services provided on a platform to promote behavioral change should be tailored to the physical, psychological, and social conditions of the target population and provided at appropriate times. These services are expected to utilize the research on behavioral change that has been accumulated to date. Therefore, we will introduce the theories and models of behavior change that have been proposed to date and their outlines.

Level of Factors that Affect Behavioral Changes

Behavioral change is influenced by an individual approach and other factors at multiple levels (individual, organizational, and community/regional)[43]. McLeroy et al. [44]presented five levels of influencing factors on health-related behaviors and conditions. (1) "intra-individual" or "individual", (2) "inter-individual", (3) "systematic" or "organizational", (4) "community/regional", and (5) "public policy" factors. Of these, this paper focuses on the levels of (1) "intra-individual" or "individual", (2) "inter-individual", and (4) "community/regional" factors as the scope that can significantly influence behavioral change using the digital platform directly related to individual behavior, by introducing related behavior change theories and models.

Table 4-1 Organization of Behavioral Change Theories and Models

	Theory	Focus	Key Concepts
Individual level	Health Belief Model	Individuals' awareness of the threats posed by health problems, the benefits of avoiding threats, and the factors that influence decision-making	Perceptions of awareness, Perceived severity, perceived benefit, perceived barriers, triggers for action, and self-efficacy.
	Stages of Change	Individual motivation and readiness to change problem	Non-interest, interest,

[42] Koji Takenaka, ["Building an Active Lifestyle: Behavioral Change Research in Physical Activity and Exercise,"] "Actice Lifestyle no kouchiku shintai katsudou undou no koudou henyou kenkyu," Waseda University Press, 2015.
[43] National Institute of Health and Medical Sciences "Health Promotion Theory and Practice Guidebook at a Glance" p.8 https://www.niph.go.jp/soshiki/ekigaku/hitomedewakaru.pdf
[44] McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. Prev Med. 1988;15(4):351–377. doi: 10.1177/109019818801500401.

	Model	behaviors	preparation, action, and maintenance phases.
	Theory of Planned Behavior	Individuals' attitudes toward behavior, awareness of norms, and beliefs about the ease and difficulty of change	Behavioral intention, attitude, subjective norm, and awareness of behavioral control.
	Preventive Behavior Adoption Process Model	The individual's journey from ignorance to action and maintenance	Non-awareness of the problem, deciding to act or not, taking action, and maintenance of the behavior.
Inter-individual level	Cognitive Theory of Society	Personal, environmental, and human behavioral factors influence each other.	Mutual decision-making, practical ability, expectation, sense of self-efficacy, observation and learning, and reinforcement.
Community level	Community Organization	Community-driven ways to assess and solve health and social concerns	Empowerment community capacity, participation, suitability, problem selection, critical awareness
	Innovation Diffusion	How new ideas, products, and practices spread within or from one society to another	Relative advantage, suitability, complexity, testability, observability Example: Agenda Setting Media agenda setting
	Communication Theory	How different types of communication influences health behavior	Public agenda setting, policy agenda setting, problem definition, and framing

"Intra-individual" or "Individual" Factor Level

Individual behavior is the fundamental unit of group behavior, and individual-level behavioral change theory includes models for the group, organization, community/region, and nation. Additionally, intra-individual factors include knowledge, attitudes, beliefs, motivation, self-concept, upbringing, past experiences, skills, and expertise. Theories at the individual level include the following.

・ **Health Belief Model**

Focuses on the perception of threats arising from health problems (vulnerability and severity); benefits from avoiding threats; and factors that influence behavioral decisions (barriers, triggers for action, and self-efficacy).

・ **Transtheoretical Model**

Behavioral change is a process. For a person seeking to change behavior, they progress through the following five stages: precontemplation, contemplation, preparation, action, and maintenance. People in each of these five successive stages require different information; and intervention

