

# 사물인터넷 기반 활동량측정기의 고객사용특성 및 욕구에 대한 종단연구<sup>☆</sup>

## A Longitudinal Study on Customers' Usable Features and Needs of Activity Trackers as IoT based Devices

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### 요 약

2016년 세계경제포럼(WEF)에서 4차산업혁명이 소개된 이래 사물인터넷, 인공지능, 빅데이터, 5G, 클라우드 컴퓨팅, 3D/4D 프린팅, 로봇틱스, 나노기술, 바이오 공학 등 다양한 분야에서 이런 기술을 활용한 제품과 비즈니스가 빠르게 확대되어 왔다. 사물인터넷 중에서는 웨어러블 디바이스가 최종고객을 대상으로 활용되는 선도적 적용분야로 인식되고 있다. 본 연구의주요 목적은 활동량 측정기에 대해서 고객의 욕구를 파악하고, 이를 마케팅 믹스와 연계시킨 제1차 연구에 기반하여 제2차 연구를 수행하고 이 결과를 제1차 연구결과와 비교하는 종단연구이다. 더불어서 미래 활동량 측정기 개발을 위한 잠재욕구를 파악하는 것이다. 이를 위해서 2018년 5월 대학생들을 대상으로 서베이가 수행되었으며 이용특성에 관한 주요변수에 대해서 ANOVA 등 실증연구가 이루어졌다. 또한 제1차 연구와는 달리 잠재욕구에 대한 분석결과를 단어구름기법을 사용하여 시각화하였다. 제품·가격·유통·촉진 등의 마케팅 믹스에 기반을 둔 종단연구결과에 따르면 현재 활동량 측정기는 도입기에서 성장기로 이전하고 있으며, 마케팅 믹스 각각에 대한 변화를 발견할 수 있었다. 연구결과는 학계뿐 아니라 사물인터넷 기반의 디바이스를 개발하려는 개발자에게 고객의 욕구에 기반 개발과 관련하여 시사점을 제공한다.

☞ 주제어 : 사물인터넷, 활동량 측정기, 종단연구, 분산분석, 단어구름기법

### ABSTRACT

Since the information of 4<sup>th</sup> Industrial Revolution is introduced in WEF (World Economic Forum) in 2016, IoT, AI, Big Data, 5G, Cloud Computing, 3D/4DPrinting, Robotics, Nano Technology, and Bio Engineering have been rapidly developed as business applications as well as technologies themselves. Among the diverse business applications for IoT, wearable devices are recognized as the leading application devices for final customers. This longitudinal study is compared to the results of the 1st study conducted to identify customer needs of activity trackers, and links the identified users' needs with the well-known marketing frame of marketing mix. For this longitudinal study, a survey was applied to university students in June, 2018, and ANOVA were applied for major variables on usable features. Further, potential customer needs were identified and visualized by Word Cloud Technique. According to the analysis results, different from other high tech IT devices, activity trackers have diverse and unique potential needs. The results of this longitudinal study contribute primarily to understand usable features and their changes according to product maturity. It would provide some valuable implications in dynamic manner to activity tracker designers as well as researchers in this arena.

☞ Keyword : Internet of Things (IoT), Activity Trackers, Longitudinal Study, Variance of Analysis (ANOVA), Word Clouding Technique

## 1. Introduction

According to the definition of the 4<sup>th</sup> Industrial Revolution by Klaus Schwab, it can be referred as a

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convergence of diverse technologies, and presented by IoT (Internet of Things), 5G (fifth-generation wireless technologies), 3D/4D printing, AI (Artificial Intelligence), robotics, biotechnology, nanotechnology, blockchain technology, quantum computing etc. [1]. Specifically, IoT has been pervasively expanded as a key role in the 4<sup>th</sup> Industrial Revolution. Furthermore, initially explained by Cisco, Internet of Everything (IoE) and Internet of Brains (IoB) are also used as the advanced terms of IoT integrating

people, process, data, and things [2]. Since Industrial Internet of Things (IIoT) initially was introduced in Proctor and Gamble and later MIT's Auto-ID Center in 1999, it has been expanded to IoT, IoE, and IoB, and more relevant applications for them have been developed in the real world [3].

