INITIATIVES TO MOTIVATE PEOPLE TOWARDS WELLNESS

—PROSPECTS OF INCORPORATING BEHAVIORAL SCIENCE AND TECHNOLOGY TO EXPAND THE HEALTH PROMOTION/DISEASE PREVENTION MARKET—

Mika Kinoshita
Consumer Innovation Dept., Technology & Innovation Studies Div.
Mitsui & Co. Global Strategic Studies Institute

SUMMARY

- As the increasing burden of medical expenses in accordance with the aging societies becomes a major global issue, health promotion and disease prevention to nip the bud of chronic disease is gaining greater significance.
- The challenges for business operators in the field of health promotion and disease prevention include prompting an early awareness of the illness risk, quantitatively measuring and evaluating the effectiveness of services, and implementing effective measures for health and wellness improvement. The use of prediction algorithms, non-invasive/non-contact monitoring technologies, and behavioral science is expected to address these issues.
- To support health promotion and disease prevention, it is thought to be important to incorporate the above technologies and social mechanisms into the everyday lives of people. If the business target expands to include individual consumers, the health promotion/disease prevention service market itself will also expand accordingly.

1. THE INCREASING IMPORTANCE OF HEALTH PROMOTION AND DISEASE PREVENTION IN THE GLOBAL AGING SOCIETY

By 2050, the world's population of people aged 65 and over is forecast to reach 1.5 billion (more than double the figure in 2019; United Nations, World Population Prospects 2019 Highlights), and the rapid aging of the population is expected to increase both the prevalence of chronic diseases[1] and healthcare costs (Figure 1).

Figure 1: Chronic disease-related costs (global basis, US$)

Diabetes[1]	Heart disease[2]	Cancer[3]
2019 $760 billion	2010 $863 billion	2017 $97.4 billion
2030 $825 billion	2030 $1.044 trillion	2025 $176.5 billion

Note: Figures for 2025 and 2030 are estimates. Figures for cancer reflect the cost of therapeutic drugs. Recent research on heart disease-related costs includes a forecast that costs in the US alone could reach $1.1 trillion by 2035. (Cardiovascular Disease: A Costly Burden for America, Projections Through 2035)

Source: 1. IDF Diabetes Atlas Ninth edition 2019
2. World Heart Federation website, The costs of CVD (http://www.championadvocates.org/en/champion-advocates-programme/the-costs-of-cvd)
3. Allied Market Research Global Oncology/Cancer Drugs Market, opportunities and forecasts, 2018-2025

[1] A chronic disease is defined by the US Centers for Disease Control and Prevention (CDC) as a condition that requires continuous medical treatment for more than a year or restricts a patient's daily activities. Among the most common chronic diseases are diabetes, heart disease, and cancer.

Chronic diseases are difficult to completely cure once they develop, and when a patient's condition becomes severe, expensive medical treatments and care are required, deteriorating the patient's quality of life significantly. Given that, health promotion and disease prevention efforts, including measures to deter the onset of chronic diseases, have become even more important in our aging society, along with lifestyle-related improvements (managed with diet, exercise, sleep, and the reduced intake of alcohol, tobacco, and other such products).

The recent advancement in the development of digital technologies, such as for ICT equipment, sensors, and communications, is expected to provide a foundation for various new applications in the field of health promotion and disease prevention. Moreover, millennials in the US, who are digital natives, have a high level of interest in health promotion and disease prevention, and a study has found that 45% of them use technology for healthcare monitoring and other related purposes (KPMG, Healthcare 2030). In addition, the spread of COVID-19 has increased demand for online medical examinations and test kit development, and people's interest in health is ever increasing. Services provided in the field of health promotion and disease prevention are difficult to get reimbursed by health insurance. As such, health promotion programs, which have been the main type of service in this area so far, have primarily targeted companies that have a keen interest in health enhancement, such as health insurance companies and corporate employment insurance companies (in the case of Japan, health insurance associations or companies that place particular focus on health management). However, as technologies become more easily accessible, it is expected that the market will expand from these companies and highly health-conscious individuals to a wider clientele of individual consumers. According to a JETRO survey, companies in various countries and regions are stepping up their activities in the area of employee health management, such as through the provision of health promotion programs (Figure 2). The aim of these initiatives has expanded from the original purpose of curbing medical expenses to include relatively new objectives, such as to improve employee productivity and satisfaction, secure human resources, and foster a healthy workplace culture, and these efforts lead to enhancing health awareness on a national scale.