methods designed for each stage are useful. In this paper, intervention services for behavioral change were examined mainly with reference to this model and are therefore presented in detail.
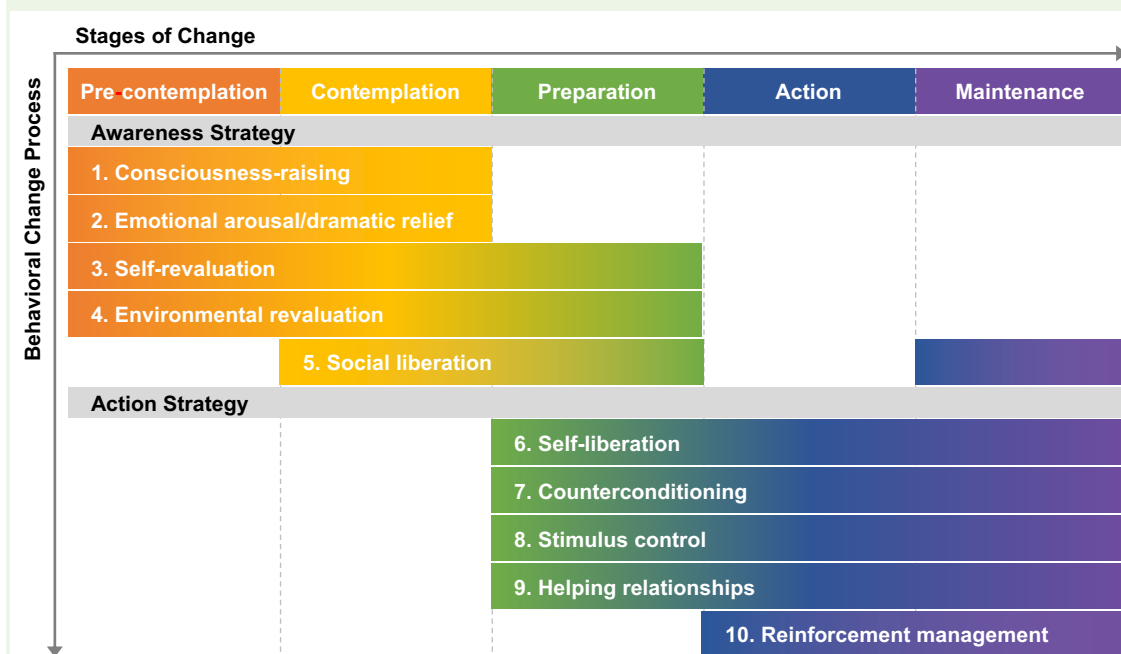

Fig. 4-2 Relationship between the five Stages and Behavior Change Process[45]

Table 4-2 Transtheoretical Model and Behavior Change Processes

	Process	Definitions and Examples of Interventions
Cognitive Strategies	Elevated Consciousness	Seek out new information and efforts to gain understanding and feedback on problem behaviors. Examples of interventions: Provide simple knowledge or encourage reading of health journals.
	Dramatic Relief	Informational component regarding making change, often intense emotional experiences related to problematic behavior. Intervention example: Have the participants think about a person who had a serious illness because they were not exercising enough.
	Self-reappraisal	Reassessment of the individual's estimate of the emotional and cognitive value of the problematic behavior. Intervention example: Aid the person in visualizing their future should they remain inactive and how exercise will change his/her life.

[45] Partially modified from Velasquez MM, Maurer G, Crouch C, DiClemente CC. Group Treatment for Substance Abuse: A Stages-of-Change Therapy Manual. Partially adapted from New York, Guilford Press, 2011.

	Environmental Reappraisal	Aid the person in evaluating how the problematic behavior affects the physical and social environment. Intervention example: Have the person consider the effects of the lack of exercise on family and friends.
	Social Liberation	The person's building, exploring the possibility of using, and accepting alternative behaviors, and accepting how the promotion of a lifestyle free of problematic behaviors is progressing in society. Examples of interventions: Public view of metabolic syndrome, introduction to existing walking circles, and walking trails.
Action Strategies	Self-liberation	Verbal qualities to change problem behavior. Examples of interventions: Post the target number of steps on the refrigerator, and have a child declare the number of steps publicly.
	Counterconditioning	Alternatives to problematic behaviors. Examples of interventions: Encourage walking instead of driving for short distances and using stairs instead of escalators.
	Stimulus Control	Manipulating the environment to produce the behavior or creating cues that trigger the behavior. Examples of interventions: Setting out walking shoes in a prominent place at the entrance and displaying training clothes.
	Assistance Relationships	Trusting, accepting, and using the assistance of others to change problematic behaviors. Intervention example: Find someone to watch the children while their mothers play volleyball.
	Reinforcement Management	Varying the content associated with controlling or maintaining the problematic behavior. Examples of interventions: Rewarding oneself after maintaining a walking habit for 1 month and removing barrier factors that prevent walking activity.

In this model, effective behavior change process interventions are presented in the following five stages: precontemplation, contemplation, preparation, action, and maintenance. Briefly, it is necessary to provide specific behavioral change process interventions according to the participant's condition (stage).

· **Theory of Planned Behavior**

The theory of planned behavior shows the relationship between behavior and beliefs, attitudes, and intentions. Behavioral intention is considered the most important determinant. Behavioral intentions are influenced by an individual's attitudes, subjective norms, and sense of behavioral control.