Next to matured smart phones market, wearable devices are considered as the top of line to be developed for mobile devices as the application of IoT [3]. Some representative wearable devices as applications of IoT have been developed in the areas of watches, wrist bands, eye glasses, shoes, headgear, pendants, clothing, and sensors/robots etc. [4]. Abundant research has been conducted on the applications of IoT. While some results are positive to application development of IoT, others are not. Even though the technologies for wearable devices development are important, market acceptance of those technologies may more important. A traditional two competing perspectives of the strategies for invention and innovation, 'technology push' or 'market (demand) pull', are also important for application success of wearable devices [5].

Regardless of the two different strategies for innovation and invention, customer utilities (satisfaction) should be created through using wearable devices, which means value creation. The value should be greater than price paid by customers, which should greater than costs incurred throughout the development and production processes. Diverse perspective has exist on this subject. For instances, (1) 4P's classification (Product, Price, Promotion, and Place) introduced by McCarthy proposed in 1960, which has since been used by world wide marketers [6]. (2) NTER (Needs, Technology, Economics, and Regulation) for the market analysis [7] [8]. (3) TAM (Technology Acceptance Model) by Davis in 1988, which explain how users come to accept and utilize a technology [8]. All of above three provide valuable insights in the personal level for successful development of innovative and inventive products like wearable devices.

Among diverse wearable devices introduced in the market, activity trackers, which are also called fitness trackers as types of wrist bands, were selected for this research. The reason of selection is that activity trackers are exemplar wearable devices, and these were introduced in global market as well as expanding in Korea. Despite of the

pervasive spread of the wearable devices in our real lives, the research on activity trackers has not been conducted sufficiently in the academic arena including Korea.

The main purpose of the research is to identify customer needs (the first item of NTER) for the activity trackers and further to link their needs to Marketing Mix of 4 P's. It is also closely related to the TAM, which was described above. For this research, the survey method was conducted and data were collected from university students in Korea. In addition to descriptive analysis, ANOVA were applied for the statistical analysis. Further, word clouding technique was also used to visualize some potential needs for functions and design identified through the survey.

## 2. Activity Trackers as IoT Applications

### 2.1 A Type of Wearable Devices: Activity Trackers

Wearable devices are combined of wearable and devices, which are attached to or worn on the human body. It eventually means that ubiquity of 'anytime and anywhere' are possible, because users wear the devices. Wearable devices include devices with sensors, users, and terminals for the function like servers. Wearable sensor devices collect data and send smart terminals. Smart terminals like activity trackers analyze data and feedback the analytic results to users. Smart terminals sometimes control users according to users' context.

Wearable devices usually can be categorized by three distinct types (1) lifestyle, (2) entertainment, and (3) healthcare [9] [10]. Lifestyle wearable devices provide convenience and simplification of daily life. Entertainment type is related to music, game, and movies for providing pleasure of users. Healthcare type is focused to promote users' health and vitality. For the research focus and statistical analyses, the research is limited to healthcare type wearable device among the three. According to the statistics for wearable devices users from 2013 to 2018, activity trackers are mostly used up to 61% of total wearable devices users [8] [11]. Representative brands for the healthcare wearable devices in the world are *Fitbit*, *Garmin*,

*Fuelband, Jawbon, Xiaomi* etc. Compare to the former research conducted in 2015, *Garmin and Xiaomi* have grown as new market leading brands [12].

Representative of healthcare type wearable devices, activity trackers usually monitor diverse physical activities like distance, steps, exercise time, calorie consumption, sleeping type tracking, heart rate etc. Activity trackers communicate users' activity data with other Bluetooth-enabled devices through the Bluetooth technology like smart phone or personal computers. Activity tracks track users' physical activities, and further can compare the activity data to those of other users of the same user community. By comparing the data, users are motivated to promoting or controlling their activities. Collected user data can be big data, and some meaningful health information can be analyzed from the big data. Because telemedicine usually depends on big data as well as ICT, wearable devices, specifically activity trackers, are considered as a prerequisite for applications of telemedicine.

More popular smart watches are different from activity trackers. Smart watches' primary functions are very similar to smart phones, and partly encompass the functions of the digital wallet for a small money transfer and users' healthcare. On the other hand, activity trackers are dedicated to users' healthcare. Those help their users control weight, promote physical activities, or improve overall health. *Fitbit, Garmin, Nike Fuelband, Jawbon, Xiaomi,* and *Inlab* are exemplar activity trackers in the world market, and *Inlab* from *Inbody* is the only product of Korean.