Figure 2: Companies' health promotion initiatives in various countries and regions

<table>
<tr><th>Country/ region</th><th>Income classification</th><th colspan="2">Details of initiatives</th></tr>
<tr><td>US</td><td>High-income country</td><td colspan="2">• Implementation of health promotion/disease prevention measures began relatively early on, starting in the 1960s.
• In recent years, companies' offerings of health promotion programs have increased and the program content has become more diversified.
• Many companies adopt employer-provided medical insurance (Self-Insurance) for their employees, which provides strong incentives to employers for promoting their employees' health.</td></tr>
<tr><td>China</td><td>Upper middle-income country</td><td colspan="2">• Health promotion and disease prevention efforts are relatively new.
• Many multinational companies in China provide health programs for their employees, while some companies headquartered in China have also set up employee-use fitness facilities within their offices in an effort to recruit competitive talent.
• Many local companies are also starting to give attention to the importance of employee health management.</td></tr>
<tr><td>Germany</td><td>High-income country</td><td colspan="2">• Companies have started introducing employee health management programs, as interest is growing due to the effects of an aging society.</td></tr>
<tr><td>Mexico</td><td>Upper middle-income country</td><td rowspan="3">• In an effort to respond to the increasing number of lifestyle-related disease cases, companies are stepping up health promotion and disease prevention activities.</td><td>• Employee health management initiatives are being deployed, centered on major companies.</td></tr>
<tr><td>Turkey</td><td>Upper middle-income country</td><td>• Employee health management initiatives are being deployed, centered on foreign companies.</td></tr>
<tr><td>India</td><td>Lower middle-income country</td><td>• Companies are increasingly outsourcing health management to health and longevity-related domestic startups.</td></tr>
<tr><td>Brazil</td><td>Upper middle-income country</td><td colspan="2">• Employee health management initiatives are being deployed, centered on major companies.</td></tr>
<tr><td>Malaysia</td><td>Upper middle-income country</td><td colspan="2">• Some companies are supporting the health and longevity of citizens and contributing to the promotion of sports by sponsoring exercise and sports programs, and through other efforts.</td></tr>
<tr><td>UAE</td><td>High-income country</td><td colspan="2">• An increasing number of companies are investing in health measures with the aim of ensuring corporate growth and employee satisfaction.</td></tr>
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Source: Compiled by MGSSI based on JETRO's 2016 survey of trends in longevity-related markets in leading countries and regions

2. HEALTH PROMOTION/DISEASE PREVENTION CHALLENGES AND TECHNOLOGICAL EXPECTATIONS

Companies operating in the field of health promotion and disease prevention services face three challenges. The first is the need to raise awareness of the illness possibility at an early stage among the people at risk of chronic diseases (for healthy people, identify areas needing improvement based on a recognition of their current health status). The second challenge is to develop mechanisms to quantitatively evaluate how actions taken so far have contributed to promoting health. The third is to effectively implement measures to promote and maintain lifestyle habits that support good health.

As chronic diseases often have no noticeable symptoms until they become severe, it is important for people in pre-chronic disease state to be aware of the illness risk and to take early action to improve their health. However, it is difficult for people to proactively respond to something that does not show immediate results. Therefore, the use of prediction algorithms for forecasting future health conditions based on big data analysis is expected to become a promising approach for motivating people to take action to promote good health.

In addition, it is essential for business operators in this segment to verify the effects of health promotion measures to realize further personalization and quality improvements of the health promotion services they provide. To that end, monitoring becomes important for the management of user behavior and lifestyle habits, and the adoption of non-invasive (not introducing medical instruments into the body) and non-contact monitoring technologies is expected for that purpose.

The combination of these prediction algorithms and non-invasive/non-contact monitoring and other technologies with behavioral science, which is a discipline that seeks to scientifically elucidate the general laws of human behavior, is expected to lead to effective health promotion strategies.