Attitudes: personal evaluations of behavior.

Subjective norms: beliefs about whether someone important will behave in a certain way, and the motivation to act in accordance with their ideas.

Behavioral sense of control: the belief that one has control over behaving a certain way.

- **Precaution Adoption Process Model**

Comprising seven different stages in the process from lack of awareness to adoption and maintenance of a behavior. This is a relatively new model that is increasingly being applied to healthy behavior.

Interindividual Factor Level

- **Social Cognitive Theory**

Three factors that influence the likelihood of changing health behaviors are 1) self-efficacy, 2) goals, and 3) outcome prediction. Social cognitive theory emerged from social learning theory, which asserts that people learn not merely from their own experiences but from observing the actions and benefits of other's actions.

Community Factor Level

Health intervention strategies at the community level include the following:

- Community Organization and Other Participatory Models

Emphasizes a community-driven approach to assessing and solving health and social issues.

- Diffusion of Innovation Theory

This deals with the spread of new ideas, products, and social behaviors related to health from one organization, community, society, or one society to another.

- Communication Theory

Describes how different types of communication influence health behaviors.

For example, a user's journey for businessmen. In the morning, when a person taps his employee ID card on a reader to enter his office, a problem occurs: the gate sounds an alarm in response to their inadequate lifestyle or health condition, or the gate does not open for a few seconds. While working in the office, the worker's posture is monitored, and feedback is given to improve posture. A group led by Associate Professor Takeo Kato from the Faculty of Science and Technology, Keio University, is developing a system that uses infrared cameras to measure seated posture, estimate the load on joints and muscles, and provide feedback via a device on the desk (a doll is under consideration)[46]. As an example of a system with a higher degree of intervention, Professor Yutaka Arakawa's group at Kyushu University is developing a system that restricts the functions of a personal computer when the sitting posture becomes prolonged and then releases

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[46] Kato- Lab http://www.kato.mech.keio.ac.jp/research/

the restriction when the user performs a prescribed number of squats (detected using an acceleration sensor in the earphones). Furthermore, should you order a set meal at the company cafeteria at lunchtime, rice mixed with konjac will be served. On the way home, a colleague invites the worker to participate in a 10-km marathon. Should they walk to the next station on the way home, they can get a discount on a salad from the delicatessen in front of the station.

This system could be used to maintain physical and mental health. This system could be used to detect the degree of mental strain owing to excessive workload or other reasons, by facial expression detection or vital data measurement, and when a person is found to have a high level of mental strain, an alert could be issued to the entire team or department, without specifying who, to encourage mutual care and consideration. For those who have trouble sleeping, snacks that improve sleep quality could be offered in the office.

In addition to connecting to intervention services for health maintenance, it may also be possible to connect to interventions that promote early diagnosis and treatment and guide people to medical care. In contrast, it may be possible to support "social prescribing[47]" to encourage connections with the local community.

4.1.3. Circulation of Value Created through Environment-Transformative Digital Service Platform for Behavioral Change

We categorized the value that our proposed platform could provide into Gain Creator (a value that brings gain) and Pain Reliever (a value that relieves worries), as organized in Table 4-4.

This section describes the value of the direct stakeholder, user, and service providers (companies and services provided by individuals who could be linked) who use the platform to provide services. The target users are those who are experiencing health problems but are unable to sustain actions to improve their health. The main value that users can enjoy as Gain Creators is that they can obtain the desired effect on their health through external intervention without being forced to work hard by visualizing and feeling this effect. Moreover, regardless of the tax deductions listed in the table, should there be some financial incentive for using this system, people will be motivated to maintain their health.

The value of Pain Reliever is that it enables people to sustain actions to improve their health without effort and receive services matched to their physical condition without having to disclose

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[47] Social prescribing is a system that, starting from medical institutions, provides solutions to patients with social issues that may cause health problems or interfere with treatment and activities that connect patients to non-medical social resources and create opportunities for care together with patients. Daisuke Nishioka, Naoki Kondo, ["Literature Review on Cases and Effects of Social Prescription – Possibilities and Challenges of How to Respond to Patients' Social Issues in Japan",] "Shakai teki shohou sen no jirei to kouka ni kansuru bunken review – nihon ni okeru kanjya no shakaiteki kadai heno taiou houhou no kanousei to kadai-," [Medical Care and Society] Iryou to shakai 29 (4), p.527-544, 2020-02-28 https://www.jstage.jst.go.jp/article/iken/29/4/29_2020.002/_pdf

sensitive personal information such as illnesses to multiple service providers.