## 2.2 Product Features of Activity Trackers and Survey Questions

According to the review article [7][8] [13], activity trackers are usually reviewed under the following features; (1) wearable style (e.g. wrist band, ankle band, armbandetc.), (2) costs (e.g. under \$40 to above \$200), (3) water safe (e.g. splash/water resistant, and water proof), (4) steps, (5) elevation/stairs, (6) swimming and cycling (bike), (7) heart rate, (8) heart rate notes, (9) sleeping, (10) silent alarm, (11) calories consumed, (12) distance, (13) syncing(manual or wireless) (14) data viewing, (15) reviews. Because these are too comprehensive features,

most activities encompass some of the features above as the marketing purpose. For this research some of the features are analyzed, which are important to the Product and Price of 4P's in Marketing Mix explained above.

Product, the first of 4P's, consists of functions and design. For the survey questionnaire, the 9 closed questions were asked for the functions of activity trackers. Specifically, the functions encompass activity distance, number of steps, activity time, diet guidance, consumed calories, sleeping analysis, pulse, blood pressure and watch. Further, one open question is provided to identified users' potential need for functions. The 7 closed questions were asked to design. Specifically, those are related to size, uniqueness, color, wearing comfortness, water proof, brand prestige, operating time after charging.

(Table 1) Survey Questions for Research

Marketing Mix (4Ps)	Survey Questions
<b>Product</b>	Functions(9)
	Design(7)
<b>Price</b>	Appropriate(1)
	Maximum(1)
<b>Place</b>	on-line/off-line(1)
<b>Promotion</b>	Qualitative(2)

The price is composed of 2 questions, appropriate price and maximum affordable price. Moreover, the place of 4P's consists of 1 question on the channel where the respondent would intend to purchase. 2 more questions were asked for completion of the questionnaire as well as the final dimension of 4P's, promotion. For instance, those are the specific brand familiarity and intention to purchasing activity trackers and if the intention exists, the purchasing order between the two.

## 3. Mapping between Marketing Mix and Features of Activity Trackers

Marketing Mix can be referred to a strategic mix of the controllable elements of the marketing plan of 4P's (product, price, place, and promotion). These elements

should be adjusted and coordinated until the right combination is found, which serves the needs of the product's customers (users, buyers), while producing optimum income [6] [7] .

The features are analyzed for the research by mapping with product, price and place of the Marketing Mix. The research is to examine probable functions that the customers (users) needs (expectation), and acceptable and maximum prices they can afford. Furthermore, the research examines the channels that customers prefer to purchase them in. Diverse functions can be built in activity trackers. However because of the limitations of product (e.g. product size, weight, and applicable technologies) and economic feasibility, relative importance of functions should be identified before activity trackers designers conceive the ideas.

While IoT applications are recently expanding in diverse areas, activity trackers are also the relatively new and innovative product. Ordinary people are not familiar with them yet. The market may move over introduction stage to growth stage of PLC (Product Life Cycle) among 4 stages; introduction, growth, mature, and decline/regeneration [14].

## 4. Research Methodology

### 4.1 Sample for Survey

#### 4.1.1 Respondent Characteristics

The main research method is the survey, and questionnaires were distributed to the university students. University students are appropriate sample, because they usually know well advanced technologies and active users of smart phones. They might be the first potential purchasers (users), and smart phones are considered the representative comparable devices. If the product is novel in the market, the survey is usually conducted for the users who use comparable items. It is common for the high technology items.

While most closed questions on functions and design were asked by 7 point Likert type scale from the least importance of 1 to most importance of 7, some questions were asked to be open for the identification of potential needs.

#### 4.1.2 Descriptive Statistics for Functions and Design Features in Designer's Perspectives

The survey was conducted for university students through on-line from June 10, 2018 to June 15, 2018. 132 students (N=132) participated the survey, and all of the responds were effective without missing or unreasonable values. As shown in table 1, the collected data used for statistical analysis (N=132) by SPSS. Among 132 respondents, while 79 are male, 53 are female.