2-1. Prediction algorithms

A prediction algorithm is a method for meticulously calculating and predicting future health conditions based on the data of tens of thousands of people. Prediction algorithms enable to discern the impact of current lifestyle habits on future health conditions. At the same time, these computational programs are also able to derive specific measures for improving health. Players in this field include Hirosaki University's Center of Healthy Aging Innovation (COI) and PricewaterhouseCoopers (PwC).

In June, Hirosaki University COI announced the development of an AI-based model for predicting a person's probability of contracting around 20 different diseases within three years, including diabetes and dementia. In the collaborative effort with researchers from Kyoto University, the research team used big data obtained from the health checkups of 20,000 people, covering approximately 2,000 health parameters (the data was compiled from the results of general health checkups, physical fitness examinations, and genetic tests, as well as information on dietary content, lifestyle habits, social activities, etc.). The model predicts the probability of the future onset of disease by identifying the relationship and features between the disease onset and an at-risk person's health status, genetic information, and lifestyle habits (such as diet, smoking, and drinking). In the case of diabetes, the onset probability can be predicted from blood glucose levels, leg muscle mass, body fat levels, etc. As the model enables the identification of detailed risk factors for each individual, it can be used to recommend optimal measures to prevent the onset of certain diseases.

PwC, meanwhile, has developed a digital twin called "Bodylogical" that can simulate the human body's physiological conditions, by expressing physiological functions of the human body as mathematical formulas and inputting personal lifestyle and health examination data via a platform in cyberspace. The more detailed the personal data input, the more precisely future health conditions can be predicted. The company is also developing software for encouraging awareness by presenting future body shapes with avatars that can be personalized to resemble the individual user.

In order to further motivate behavior toward lifestyle improvements with the use of prediction algorithms, it is important to continuously enhance the prediction accuracy of the algorithms, such as by presenting highly accurate prediction results from other users with similar health conditions/predispositions to a targeted user, and, to accumulate evidence. In addition, it is assumed that the physical states of people who have yet to develop a certain disease are varied. Therefore, it is also important to clarify a user's health status, lifestyle characteristics, habits needing improvement, level of interest in health improvement, and other aspects in a bid to effectively apply prediction algorithms to users. The continuous collection of detailed information on an ample variety of users to ascertain health promotion measures that can be replicated for a certain segment of the population, grouped from characteristics such as genetic information, is expected to make it possible to form recommendations for detailed personalized health promotion plans. Furthermore, for facilitating health improvement actions effectively, another expected development includes the creation of mechanisms in which

users can enjoy the process of changing their behavior through the combined leverage of gamification and nudge theory based on behavioral science, which is described later in this report.

2-2. Non-invasive and non-contact monitoring technologies

For further personalization and the quality improvement of health promotion and disease prevention services, it is necessary to identify the types of users for which the measures are effective and to what extent. To understand that, monitoring is needed to accurately determine to what degree users made changes in their behavior in line with recommendations. Currently available health promotion services mainly use wearable devices for monitoring. However, the overall cost of such services is high because users must own their device, and some users find it inconvenient to have to recharge the devices and put them on every day. As such, attention has turned to non-invasive (No burden on the body) and non-contact monitoring technologies. Non-invasive and non-contact solutions allow for the monitoring of multiple users collectively, so the cost per person can be kept low compared to methods using wearable devices. On top of that, such systems can be installed in a living space, eliminating the need for the user to wear a device, and they automatically and continuously record biometric data, allowing for the accumulation of a large volume of information. The development of a diverse range of non-invasive and non-contact monitoring technologies has been gathering momentum recently, due in part to the spread of COVID-19 (Figure 3). At the present stage, such systems are mainly used for medical purposes, but some are used for home health monitoring, and in the future, applications in the health promotion field are expected.

