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# What do Consumers Prefer for the Attributes of Virtual Reality Head-mount Displays

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# What do Consumers Prefer for the Attributes of Virtual Reality Head-mount Displays

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## Abstract

Recently, the consumer virtual reality(VR) industry has been established with the introduction of VR head-mount displays(HMDs) and many have expected VR to become the next generation platform. Despite the circumstances, the adoption of VR HMDs is slower than expected. To comprehend this matter, this study explored consumers' preference on the attributes of VR HMDs by implementing the conjoint analysis methodology and deriving the marginal willingness-to-pay(MWTP) of the attributes. Based on past literature and analysis of the product, six attributes were derived: Visualization, Accessories, Weight, Ergonomic Design, Number of Contents, and Price. The results indicate that the wearable aspect of the device is the most important. Implications for future developmental directions for VR HMDs are suggested based on the results.

## Introduction

Although the virtual reality technology have existed for decades, the application of the technology have been highly restricted. However, due to recent advances in foundation

technologies like display, motion sensors, and computing networks, virtual reality (VR) became a marketable technology available to general consumers. Currently, analysts believe that the VR technology is a disruptive technology following PCs and smartphones and expects VR to be the next generation computing platform (Goldman Sachs, 2016).

Under the circumstances, in 2016, many major information technology (IT) and electronics firms released VR devices called VR head-mount displays(HMDs) for general consumers and the VR industry was formulated. Firms like Facebook (Oculus), Sony and HTC focused on creating tethered premium HMDs which connects to either a PC or a console and provide high quality VR experience. Meanwhile, Samsung and Google released mobile HMDs which connects to a smartphone and provide mediocre VR experience. Currently, as the sole type of device for consumers, VR HMD is leading the overall growth of the market, accounting for more than 65% of total VR industry revenue in 2017 ("Global Virtual Reality," 2017).

The VR industry is currently in the early stage of development. At this stage the widespread adoption of VR devices is essential for increasing consumer base, which in turn provides the foundation for the development of complementary VR services and products like contents and software. Developers need a certain amount of consumer base so that they can pursue profit from the contents and software they create. Without the considerable consumer base, developers will be reluctant to enter the market, and consequently the growth of the industry will be hindered. Despite the importance of consumer base, the increasing pace of the sales volume of VR HMD is slower than expected (Lomas, 2017 Aug 27).

Therefore, the purpose of this paper is to analyze the consumer preference on the attributes of VR HMDs to provide implications for future development directions for mass adoption. Past studies have shown that the perceived utility of new technology is crucial in the mass adoption

of that technology (Teng, Lu & Yu, 2009; Lacian, Rovere & Podesta, 2013). Teng et al. (2009) empirically investigated the factors influencing mass adoption of 3G mobile phones and found that perceived utility is one of the most influential factors that affects mass adoption of new telecommunication technology. Lacian et al. (2013) showed that the difference of perceived utility between adoption and non-adoption of a technology is one of the key factors influencing the takeoff time of innovation penetration. Thus, by identifying key attributes of the VR HMDs and analyzing the relative utility of the attributes, it is possible to provide implications regarding future developmental directions that lead to utility maximization for the consumers.

Also, this paper aims to contribute to the VR literature by providing a social scientific perspective on the industry. Currently, most literature regarding VR is limited to technological and application aspects of the technology. Such limitation may be due to the fact that consumer VR industry did not exist until recently. Currently, as aforementioned, the consumer VR industry has emerged and is growing at a very fast rate. Thus, it is important to address social scientific issues regarding the VR technology. Especially, studying the consumer perceptions of VR can provide practical implications that could lead to healthy development of the industry. Consequently, the main research question could be summarized as follows:

RQ: What are the consumers' marginal willingness-to-pay for the attributes of premium VR HMDs? In what direction should VR HMDs be developed in order to reach mainstream adoption?