Additionally, for service providers that offer services through the platform, Gain Creator enables them to offer services that match user needs, track whether the services they offer are as effective in complying with users' requests, and improve their services by doing so. Pain Reliever reduces the marketing burden of acquiring, managing, and analyzing user data in-house, and reduces the cost of acquiring new users because the platform recommends services to users.

Table 4-4   Environment-Transformative Digital Services for Behavior Change Value Propositions

Stakeholder	Gain Creator	Pain Reliever
Users: People who are unable to sustain actions to improve their health and have health problems (people who should not be made to work harder for mental reasons are also included)	• Can extend healthy life expectancy. • Enables users to increase and gain benefits without putting in effort/with limited effort. • Finds time slots for health care. • enables users to have a sense of self-esteem without putting in effort/with limited effort. • Enables users to (hopefully) receive tax reductions.	• Less prone to lifestyle-related diseases. • No need to put up with a lot of stress or inconvenience. • Low-cost or "free-of-charge" (having a system set up would be great). • No effort to continue, and benefits are long-lasting. • No need to give sensitive information about yourself to companies. • Consultation is available.
Businesses that utilize platforms to provide services (intervention service providers)	• Businesses can understand whether the products and services they provide are effective for users. • Businesses can deliver their products and services to users who match such products and services (i.e., realization of effectiveness). • Enables businesses to efficiently improve products • Enables businesses to acquire business opportunities	• Companies can reduce their marketing burden. • Companies can reduce the effort of involving multiple stakeholders. • The platform system will identify potential customers (people who may be at risk of health hazards).
Families of users	• The family can improve their health by joining in with the health-improving activities of the user. • Families can provide advice to individuals in their surroundings without feeling that they are inducing worry in them. • Allows users to spend more time with their families.	• Can be implemented without burdening the family budget. • As it maintains health, frees the family from caregiving, granting them more free time. • Alerts the family to signs of illness in other family members. • Avoids situations where employees have to leave the company due to caregiving responsibilities. • Consultation will be available on family matters.
Employers of users	• Alerts employers to signs of illness in their employees • Employee group discounts will (hopefully) be applied. • Increases corporate value (e.g., stock price) as a health-conscious company	• Avoids situations where employees leave the company because of sudden illness • Avoids claims for workers' compensation from employees with health problems • Prevents deaths from overwork
Insurers	• Increases the efficiency and effectiveness of health guidance	• Healthier insured users reduce health care expenditures and prevent financial downturns.
Municipalities and government	• Increases the working population • More people will migrate to health-promoting cities (increased tax revenue).	• Can reduce social security costs • Can avoid decreases in tax revenues

Should the insurers[48] operating the health insurance business be capable of providing aid to their users, the insured, allow them to maintain their good health by utilizing this service, indirectly reduce their medical expenditures, and prevent their financial deterioration they should do so

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[48] There are two types of health insurance insurers: the National Health Insurance Association (nicknamed "Kenkyo Kenpo") and the Health Insurance Association.

Figure 4-3 shows the value cycle for each stakeholder organized in Table 4-4. By having this platform, service providers obtain and analyze user information such as health conditions and eating behaviors, and issue intervention instructions to intervention service providers; thus, users can receive appropriate intervention services. In this figure, the platform service provider matches users with intervention services and receives a fee from the intervention service provider for using the platform service, while users only pay a fee for the services provided by the intervention service provider. In contrast, there could be a model in which the user's employer or insurer is the purchaser of the platform service.