Figure 3: Advancements in the development of non-invasive and non-contact monitoring technologies

Monitoring technology	Developer Company/university	Monitoring parameters	Development details
Image analysis	Binah.ai (Israel)	Heart rate, respiratory rate, oxygen saturation, psychological stress	A system for detecting signals from images acquired through such devices as smartphones and in-vehicle cameras, and the data is processed using the company's own AI technology. Applicable for the home monitoring of COVID-19 patients.
	Oxehealth (UK)	Pulse rate, respiratory rate	Using a video camera and an optical sensor, the pulse rate is detected from the change in skin color due to blood circulation, and the respiratory rate is determined from breathing movements. Certified as a European Class IIa medical device by the British Standards Institution.
Sound analysis	Oregon Health and Science University (US)	Sleep apnea syndrome: breathing, movement, classification of severity	A bed-mounted sensing device that detects breathing and movement on the bed from sound, and processes the data with a machine learning algorithm. Can be used at home (accuracy 82.9%).
	FAU[1] (Germany)	Heart rate, heart rate variability	Radar system for detecting heart sounds by electromagnetic waves. Allows for monitoring multiple patients at once, and measurements can be obtained through clothing and bedding.
Doppler radar[2]	Hanoi University of Science and Technology (Vietnam)	Infectious diseases: heart rate, respiratory rate	Measurement of vital signs using a medical radar with a microwave frequency of 24.05 to 24.25 GHz and processed with a machine learning model to detect infectious diseases.
	Fujitsu Components America (US)	Heart rate	A three-channel Doppler radar sensor for medical non-contact motion detection. The device can detect movement speeds from 6 mm to 6 km per second, and can be used to accurately detect heart rate by focusing the radar on the arteries.
	Circadia Health (UK)	Respiratory complications	The Circadia C100 uses a radar to predict the sudden deterioration of respiratory conditions. It can be used in hospital wards, special nursing homes for the elderly, home monitoring of COVID-19 patients, etc., and is scheduled to obtain FDA approval.
Laser ultrasound	University of Massachusetts (US)	In-vivo human imaging	Imaging accuracy is improved and the elimination of the need for the probe to come in contact with the skin compared with conventional ultrasonic echo examinations. Utilizes the sound waves generated when a laser ultrasonic wave with a wavelength of 1550 nm reaches the skin.
	University of Naples Parthenope (Italy)	Heart rate, heart rate variability	Ultrasound is transmitted to the indentation of the neck, an echo is reflected, the movement of the skin resulting from the pressure wave caused by the contraction of the heart is detected from the phase difference between the transmitted wave and the received wave, and the heart rate is measured.
Laser, sensor	EarlySense (Israel)	Breathing, respiratory rate, heart rate, movement on the bed	A non-contact piezoelectric sensor pad that is positioned under the mattress. Provides real-time information on sleep quality and health.
	ContinUse Biometrics (Israel)	Body temperature, heart rate, blood pressure, respiration, blood glucose level, blood alcohol concentration	Nanotechnology-based technology that uses a camera and sensor equipped with a special optical lens and a laser to irradiate parts of the body for a few seconds. Measurements can be obtained through clothing and from a distance of around 1 meter.
Household-use smart toilet	DeyeeTec (China)	Approximately 20 urinalysis parameters and 7 tumor markers	Developed an automatic urinalysis system for a home-use smart toilet that can perform urine analysis. Daily real-time monitoring data can be used to compile personal health management reports and issue alerts.

Note 1: Friedrich-Alexander Universität Erlangen-Nürnberg
Note 2: The Doppler radar can measure heart rate, respiratory rate, activity level, etc., from the change in frequency when irradiating ultra-short waves due to the Doppler effect (the phenomenon in which the wavelength of the reflected wave becomes longer when the observation target moves away from the radar, and the wavelength becomes shorter when the target moves closer to the radar). Use of the Doppler radar for non-invasive/non-contact monitoring is mainly adopted for medical use, but it is expected to be used for home monitoring of the elderly in the future.
Source: Frost & Sullivan May 2020, Advanced Non-contact Patient Monitoring Technologies: New Paradigm in Healthcare Monitoring

The Israeli company ContinUse Biometrics is developing a pioneering physiological monitoring technology for measuring a broad spectrum of bio-parameters. Its nanotechnology-based technology uses a camera and a sensor equipped with a special optical lens and laser to measure a person's physiological state by capturing slight vibrations in the body caused by breathing, the beating of the heart, blood flow, etc. By illuminating areas on a person's body for just a few seconds, measurements can be taken through clothing and from a distance of about one meter. The technology enables the monitoring of body temperature, heart rate, blood pressure, respiratory status, blood alcohol concentration, blood glucose level, etc. In the future, the company plans to use smartphones, tablets, and other terminals as remote monitors for this technology. At the CEATEC JAPAN 2018 exhibition held in October 2018, Lawson presented a future convenience store model equipped with a community space from which medical care can be administered remotely, and ContinUse Biometrics' technology was used to measure a person's vital signs in the model. ContinUse Biometrics is also engaged in research and development that will lead to the adoption of its monitoring system in a wider range of settings, as indicated by the announcement of a system for connecting its monitoring system to vehicles, which it unveiled at an industry event in 2019.

