A Smart Water Bottle for New Seniors: Internet of Things (IoT) and Health Care Services

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Abstract

Water intake is important for health as it helps build the resilience of respiratory organs, especially among elderly people. However, elderly individuals are unaware of appropriate ways to consume water including adequate intake, timings, frequency, etc. This study attempted to identify the potential for consuming water, existing problems, types of consumers, and water intake behavior fornewseniors. Survey and in-depth interview data were collected, and a "persona" was used to understand new seniors' goal and needs. The results showed that they struggled to adhere to habitual water consumption. Further, a smart water bottle that guides users to consistently drink appropriate amounts of water was addressed by applying the Internet of Things (IoT) technology to health care services.

Keywords: New seniors, water intake, service design, water bottle, health care, IoT

1. Introduction

Water supports health by flushing wastes from the body as well as increasing metabolic rates and the ability of respiratory organs to fight disease.

A water intake survey (female = 1912, male = 1423, mean age = 49.4 years, SD = 16.75) revealed that 91.4% and 79.3% of participants aged 19-64 years and elderly respondents older than 65 years, respectively, did not reach the recommended daily intake. This finding indicates that a number of respondents, particularly the elderly, did not reach the recommended daily water intake. [1] If they lack water in their bodies, then they could experience problems with their metabolism, and be vulnerable to various diseases. [2], [3]

Impaired central nervous system function contributes to a lack of perceived thirst among the elderly, making them more easily dehydrated and more susceptible to issues associated with dehydration compared to younger adults; therefore, intense management and education are required to promote sufficient water intake. [4]

Meanwhile, the results of in-depth interviews conducted withnewseniors in their 50s and 60sshowed that most of them were aware of the importance of water consumption. The results also demonstrated many problems these seniors experienced, such as not having enough information about the appropriate way to consume water and finding it difficultto consciously consume water consistently (n = 10, female = 4, male = 6).

This study aimed to foster correct water intake habits in new seniors in their 50's and 60s and proposed a smart water bottle and heath care service design to promote healthy and happy lives for individuals who may live to be 100 years old. Further, this research is based on Cooper's "goal-directed design" methodology, which is a user-centered method. [5]

First, we investigated the demographic characteristics of thenew senior generation through a literature review. Second, we summarized forms of water intake and types of consumers using survey and interview data. Third, we deduced specific needs and goals

using personas that participants could identify with, and suggested a design that reflected their experiences.

2. Characteristics of the New Senior Generation and Design Implications

Unlike the previous senior generation, the new senior generation contains many highly educated individuals, has a higher income level, and even has a higher demand for self-improvement. They have moved rapidly forward as an emerging consumer group, actively involving themselves in various aspects of consumption.They are a generation of strong self-determination, cultural icons, and high technology acceptance, and they are creating a newsenior lifestyle. They are baby boomers who were born in the 1950–60s and currently form a large market.[6]

The proportion of the consumer market comprised by these new seniors is drastically increasing. The proportion increased from 19% in 2008 to 21% in 2010 and purchase amountsin the new senior group increased by 37% on average. This is the largest increase among all age groups. These new seniors are also called active seniors. [7]

They are characterized by independent and active personalities, considering themselves to be young and being very interested in health and appearance. They value quality of life, such as wanting to know"how to livelonger."Based on their economicstrength, they pursue life's purpose through meaningful value-based consumption, such as leisure activities. In addition, they have strong desiresto enjoy culture and they have a high technology acceptance levels and Internet usage rates.[8]

Therefore,where water intake is concerned, it should be possible to produce a positive user experience by producing healthcare products and services that combine youth sentiments and high technology.[9] Furthermore, we expect that this bottle could easily be used universally, regardless of age or gender, and it can help cultivate proper lifestyle habits.

3. Survey and In-depth Interview

We conducted a survey and in-depth interviews to assess water intake behavior and other related issues.