This value chain is only possible when all the functions necessary for operating the platform are fully in place and the stakeholders are properly connected. In the next section, we will consider the mechanisms that make the platform possible.
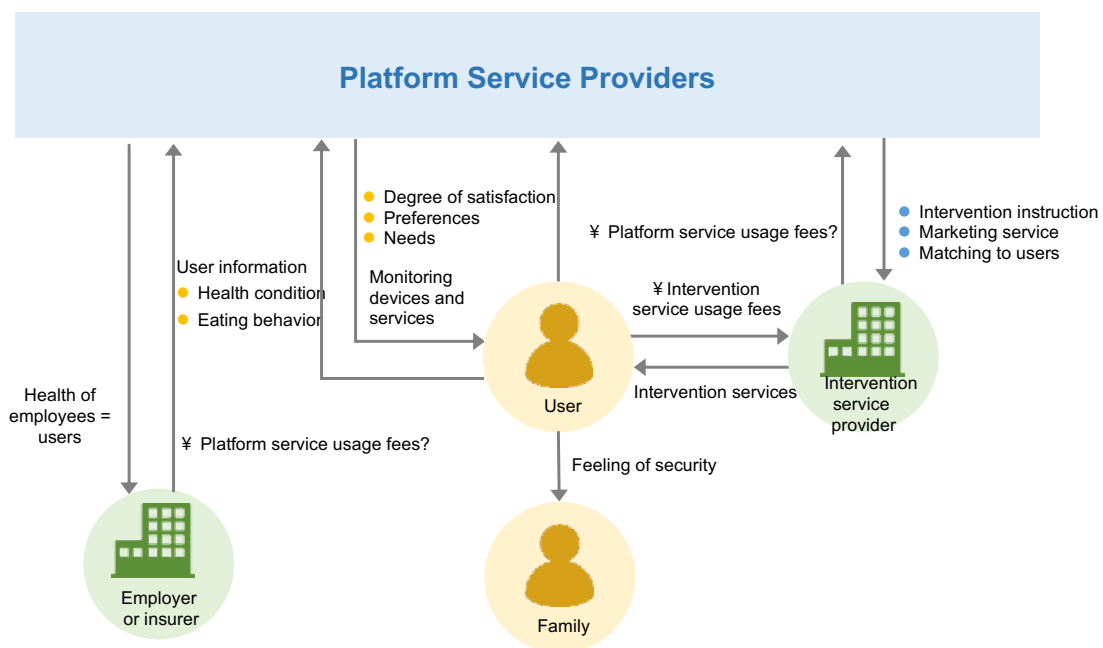
Fig.4-3   Environment-Transformative Digital Service Platforms for Dynamic Transformation Customer Value Chain Analysis

4.2. Mechanisms Needed to Realize New Service Models

4.2.1. Platform System to Enable Environment-Transformative Digital Services for Behavioral Change

In 4.1.3, we considered the values that our proposed platform should provide; however, here

we are speculating about the appropriate mechanisms to create that value. First, the platform will be structured to connect and match users with multiple service providers. Additionally, to create a structure that enables service providers to provide services without obtaining users' personal information, we propose a structure in which the platform conveys only service instructions and information for service improvement to service providers without providing users' personal information.
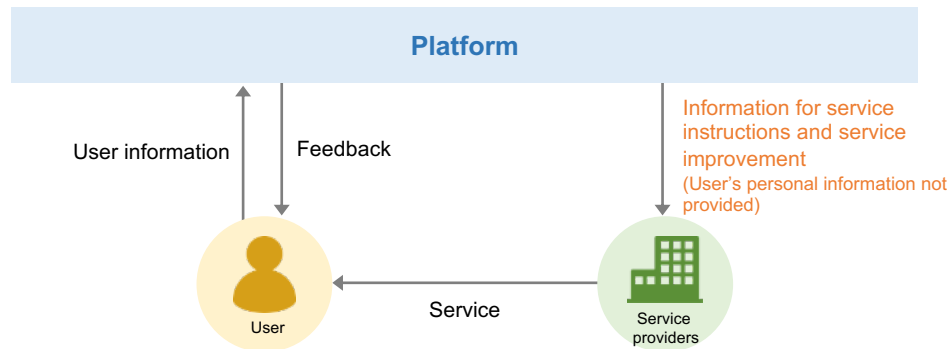