Another notable technology is the smart toilet developed by the Chinese venture company DeyeeTec. This technology appears to be the closest to commercialization of the various efforts in recent years to develop smart home appliances and smart homes by integrating digital devices with home infrastructure. DeyeeTec has developed an automatic urinalysis system and smart toilet that allows for carrying out clinical urine tests at home. The smart toilet consists of a toilet seat and bowl/tank, automatic sampling software and system, test reagents, and an automatic analysis system. It can monitor approximately 20 urinalysis parameters and 7 tumor markers, and the test results are displayed on a mobile terminal. Personal health management reports can be compiled based on daily real-time monitoring data to alert the user to signs of a pre-disease stage before full-blown symptoms present themselves. The market for smart toilets is still in its infancy, and products are supposed to be released into the market in stages. Nonetheless, DeyeeTec possesses not only the urine testing technologies for measuring several thousand variables in urine based on biochemical color reactions, but is also developing stool testing technologies, and developments at the company will be worth watching going forward. As the accuracy of non-invasive and non-contact monitoring technologies improve and leads to wider utilization among the general public, the security of systems used to collect detailed health data will become even more important. As such, ensuring the robustness of such systems will become an important challenge in the future.

2-3. Behavioral science

Behavioral science refers to the various disciplines that seek to scientifically elucidate the series of rules that govern people's behavior, and includes sociology, psychology, and economics. One of the main behavioral science theories drawing interest is "nudge theory[2]," which is a concept that proposes indirect suggestions to induce the persons' behavior for their self-interest. The use of nudge theory is seen not only in public policy, but also in an increasing number of cases of product development and service design in recent years. Among them, as an example in the field of health promotion, is the wellness-oriented insurance service "Vitality" provided by South African financial services company Discovery, and it is offered through Sumitomo Life in Japan. The insurance product is based on the nudge theory and the loss aversion concept (not wanting to lose a benefit once gained) of behavioral science, and the more the insured takes actions that promote health, the more the insured is rewarded. For example, the insured is entitled to discounts on insurance premiums and service benefits from partner companies, contingent on online health checks, health examinations, exercise routines, and the number of steps taken daily. For an insured person who has already received a reward, the desire of not wanting to lose the reward (loss aversion) encourages them to continue their actions.

In the social implementation of technology-based health promotion services, the use of behavioral science as described above is expected to be effective in raising user awareness of health, and thereby contribute to prompting and supporting behavior change for wellness.

[2] Nudge Theory: A theory proposed in 2008 by economist Dr. Richard Thaler (who was awarded the Nobel Memorial Prize in Economic Sciences in 2017) and Professor Cass Sunstein (who currently teaches at Harvard University). The theory proposes a method of using subtle suggestions, rather than coercion, to influence an individual toward voluntarily behaving in the desired manner.

One point to keep in mind when considering mechanisms to promote this kind of behavioral change is that the context behind the behavior should be taken into consideration. While the focus tends to be on how to change people's behavior, it is also important to pay attention to the social systems behind the rules, habits, and culture that regulate people's behavior, and to also consider whether or not those existing systems can be changed. One of the challenges in utilizing behavioral science is the need to foster a strong sense of ethics among the designers of such mechanisms. Since nudge theory acts as a stimulus that affects the user's subconscious, application of the concept may be abused depending on the ethics of the designer. As the application of behavioral science progresses further, the nurturing of a strong sense of ethics in the design of behavior change is destined to become an inevitable topic for discussion.