The first 9 features are related to functions, and the rest 7 items are design features. According to the data, the average score of working time of activity trackers is the maximum value of 6.19, and standard deviation is the minimum value of 1.11. The values mean that battery volume and battery saving application and design are important with the relative consistency.

Furthermore, wearing comfortness is 6.05, which is the next important feature. Calorie and sleeping mode measurement are high scores, 5.40 and 5.28, respectively among functions of activity trackers. The designers of activity trackers should consider these statistic values. For instance, these data should be valuable in applying VE/VA (Value Engineering/ Value Analysis) during the new product development process.

(Table 2) Descriptive Statistics for Features by Gender

Stat. Features	Ave	Std. Dev.	Male(79) Ave	Fem(53) Ave
Steps	4.68	1.58	4.52	4.92
Distance	4.93	1.52	4.78	5.15
Act-Time	4.89	1.54	4.87	4.91
Calories	5.40	1.52	5.46	5.28
Diet	4.60	1.58	4.57	4.64
Sleep	5.28	1.56	5.24	5.34
Blood-P	4.89	1.47	4.72	5.15
Pulse	4.58	1.58	4.51	4.68
Watch	4.84	1.66	5.08	4.49
Colors	5.16	1.68	5.30	5.00
Unique	4.91	1.54	4.89	4.94
Size	5.70	1.18	5.70	5.72
Work-Time	6.19	1.11	8.05	6.40
Wear-Com	6.05	1.21	6.00	6.11
Water-Prof	5.61	1.47	5.58	5.64
Brand	3.95	1.71	3.84	4.11

## 5. Research Analysis and Results

### 5.1 Product: Design and Functions between Genders

The relative importance of function and design is identified by average scores of Likert type scales as shown in Table 2. In order to examine gender difference, ANOVA were applied by SPSS. Specifically, ANOVA were conducted to examine the difference by gender on the features, 9 function features and 7 design ones. In general, for the statistical analysis by ANOVA, Levene's tests should be conducted for homogeneity of variance in advance. Because all of the features for functions and designs were fullfil the homogeneous condition at the significance level of 0.05, ANOVA could be applied. In additions, reliability value in total is 0.852 represented by Cronbach's Alpha, which means the measurement is reliable.

As shown in Table 3, most features of the functions and designs, except watch, were not different between gender, at the significance level of 0.05. Gender difference was

(Table 3) Functions and Design Difference by Gender

Stat. Features	F	Sig. prob.
Steps	2.097	0.150
Distance	1.842	0.177
Act-Time	0.014	0.906
Calories	0.508	0.477
Diet	0.065	0.799
Sleep	0.128	0.721
Blood-P	2.729	0.101
Pulse	0.377	0.540
Watch	4.028	0.047
Colors	1.038	0.310
Unique	0.044	0.835
Size	0.010	0.922
Work-Time	3.149	0.078
Wear-Com	0.276	0.600
Water-Prof	0.051	0.821
Brand	0.841	0.361

apparent for watch at the significance level of 0.05. Male respondents think watch is more important than the female ones (average 5.08 vs 4.49). This may imply that activity tracker designers should consider watch function for the activity trakers of male. Different from the research result, the previous research result in 2015 showed that uniqueness was the different between genders at the significance level of 0.05.

### 5.2 Price: Appropriate and Maximum Prices

In order to examine the prices customers can afford (price elasticity), appropriate and maximum affordable prices were asked to the respondents. The result shows in Table 4. The mostly frequent appropriate price is about 100,000 Korean Won (48%), while the maximum affordable price is 200,000 Korean Won (30%). It implies that if product prices are set over 200,000 Won, majority customers will not pay for those.

Current market prices of the most products are similar to the most frequent maximum affordable price (200,000 Won, 30%). It implies that price policies would be restricted in the market, because current prices are similar to maximum affordable price. Different from the most activity trackers, *Xiaomi*, Chinese electronic company, introduces in the very competitive price (around 20,000 Won) [12]. In operations perspective, operational excellence building the ways to decrease the current price (costs) will be an competitive factor.