Fig.4-4　Proposed Relationship between the Platform, Users, and Service Providers

Should a specific platform be responsible for acquiring user data, analyzing it, and providing services, then when a system is realized in which interventions occur everywhere in our lives, it is possible that users will be monitored and analyzed by a particular platform, and their various behaviors will be controlled by the interventions. Even should the platform not provide the intervention service itself but only matches users with service providers, should the service providers and users share their information, a situation could arise in which users' personal information is known and intervention occurs at any location. Moreover, since the service is related to health, it uses highly sensitive personal information, such as data on the user's health conditions.
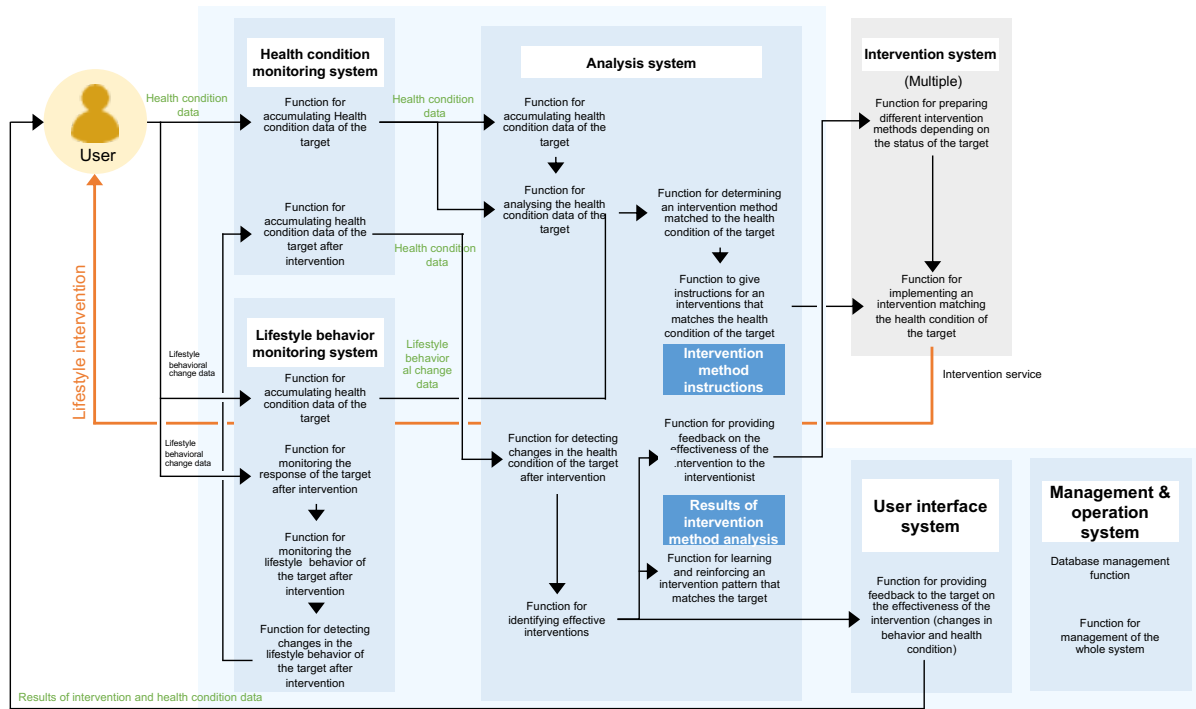
Fig.4-5 System Diagram of the Platform for Enabling Environment-Transformative Digital Services for Behavioral Change

Most existing platforms, including cases where the platform is the same as the service provider, are based on a model where the service provider has the user's personal information. In contrast, our proposed model is one where service providers provide services without obtaining users' personal information. This model may be difficult to accept should service providers themselves want to utilize users' information for marketing and business strategy formulation; however, it may have advantages for sole proprietors, single stores, venture companies, and other businesses that cannot collect, manage, and analyze users' information by themselves. Although not in the field of health care, there are already companies in the field of environmental protection that have realized a model in which platform providers issue service instructions without communicating user information to service providers. Fills Co., Ltd.[49] offers a platform called "Fills," which aims to reduce the use of plastic resources by contracting with partner stores to allow registered users to purchase drinks and food without packaging or containers. Fills analyzes the purchasing behavior of customers, directs them to stores, and offers promotions, however partner stores do not handle personal information. Since such a platform model is already in place, it is possible to realize it in the health field as well, although it depends on revenue monetization[50].

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[49] Fills website, https://www.go.fills.app

[50] This is a business model in which affiliated stores pay a commission in return for the value of being able to reduce costs for packaging and containers, and the platform "Fills'" handles sales promotions.

Then, we consider a more detailed system structure based on the functions that our proposed platform should fulfill. To provide appropriate intervention services at the right time, we need a "health condition monitoring system" that acquires users' information on health conditions and lifestyle behaviors, considering elements such as users' living location, preferences, health condition, and behavioral change stage, an "analysis system" that integrates and analyzes the acquired data to determine appropriate intervention services, and an "intervention system" that provides intervention services. Additionally, it is necessary to prepare several different intervention services to provide new services successively, particularly targeting patients who lose interest and discontinue using the services in the middle of the intervention. Additionally, a "user interface system" such as a cell phone that informs users of changes in behavior and health condition after the intervention and provides feedback, and an overall "management and operation system" (probably managed by human resources) would probably be necessary. The analysis system could learn patterns of success or failure of the interventions that match the type of target user or specific group and thus make more accurate judgments.

The Health Condition Monitoring System shown in Fig.4-5 is expected to be realized by linking with existing monitoring services that use wearable devices and sensors. Additionally, the functions of analyzing the health condition of the participant as well as determining and proposing intervention methods in the analysis system are already provided as services. In the monitoring system for daily activities, the amount of activity such as distance traveled and number of steps taken can be measured using wearable devices; however, methods and services for automatically monitoring eating behavior are still insufficient. Intervention systems are expected to be facilities such as stores that provide intervention services. User interface systems are systems that provide information to users, such as mobile applications. Thus, the platform can function by combining existing systems.