3. FUTURE MARKET OUTLOOK — EXPANSION AND FURTHER HEALTH PROMOTION

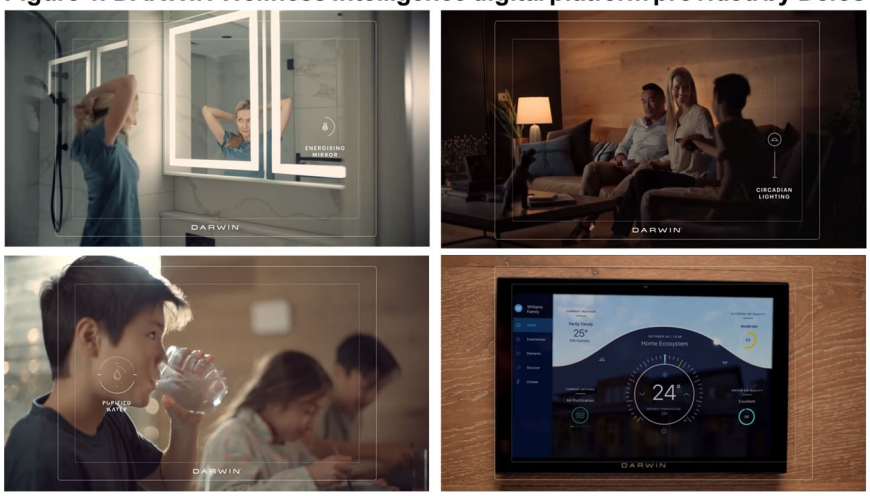
The evolution of digital technology has spawned new technologies that are expected to provide solutions for problems in the field of health promotion and disease prevention services, and practical applications of those technologies are starting to materialize. How can people's health be promoted further without placing undue demands on them?

Until now, health promotion and disease prevention services have been provided as corporate wellness programs, which have included lifestyle- and health-related consultations, health risk diagnosis by blood tests, etc., and lifestyle improvement programs aimed at increasing fitness, quitting smoking, enhancing healthy dietary habits, etc. In addition, nurses and other such healthcare workers have played a primary role in working with individuals by communicating face-to-face, by telephone, and by e-mail. In recent years, health promotion programs have evolved with the incorporation of digital technologies, including devices such as wearables, and effective approaches through AI chatbots together with medical professionals as well as behavioral science, and good results are beginning to appear in the form of a reduction in medical expenses and others.

Under these circumstances, the wellness real estate business presents itself as an example of a business model that can be developed to target individual customers in the future.

Wellness real estate is defined as residential properties for which the construction design of the living space has been optimized by incorporating environmental conditions suitable for people's activities and mechanisms that are said to have a positive effect on the human body. A good example of an initiative in this area is the Well Living Lab collaboration between Delos, a wellness real estate company, and Mayo Clinic, a leading general hospital in the US. The lab is a scientific research center that is conducting various studies on environments that can improve people's productivity and health, and Delos is using the results of these studies for its technology development. Delos offers a digital platform called DARWIN Wellness Intelligence for displaying the wellness level of the user's everyday living environment on a tablet device (Figure 4).