(Table 4) Prices: Appropriate and Maximum (Thousand: W)

Price	Freq.(Appr.)	Ratio	Freq.(Max)	Ratio
50	27	20%	10	8%
100	64	48%	34	26%
150	28	21%	30	23%
200	11	8%	40	30%
250	1	1%	14	11%
300	1	1%	4	3%
Total	132	100%	132	100%

### 5.3 Place: Dealer Types and On/Off-line Channels

For the research, distribution channels which customers prefer to purchase are important. The analysis results could be shown in Table 5.

(Table 5) Customer Preferred Distribution Channels

Channels	Freq.	Ratio
Trad. Shop. Mall	45	34%
Social Comm.	16	12%
Dealer(off-line)	26	20%
Auth. Dealer(off-line)	28	21%
Auth. Dealer(on-line)	17	13%
Total	132	100%

Customers planed to purchase those in on/off-line authorized dealers (34% = 21%+14%). 34% of them intend to purchase in traditonal shopping malls like Aution, Gmarket, 11street etc. The ratio is higher than the previous research result (26%). It might imply that coustomers more regarded activity trackers as household/sports electronics than (medical) health devices, in which reliability and authenty is important. Marketing management should consider the changing trend when they develop distribution channels.

### 5.4 Promotions

Activity trackers were new products in 2015, and 29% of respondents did not know the products themselves. 62% know the product, but have never seen them actually. However, as shown in Table 6, the research results show the numbers decreased 22% and 52% respectively. While nobody (0%) uses the product and only 7% actually considered to purchasein 2015. The numbers increased to 14% and 13% respectively.

Activity trackers market is growing according to the PLC. Marketing management should apply appropriate marketing policies for their positions on the PLC curve.

(Table 6) Familiarity on Activity Trackers

Familiarity	Freq.	Ratio
Never heard	29	22%
Know but not seen	68	52%
Considered purch.	18	14%
Already using	17	13%
Total	132	100%

## 6. Potential Needs for New Activity Tracker Development

Different from the previous research conducted in 2015, one of the major research purposes is examine the potential needs for activity trackers. Applied technologies for activity trackers are usually the advanced ones, and sometimes needs much investment. However, technology push-based new products often fail in the market, because innovative technologies do not guarantee market success if they do not reflect users' needs. Technologies should be based on the market acceptance, so called market pull -based new product development approach.

The open question for the future functions was asked to examine potential users' needs, which should be considered in the future product development processes by designers. In order to examine the users' potential needs, word clouding

(Table 6) Potential Needs for Future Product Development

Potential Needs	Freq.	Ratio
Body fat index	21	22%
Alarms for dangers	15	16%
Geotracking	8	8%
Camera	8	8%
Automobile key	7	7%
Excercising guidance	4	4%
Weather casting	4	4%
Blood surgar monitor	3	3%
Electric payment	3	3%
Campas	3	3%
etc.	20	21%
Total	96	100%

techniques were applied. First, wording and expressions of the answers for the open question were preprocessed for inducing the consistent meaning. Common potential needs were categorized by the same terms through the preprocessing procedures. Second, the induced meanings were categorized into common concept as shown in Table 6.

In final, word clouding techniques were applied based on the induced meanings as shown in Figure 1.



(Fig. 1) Word Cloud for Potential Needs

## 7. Conclusions and Future Works

The research first explained the concept of marketing mix (4P's), and activity trackers as exemplary wearable devices, leading applications of IoT. Secondly, through the empirical research (mainly ANOVA), functions and designs were tested, and some managerial implications have been found. Finally, potential needs were identified through word clouding techniques.

IoT is rapidly developing in technologies in areas of sensors, communication tools, and big data analyses. Market success of IoT applications is depends on the needs of users (customers), rather than the advanced technologies alone. That is, technology application to products and services coordinated to and congruent with customer needs. Otherwise the IoT applications would not be successful because of market acceptance but technologies.

The research would expand the perspectives of designers of activity trackers as the first research in 2015 has done. The research, through empirical analysis and word clouding techniques, identified potential needs for activity trackers. Respondents want the function of body fat index (22%), alarm for dangers (16%). Designers should apply VA/VE for achieving users' needs (values) with minimal costs. In addition, the price should be under users' maximum affordable limits. The new technology product development has diverse perspectives, both management and engineering ones. The research conducted in 2015 and this research (in 2018) will provide implications to academic arena and industry ones.

In the future, similar research should be applied smart watches and the two consecutive research would be a research ground on wearable devices.

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