4.2.2. Governance of Environment-Transformative Digital Services for Behavioral Change

Since the Environment-Transformative digital service platform that we propose for behavioral change makes it possible to control people's behavior, personal information protection and security are extremely important to protect users from malicious use. However, some kind of control system must be created to ensure that controls do not go beyond the scope of the user's self-determination. The New Governance Model Review Committee of The Ministry of Economy, Trade and Industry's report "GOVERNANCE INNOVATION Ver.2: Designing and Implementing Agile Governance[51]" defines

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[51] Ministry of Economy, Trade and Industry "GOVERNANCE INNOVATION Ver.2: Designing and Implementing Agile Governance" p.14 https://www.meti.go.jp/press/2021/07/20210730005/20210730005-2.pdf

governance in Society 5.0 as "design and implementation of technical, organizational, and social systems by stakeholders, to manage risks in a society based on systems which integrates cyberspace and physical space (Cyber-Physical System) at an acceptable level, while maximizing the positive impact arising from the system." While aiming to address user needs to sustain behavioral changes for health and contribute to the extension of healthy life expectancy in society, it is essential for this platform to adequately explain the risks posed by this platform to society, manage the risks appropriately, and build social trust. For example, it is necessary to consider what kind of governance mechanisms are needed, such as laws and regulations, industry rule-making, audits, and citizen dialogue. In this case, the appropriate governance mechanism will likely change depending on the type of participants in the platform. Possible operating participants include local governments, single companies, alliances of multiple companies, and non-profit organizations. For example, should a local government be the main participant, only the residents within purview the of that local government will be eligible for services, making it difficult to provide services that go beyond the area under the control of the local government; thus, creating issues in terms of dissemination. While it may be easier to gain an understanding of using personal information owing to the sense of security that comes with governmental management of personal information, there is also a concern that there may be a backlash arising from the perception that the government uses such information to control residents.

However, it is most likely that a single company will operate this platform service. To envision what kind of governance would be required, we created a customer value chain analysis diagram assuming a business model where a single company operates the platform[52]. There is more than one monetization method, with various patterns. Here the platform service provider presents appropriate intervention instructions to the intervention service provider, marketing analysis, and user matching services, and we tentatively created a model in which the operating company receives compensation for various services it provides. With this business model, while there are concerns regarding the reliability of user data management obtained by platform service providers and health/life behavior monitoring service providers, platform service providers may favor certain intervention service providers who pay more for their services. In such a case, users may be induced to purchase undesired intervention services, thus there is a need for governance to function as some kind of restraining mechanism.

Furthermore, in cases where the operating entities may be an alliance of multiple companies or non-profit organizations, different monetization mechanisms and governance considerations may apply. Although not analyzed here it will be necessary to consider appropriate governance in conjunction

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[52] Customer Value Chain Analysis visualizes the flow of money, goods, services, and information exchanged between stakeholders related to products and services and analyzes relationships among various values from a bird's-eye view and design methods. Kosuke Ishii, Kenji Iino, [Science of Design: Value Creation Design,] Sekkei no Kagaku kachi dukuri sekkei, p.20-25, Yokendo, (2008). Donaldson, K.M., Ishii, K. and Sheppard, S.D., "Customer Value Chain Analysis," Research in Engineering Design, Vol. 16, (2006), p. 174-183.

with monetization mechanisms for each scenario.

The discussion thus far has focused on a model where data is aggregated and used by the platform (Web 2.0). However, it is necessary to think about what kind of system structure will be in place when utilizing an information-distributed model based on blockchain (Web 3), as well as its advantages and disadvantages.

4.3. Impact of Implementation on Society

Should an environment change-based digital service platform for behavioral change be successfully implemented and widely adopted in society, it is expected that it will have a positive impact on individuals and society, as it allows users to sustain healthy behavior without over-exertion and maintain their health. Additionally, a new industry field, the intervention service industry for behavioral change, may emerge. Since there are currently only a few services that use digital technology to physically intervene in behavior[53], we anticipate the new ideas regarding this completely new service field.

In contrast, negative impacts need to be considered from an ethical perspective. Users decide to use intervention services of their own free will; however, should the intervention be performed without the user's knowledge, can this be said to be an independent and autonomous choice? Furthermore, even should we create a system in which all intervention history is visualized and interventions can be implemented selectively, whether independence and autonomy are truly guaranteed is debatable. Even should it appear that the conditions for users to consent are formally set by visualizing the intervention conditions, many users often do not completely read the terms and conditions; thus, it is difficult to obtain consent based on a full understanding of the terms of use by users. Furthermore, should a site be designed to induce consent by exploiting the user's cognitive biases, even should the user believe that they are making an independent choice, it may be induced self-determination, and the user may be unconsciously undermining their right to self-determination. Just because a user has made an independent decision, does not mean that any kind of intervention is permissible; the mechanism of this platform is based on the premise that various decisions are made in areas that are invisible to the user, and the user's autonomy must be guaranteed in all cases.