First, a survey regarding water intake behavior was conducted on 60 subjects in their 50-60s who enjoyed climbing and jogging (female = 30, male = 30, mean age = 56.7 years, SD = 3.9).

Second, an in-depth interview was performed on 10 subjects in their 50-60s to understand new senior lifestyles and investigate their water intake behaviors and purposes (n = 10, female = 4, male = 6).

3.1. Survey Results and Discussion

All respondents were aware of the importance of water intake; however, 75% reported not feeling thirst and 47% ingested water intentionally for health even when they were not thirsty. Their primary reason for not intentionally ingesting water, 'do not feel thirst,' accounted for 73.5% of responses, indicating that this was the largest obstacle for water intake.

Of water intake behaviors queried, a considerable number of respondents were not familiar with correct water intake methods and claimed difficulties in building steady water intake habits.

Drug administration is one variable that affects water intake. Among study respondents, 78% were administered drug treatments and 72% drank more than 1 L of water daily.

3.2. In-depth Interview Results and Discussion

All respondents were aware of the importance of water consumption. Most respondents were consuming water for health, but none of them were knowledgeable about the proper methods for water consumption, such as adequate amountsor when, etc. On one hand, they had a difficult time developing consistent habits of drinking water because consuming water was an daily instinctive behavior. On the other hand, they consumed a significant amount of water when they took medicine.Most of the respondents felt that it was a hassle to adhere to medication times and to prepare the medicine and water.

In terms of lifestyle, the respondents were still actively involved in social activities, felt themselves young, and actively enjoyed civilized living. They also showed high levels of interest in water intake, including having individual portable water bottles for outdoor activities.

As a result, they required information regarding the state of their bodies, particularly in relation to hydration, as well as the formation of water intake habits. Further, this study applied drug administration, as the majority of the elderly persons were undergoing treatment.

4. Persona

4.1. Persona Sheet

Based on user research, the persona we selected were users in their 50s and 60s who pursued simplicity rather than cumbersome and complex things, actively participated in social and economic activities, and aimed to have a young and healthy life. These users were "Eul Dong Kim" (Table 1) and "Mija Han" (Table 2).

Table 1. User Who Drinks Water Consciously

	Eul Dong Kim(Male) "I am still not used to drinking water so I sometimes forget to do so, but I would like to maintain a healthy life by developing a habit of drinking water."
Age	58
Familiaritywith Water	Not used to drinking water frequently and sometimes he forgets to drink water
Amount of Water Consumed in a Day	About 1.5L
View of Health	Very interested in hiking and would like to live a youthful life
Empirical Goal	Living a healthy and active life
Goal for Usage	Would like to become healthier by developingthe habit of drinking water frequently

Table 2. User Who Drinks Water Habitually

	Mija Han (Female) "I would like to know if I am consuming the appropriate amount of water and it's a hassle to get water every time I take medicine."
Age	60
Familiaritywith Water	Habitually drinks water but does not know if she is consuming the appropriate amount
Amount of Water Consumed in a Day	About 2L
View of Health	Would like to enjoy what she does and live a young and classy life.
Empirical Goal	Living a healthy and active life

4.2. Persona Analysis

The user analysis with personas showed that the new senior generation seekssimple things rather than things that are inconvenient and complex, actively participates in economic activities, and pursues a youthful, healthy life. Firstly, we chose Eul Dong Kim who consciously tries to regularly drink water, but often forgets. To overcome these difficulties, we design a product and service to regularize his water intake and promote an active, healthy life. Secondly, we chose Mija Han who drinks water habitually, but is unware ofadequate intake.This study attempts to addressthe appropriatetime and amount for water intake with the medicine-ingestion process.Therefore, we must thoroughly understand consumer characteristics and design products and services accordingly.

5. Users' Needs and Insights

We suggested design plans after deducing user needs and insights and conceived a smart water bottle and healthcare service.