This paper focused on the premium VR HMDs, for two reasons. First, the tethered premium HMDs provide more functionality and high quality experience compared to mobile HMDs. More functionality and high quality would lead to better and more diverse content and software creation in the future. Second, since mobile HMDs are sometimes handed out as package deals

when buying smartphones, consumers' purchase intentions may be biased in the case of mobile HMDs.

The remainder of this paper proceeds as follows. First, the research model is introduced. Then, the method for the analysis will be explained. In the following section, the empirical results are provided. Finally, conclusions and implications will be presented.

## Research Model

*Choice-based conjoint analysis*

The conjoint analysis has been extensively used in both academic and business areas to measure consumer preferences for products or services with multiple attributes. By implementing the conjoint design, it is possible to obtain the relative importance and the marginal willingness-to-pay (MWTP) of the attributes. Implications for future development directions for the service or product can be obtained by analyzing the relative importance and MWTP of the attributes. For example, Jung, Kim & Choi (2016) conducted the conjoint analysis to explore the preference structure of smartwatches. Also, Kim, Nam & Ryu (2017) measured the MWTP for music streaming services and provided implications regarding future optimal business models for the streaming industry.

Among the different forms of conjoint designs (rating, ranking, choice), this paper implements the choice-based conjoint analysis. In the choice-based conjoint analysis, the respondent is provided with several profiles consisting of different levels of attributes and is asked to choose the most preferential alternative. This type of conjoint analysis has several advantages over the other types. First, compared to other methods, the respondents' cognitive

burden is considerably reduced (Kim & Kim, 2017). Also, the choice-based method has a relative advantage in that the values and statistical significance of all parameters are easily reported (Elrod, Louviere & Davey, 1992).

*Virtual reality head-mount displays*

In the current VR market, the VR HMDs can be widely classified into premium tethered HMDs and mobile HMDs (Greenwald, 2017 Dec 5). The premium tethered HMDs uses PCs or consoles as the processing device and is connected to the processing devices via a cable. These devices provide high-end VR experience and includes more functionalities compared to mobile HMDs. Meanwhile, the processing device for the mobile version is a smartphone. In general, a smartphone is mounted on the mobile HMDs and it acts as both the processor and display. Mobile HMDs only provide mediocre VR experience but are much cheaper compared to tethered HMDs.

This paper focuses on premium tethered HMDs for the following reasons. The premium versions provide higher quality VR experience and more diverse functionalities. The processing abilities of computers and consoles are usually much higher than smartphones, which lead to higher immersive experience. Also, with the aid of many advanced accessories like controllers and sensors, the premium versions offer diverse functionalities and higher interactivity. Such advantages in quality and functionalities can provide a basis for the development of a stronger ecosystem with the participation of more diverse third-party developers.

Also, some of the mobile versions have been handed out as promotional package deals to promote certain smartphones. A representative example is the Gear VR by Samsung, the current leader of the mobile VR HMDs. In 2016, to promote their main smartphone, Galaxy S7,

Samsung handed out the gear VR free with the purchase of the smartphone (Boxall, 2016 June 2). Such promotional deals may cause a bias in the purchase intentions of the consumers and thus, this paper focused only on the premium versions.

*Attributes*

There are four key elements of VR experience, of which are, virtual world, immersion, sensory feedback, and interactivity(Sherman & Craig, 2002). In VR settings, the virtual world is the artificial context or space provided by the contents or software developers. Sherman & Craig (2002) defines immersion as the sense of being in an environment. Sensory feedback and interactivity are highly related concepts. In a VR experience, the user interacts with the virtual environment with the movement of his or her body. The interaction is realized by the user through direct sensory feedback. For example, when the user changes the position of his or her body through physical movement, the VR system tracks the movement and provides visual sensory feedback by changing the vantage point of the user.