Additionally, should a municipality provide this service as a public service, whether the individual decides to receive the service of his or her own volition, there may be the question of whether there is

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[53] For example, there is device called "PAVLOK" which is a wearable device that can be used for avoidance conditioning to help with bad habits that the user desires to change, such as smoking. The user presses a button on the device to apply electrical stimulation to associate the bad habit with the unpleasant stimulus. https://pavlok.com/how-pavlok-works/

any public justification for the government to intervene in the individual's behavior[54]. Gaining societal and community consensus and trust is vital[55]. In any case, it will be important to continue discussing ethical issues that may arise in the future while observing practical examples of intervention services that are provided on digital platforms.

CHAPTER 5.   Role of Universities

In this final chapter, we discuss the role that universities should play regarding our proposal, considering their academic responsibilities, functions, and unique strengths that set them apart from other sectors. This also includes the future vision of the ideal position of universities in 2040.

The proposals in Chapter 4 of this working paper delve into creating new services in the industry; however, in making proposals for industrial areas that have not traditionally been given much attention in terms of the role of universities, we will focus on the important roles unique to universities as research institutions.

As neutral organizations, it is possible to explore areas of cooperation that go beyond interests. Owing to the nature of universities, as neutral coordinators, they can go beyond the pursuit of short-term profits in competitive areas and explore areas where multiple sectors can cooperate. It is precisely because universities are isolated from interests that they can become institutions that foster free discussion and creativity and promote innovation.

Furthermore, because they are multidisciplinary research institutions, they can grasp in advance the unexpected consequential effects and side effects of new social systems. For example, (1) grasping the signs of indirect effects and unintended consequences arising from intervention; (2) pre-assessment of chain reactions and detection of signs that the intervention structure is turning into a black box or malfunctioning as a device, when viewed from the perspective of the overall system, is an advantage that cannot be replaced by other sectors. Viewing society as a complex system, we aim to detect failures and abnormalities, to realize early detection by incorporating diverse design ideas, propose countermeasures in advance, and develop grand designs and academic systems related to these overall designs, all made possible by the university's academic cross-disciplinary nature. Furthermore, it should be possible to rebuild teams that go beyond the boundaries between companies, create trial-and-error combinations of services, and simulate how individual support will work out.

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[54] The constitutional provisions guaranteeing human rights apply directly to intervention in private lives by public authorities, and careful consideration is required.

[55] Points for discussion regarding consensus include whether it is acceptable to introduce a service that will change the lives of a whole town and its residents through a simple administrative decision, or whether there is a need to enact an ordinance, or whether public comment is required without even requiring an ordinance, and whether there is a need to formulate a platform based on town meetings and other events.

In the future, we plan to conduct field-based verification experiments based on the proposals herein. These experiments will verify the infrastructure development in an academic process to provide solid evidence through multidisciplinary collaboration with the university's comprehensive knowledge and strong interdisciplinary characteristics. Currently, in the Minato Mirai area of Yokohama, we are planning an intervention experiment for behavioral change involving multiple companies and a verification experiment for an intervention service platform. Additionally to ensure outstanding knowledge and scientific processes, we aim to comprehensively demonstrate the "state" and "situation" of health that includes relationships with the surrounding environment and fulfill the responsibilities unique to a university.

CHAPTER 6.　　Afterword

This paper focuses on the issue of how to extend healthy life expectancy within the KGRI Independent Self-Respect Project, which aims to solve the 2040 problem and introduces the process of exploring research themes from a social rather than a technological perspective.

Health is related to a highly wide range of fields such as medical, non-medical health, and long-term care, and our project considers the social situation in a wide range of health-related fields and the various initiatives currently being carried out. Thus, we can address what may be lacking. The search and setting of the issue were turned into a project, and the investigation took more than a year. KGRI's project funding allows us to conduct research and analysis to get a broader picture of an area where society and university research remain unconnected. This paper primarily aimed to sort and report the investigation and analysis process, which is a challenge rarely observed in university research. We also aimed to question the significance and potential of a newly proposed digital platform that connects services that encourage behavioral change for health reasons and to gain widespread cooperation in realizing that platform. We hope that this paper will serve as a starting point for vitalizing discussion on the concept of creating a system that encourages behavioral change throughout society and action toward its realization.

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