5.1. The Design of a Smart Water Bottle

Self-directed Health Care. Drinking water is an instinctive and ordinary behavior and forming elderly habits is not easy. Motivation is necessary to change behaviors and form healthy and positive water intake habits.

Based on Internet of Things (IOT) technology, in this study, a smart water bottle was designed and equipped with a weight sensor system and other functions, to facilitate the development of positive water intake habits. The bottle could also automatically detect water volume and had an alarm function to alert users when it is time to consume water. Importantly, the alarm offers a planning function, which enables the recording and management of water intake details, then rewards users with membership points, based on

water intake. This ultimately facilitates consistent motivation to consume water and improves users' intake behavior, by giving them a sense of accomplishment and self-esteem in relation to the management of their own hydration.

Convenience of taking medicine. According to survey results, a large proportion of early seniors (78%) require drug treatments. However, preparation of water and medications may be cumbersome and lead to missing drug administration times. Based on the close relationship between drug administration and water intake, the design should also reflect drug administration habits to simplify administration and overall water intake. This would be accomplished with a design of water bottle that combines water and medication storage and provides an alert when drugs should be administered. These measures satisfy the requirement for 'simple drug administration', thereby improving the overall water intake experience.

5.2 Health Care Service Design

Customized hydration management. According to the U.S. National Institute for Health, one third of modern diseases are due to water imbalance in the body, predisposing individuals to inadequate water intake; therefore, the correct water intake can prevent diseases by one third [9]. It is helpful for early seniors to adopt correct water intake habits, especially if they are aware of their hydration levels and the amount of water that they need to ingest. Establishment of a systematic hospital-connected hydration management system would allow investigation of body hydration levels and provide customized water intake information to individuals. This service would go beyond the limits of a simple accessory for water intake to provide concrete and practical effectiveness for effective water intake management.

Additional services to improve mental health. The ultimate purpose reported by users for their water intake was 'for health'. Water provides 'health' rather than simply 'survival'. [10] Healthy life is defined as a balance of physical and mental health. Therefore, providing both physical (water intake) and mental health services can lead to improved water intake. Service measures to enhance mental health associated with water intake might include the following: through membership points obtained on the basis of water intake, users could use these points to enjoy involvement in diverse cultural activities, such as exhibitions, performances, and point donations.
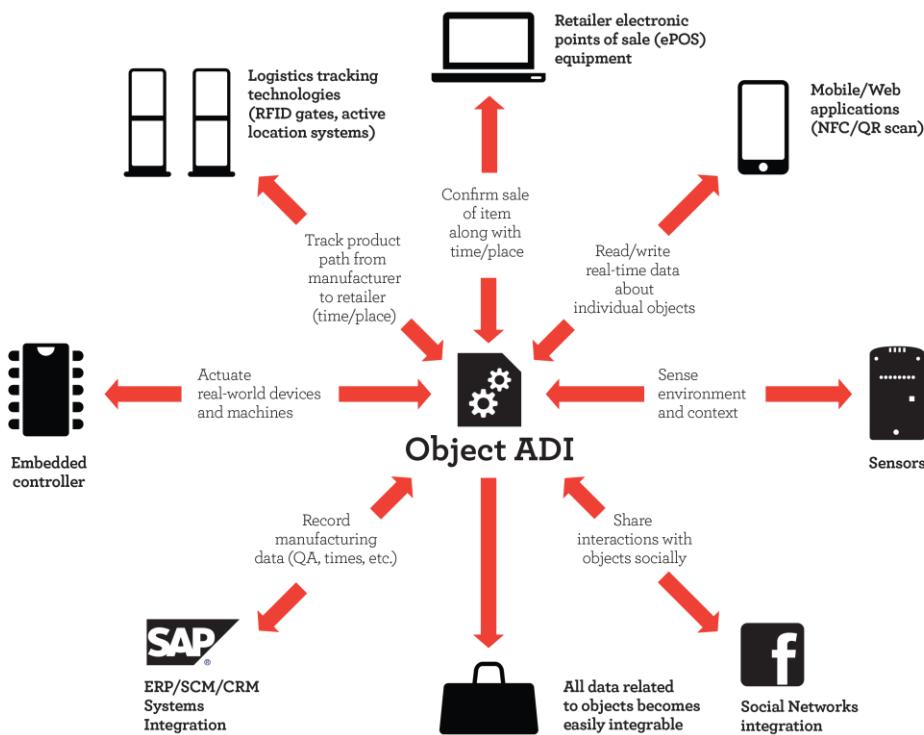
This study indicated the use of a smart water bottle and healthcare services in the fostering of water intake habits among early seniors, so that they can lead healthy lives. In order to meet users' needs and provide them with insight, by indicating the use of a smart water bottle and healthcare services, the following considerations were identified: To enable the formation of water intake habits, a smart water bottle with an alarm function indicates the appropriate time for water intake and drug administration. Further, it gives consistent motivation, by rewarding users with membership points, based on their water intake; users could use these points to improve their lives, such as attending exhibitions or performances, so as to improve mental health.