Based on these elements, two attributes were derived. The first attribute is visualization.. This attribute is highly related to the immersion element. Currently, visual stimulus is the main mediator that affects the users perception of being inside the virtual environment. Therefore, the visualization factor of the VR HMDs is very important in achieving immersion. Bowman & McMahan (2007) stated that the level of immersion in a VR system depends highly on display technology and provided the components that effect the level of visual immersion[1]. Among the components, this paper defined the level of visualization attribute based on display

[1] The components provided in their paper are, field of view, field of regard, display size, display resolution, stereoscopy, head-based rendering, realism of lighting, frame/refresh rate (Bowman & McMahan, 2007).

resolution and latency. The reason for this is because, first, the development of display resolution and latency is the main criteria for achieving true immersion (Konduri, 2015 Sep 02). Also, the specifications of the two components are usually provided by the manufacturer of devices while the specifications of other components are not provided. Thus, it is much easier for general consumers to differentiate the visualization of the devices based on these components.

Also, the accessories attribute was derived from the elements. The accessories include controllers and motion sensors which enhance the sensory feedback and interactivity of the VR experience. The manufacturers of the premium VR HMDs offer many additional accessories that can either be purchased separately or are given as a bundle with the purchase HMD. For example, HTC Vive provide Lighthouse sensors which lets the user experience room-scale VR experience[2], as a bundle with their HMD. Meanwhile, other manufacturers like Oculus and Sony either provide similar room tracking sensors separately, or do not provide them at all. The levels of this attribute was decided based on the variety of accessories that is provided with the purchase of the HMDs.

Another important aspect of the VR HMD is the platform-centric aspect of the device. Currently, the top 3 best-selling premium VR HMDs offer different software platforms. Thus, when a consumer purchases a VR HMD, the consumer is also purchasing the platform that is implemented. Among the many factors of platform, the variety of contents is especially important in the adoption of platform-centric computing devices and many researchers have

[2] Lighthouse sensors are room tracking sensors that tracks the user's body movement and applies the movement into the virtual world. This lets the user experience room-scale VR experience where the user cThean move around with the headset on.

addressed this attribute. For example, Nair, Chintagunta & Dubé (2004) analyzed the effect of software variety on the diffusion of PDAs and found a positive relationship. Also, Steiner, Wiegand, Eggert & Backhaus (2016) investigated the factors influencing the adoption of gaming consoles and found that the variety of contents to be one of the most important factors. Especially, the result of Steiner et al. (2016) is highly related to VR HMDs as the most influential contents within the VR industry is gaming and media. Thus, the number of contents attribute was included for the analysis. The levels of this attribute was decided by investigating the number of contents that is accessible to the users of leading premium HMDs.[3]

Finally, it is important to recognize that VR HMDs are wearable devices that the user puts on his or her head. Since the user "wears" the device, comfortability is an important issue. Knight et al (2006) highlight the physicality of wearable computers. In the study, they state that inappropriate design or excessive stress on the body will result in the inability to perform tasks, discomfort and ultimately, raise concerns regarding safety and health. In order to address this aspect, this paper derived two attributes that are related to safety and comfortability of the device.

First, the weight attribute was included. Since the VR HMDs are placed on the head of the user, weight is especially important. There have been suggestions that long-term usage of heavy HMDs may cause neck disks (Lee, 2016 January 11). Also, actual users of the device have stated that the weight of the device is felt relatively quickly (Biocca, 2017 February 18). Since the weight of the device is especially important in long-term usages, the levels of this attribute

[3] The number of contents for the leading premium HMDs (HTC Vive, Playstation VR, Oculus Rift) was investigated through a website called "VR games for" (https://vrgamesfor.com). The website provides a list of apps that are available within the market platform of each device.

was established based on whether the user may or may not feel discomfort with long usage.

The other attribute, related to the comfortability of the device, is ergonomic design. Ergonomic design refers to the consideration and implementation of human factors into the design process of products so that the product will become optimized for human use. Researchers have addressed ergonomics as an important factor in design considerations for wearable devices (Motti & Caine, 2014; Kong, Luo, Huang, & Yang, 2018). Since there are many factors behind the ergonomic design of the product, we utilized the levels broadly depending on how much comfort the user perceives.