Figure 4: DARWIN Wellness Intelligence digital platform provided by Delos

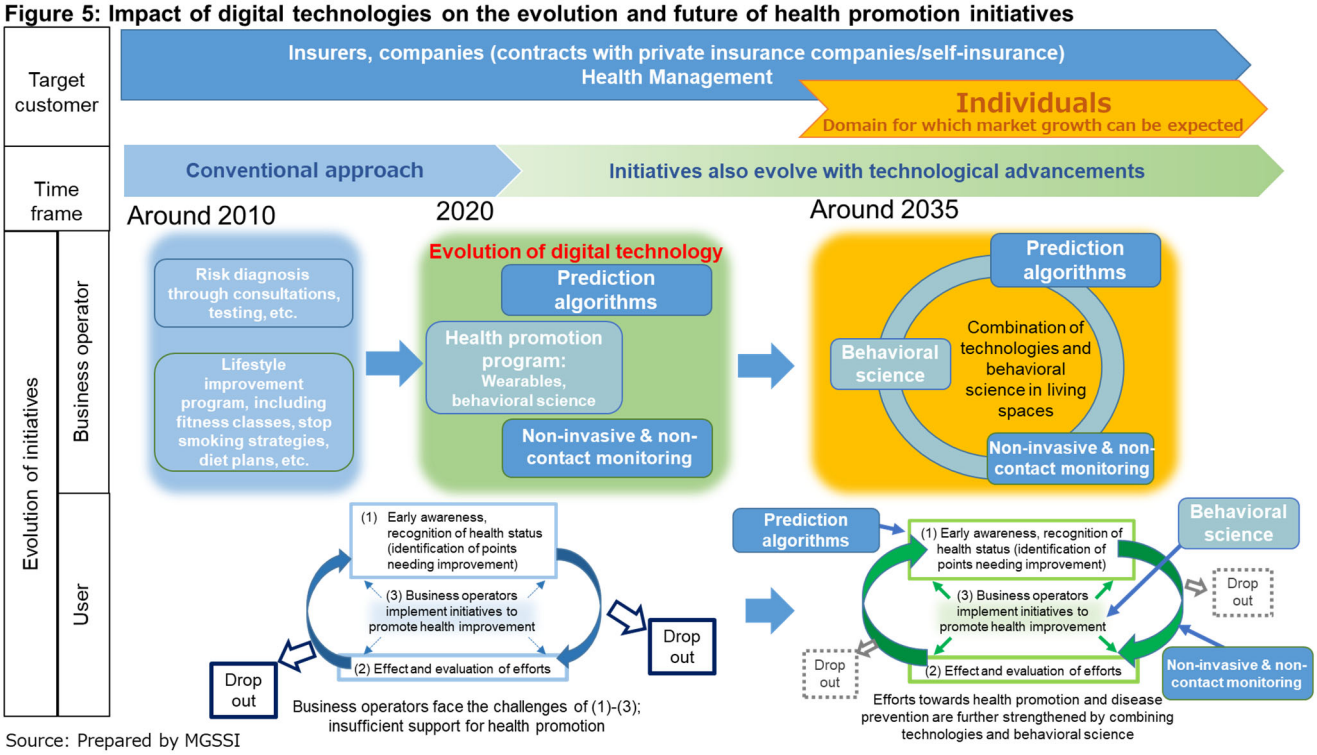


Upper left: Lighting that promotes wakefulness. Upper right: Light dimming system that reduces brightness in accordance with bedtimes. Lower left: Purification of drinking water. Lower right: Control panel of the DARWIN Wellness Intelligence digital platform (operation is possible via a smartphone or tablet device)
Source: Delos' YouTube video, "DARWIN Home Wellness Intelligence"
(https://www.youtube.com/watch?v=m75sTbARSGo)

The value of the global wellness market was estimated at US$4.2 trillion in 2017, according to a 2018 research report by the Global Wellness Institute. Of the total, the wellness real estate market was estimated at US$134 billion, and is projected to reach US$180 billion by 2022 (annual growth rate of 6%). The average price of such properties, compared to ordinary real estate, is 10 to 25% higher (a wider price range — 5 to 55% higher — is shown before averaging out). Wellness real estate is reportedly becoming popular mainly among health-conscious millennials, and for the time being, the main customers are expected to be those who have a strong interest in a healthy lifestyle.

The wellness real estate concept incorporates health-positive elements in places of living themselves. Taking a hint from this trend, for stronger support of health promotion efforts in the future, the integration of prediction algorithms, non-invasive/non-contact monitoring technology, and behavioral science into people's living space can be expected to take on greater significance. If business operators can achieve this while promoting user awareness of the illness risk at an early stage by using prediction algorithms, and realizing more personalized and higher quality services through non-invasive/non-contact monitoring, it will become easier for those companies to provide the results of users' health promotion efforts as feedback in real time. Furthermore, a cyclic loop can be formed in which business operators use behavioral science to subtly and effectively guide users to take actions for improving their health, and that in turn has the effect of strengthening users' early awareness of health issues and recognition of their health status, along with strengthening measurement and evaluation of health promotion efforts (Figure 5).

Figure 5: Impact of digital technologies on the evolution and future of health promotion initiatives



Source: Prepared by MGSSI

According to the Science and Technology Foresight Report and Delphi Survey conducted by the National Institute of Science and Technology Policy (NISTEP, Ministry of Education, Culture, Sports, Science, and Technology), it is estimated that the realization of health promotion and timely and appropriate preventive medicine using such big data will occur around 2035. If the market for health promotion and disease prevention services for individuals expands in this way, it is expected that a virtuous cycle will form, in which the development of services will gather impetus and new markets will be created.