6. IOT and the Smart Water Bottle

6.1. Definition of IOT

IOTrefers to technology where objects participate as actors in the conventional human-based communications paradigm. It is a comprehensive term for technologies that create new IT services by implementing functions for information creation and communication with a variety of objects such as vehicles, refrigerators, shoes, etc. [12]

Smart products created by connecting existing products to the web construct channels for digital service are personalized through IOT technology and enable one-to-one communication. This is also a system that links the product creator and the consumer to obtain real-time information about usage.[13]

6.2. IOT and Healthcare Cases

6.2.1. 23 and Me

A personalized genetic information analysis service):Use of the 23andMe service itself is being regulated by the Food and Drug Administration (FDA) after problemswith accuracy during genetic information analysis.It is uncertain whether users can prevent diseases and improve their own health based on the analysis results and it does not provide them with specific methods to do so.There is limited effectiveness when a service does not provide specific methods for the users to actually complete.[14]

6.2.2. Alive Cor

A smartphone ECG measuring instrument): Developed so that users can accurately see their personal data, AliveCor is practically useful by providing a structured systemwhere users can share their data results with doctors and receive a diagnosis. This service is available to users in partnership with the largest EMR company in the United States calledPractice Fusion.[14]

6.3. Goals of the IOT Water Bottle

The bottle should provide users with specific and accurate data while providing services that make practical use of that data. This should be deduced from actual user needs.[14,15]

Rather than simply offering users remote treatment, it is more important to provide accurate information and medical services according to the provision cycle.If healthcare services, remote treatment, and customized medical services are added, the method of

treatment should be more advanced and more accurate than current healthcare services.[16]

Combining suchIOT serviceswith water bottle products will create a network between the object, user, and service provider, improving product usability, inducing supply and demand for future services and content, and making it possible to draw a product blueprint.

7. Service Content Components

7.1. H/W: IOT Water Bottle

The amount of water is automatically recorded using the weight sensor installed in the water bottle. It has an additional feature to store pills.Based on IoT technology, it interacts with devices that have the application (app) installed.Using it in this way allows sharing of usage information.

7.2. S/W: App

The app exchanges information through linkage with the water bottle. It has management, recording, and alarm functions for water intake. It also provides users with the categories of target intake amount and appropriate intake amount to guide users to consume the appropriate amount of water for their age range. Additional features include alarms for the user's medication times.

7.3. Linking H/Wand S/W

When water is consumed from the water bottle, the sensor in the bottle checks how much water has been consumed in real time and sends that information to the app. Then, the app automatically digitizes and analyzes the delivered information, helping users to manage water intake by providingthem with alerts for their status and the time they should next drink water.

7.4. Medical Examination Service

Users are connected to their personal doctors online. They can see their recommended water intake continuously throughinternal hydration status examinations. They can also review and use personal data by syncing with theapp.

7.5. Point Accumulation Service

Using the membership point accumulation service based on their water intake record, users can receive various cultural service benefits (discounts for partnered exhibits/concerts and charitable donations using points)

8. Service Scenario

The service scenario is composed of the main service [Image 1] and the sub-service [Image 2].
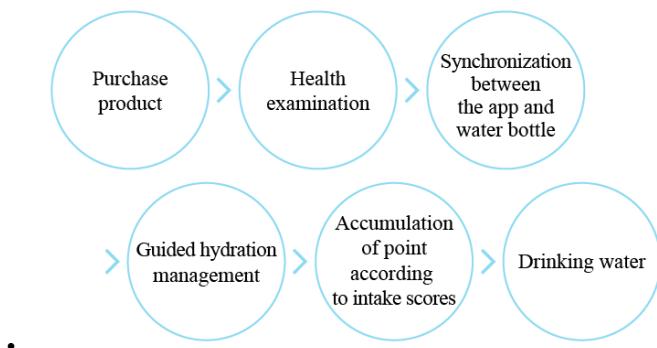
Image 1. Main Service Scenario
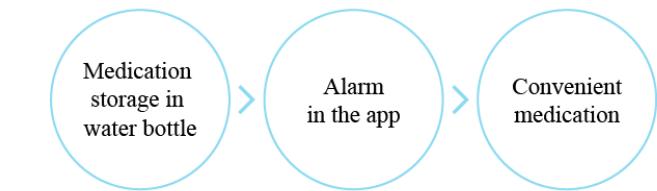
Image 2. Sub-service Scenario

9. Sustainable Businesses

We propose a sustainable business model for water intake service.[Table 3]

9.1. Expected Effect

Professionalism of health care services can be guaranteed by partnering product sales and water consumption management service with clinics.A variety of services can be provided with a single platform.

Table 3. Sustainable Business Proposal

Product→Hospitals	The product (water bottle) andapp are sold through partnerships with hospitals.This guarantees the professionalism of the healthcare product and hospitals make a profit during this process.
Product→ Cultural Content Partner Companies	Entering partnership contracts with cultural content businesses such as concerts, exhibitions, and sports companies will help users enjoy cultural activities through membership point accumulation. This is the role of the service platform.
Product→Clients	Warranties and support would be provided for the product and app, a membership point service based on water intake record, and product-themed accessories,ultimately helping users develop appropriate water intake habits.

Hospitals→Clients	By prescribing the water bottle andapp to clients and providing regular hydration status examinations and consultation, hospitals secure regular clients. In addition, the hospital's reputation can be improved by promoting water drinking campaigns.
Cultural Content Partner Companies →Clients	Partner companies provide and promote discounts for cultural services using membership points (exhibitions/concerts/experiences,etc.). This improves the users' mental health, enhances the general water intake experience, and creates a profit for the partnership businesses.

10. Discussions and Further Research

While a single cup of water might be considered beneficial excess water consumption can be toxic. [17] Investigation of early seniors showed high levels of interest in health and awareness of the importance of water intake; however, they lacked information on correct water intake and faced difficulties in managing steady intake.

Individual management is particularly challenging because it is hard to accurately measure and record water intake. Precedent papers and studies have emphasized the importance of water intake, but few studies have addressed intake behavior.

The design measure proposed in this study is very encouraging. It is aimed at developing a highly efficacious and practical water intake management planner that provides both diagnosis and prescription based on user water intake rather than simply providing suggestions and confirming ingestion.

Therefore, if this service is introduced, enabling users to develop and manage proper water intake habits, it will receive attention from members of the new senior generation who are interested in health. It will also open a new chapter in research on water intake.

However, this study is limited in that usability tests via prototype preparation and user testing have not been performed. Therefore, additional studies on Internet of Things' technology related to these services that produce prototypes and perform user tests are necessary to improve user interface and user experience.

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