Finally, the price attribute was included in this study. Price is an important factor that affects the purchase intentions of a new service or product, and has been incorporated by many researchers in conjoint analysis (Jung, Kim & Choi, 2016; Kim et al., 2017). Also, since the purpose of this paper is to analyze the MWTP for the attributes, the price attribute is essential. The prices of top 3 models of premium HMDs (HTC Vive, Oculus Rift, Sony Playstation VR) were analyzed in order to establish the levels of this attribute. Each model was searched via Google, in March of 2018 and the price ranges for each model was retrieved. For HTC Vive, the price ranged from 500 USD to 550 USD. The price range for Oculus Rift was around 400 USD and Playstation VR cost around 250 USD. Based on these prices, three levels were established ranging from 250 USD to 550 USD with 150 USD difference for each level. Since the survey was conducted in Korea, the dollar prices were converted to Korean Won. For simplicity, this paper incorporated a 1 USD to 1000 KRW exchange rate. All the attributes and the corresponding levels are presented in Table 1.

**Table 1**

Attributes and levels used in conjoint analysis

| Attribute | Levels |
|---|---|
| Visualization | High resolution and relatively low latency |
| | Ultra high resolution and very low latency |
| Accessories | Basic accessories included (controllers) |
| | Basic and function enhancing accessories included (controllers + additional sensors) |
| Number of Contents | Low number of contents (less than 500) |
| | Medium number of contents (over 500 and less than 1000) |
| | High number of contents (over 1000) |
| Weight | Relatively light but may feel discomfort with long-term usage |
| | Very light with no discomfort with long-term usage |
| Ergonomic Design | Acceptable ergonomic design with mediocre comfortability |
| | Highly ergonomic with very high comfortability |
| Price | 550,000 KRW (550 USD) |
| | 400,000 KRW (400 USD) |
| | 250,000 KRW (250 USD) |

# Method

*Profiles*

Among the six attributes, four have two sublevels while the remaining two attributes have three sublevels. Thus, there are a total of 144 possible combinations ($2^4 x 3^2 = 144$). The usage of all possible combinations is inefficient. By implementing an orthogonal design, it is possible to reduce the number of combinations to be tested, while maintaining independence among the variables. Therefore, this study conducted the orthogonal design via XLSTAT program and a total of 16 profiles were extracted.

In the survey, the respondent is given a comparison set where each comparison task consists

of two profiles and a "would not choose" option. Thus, there are a total of 120 ($_{16}C_{2}$=120) possible comparison sets. The XLSTAT program provides a design method where feasible results can be obtained with reduced number of comparisons. Using this method, a total of 24 comparisons were used and these comparisons were divided into four blocks. Finally, the questionnaire was formulated so that each respondent is asked to complete a total of eight tasks, comprised of six comparison tasks and two holdout tasks. An example of a comparison task is depicted in Fig 1.

| Comparison 1 | Alternative A | Alternative B | Alternative C |
|---|---|---|---|
| **Visualization** | Ultra high resolution and very low latency | High resolution and relatively low latency | Would Not Choose |
| **Accessories** | Basic and function enhancing accessories included (controllers + additional sensors) | Basic accessories included (controllers) | |
| **Number of Contents** | Medium number of contents *(over 500 and less than 1000)* | High number of contents *(over 1000)* | |
| **Weight** | Relatively light but may feel discomfort with long-term usage | Very light with no discomfort with long-term usage | |
| **Ergonomic Design** | Acceptable ergonomic design with mediocre comfortability | Acceptable ergonomic design with mediocre comfortability | |
| **Price** | 5,500,000 KRW (550 USD) | 4,000,000 KRW (400 USD) | |
| | ☐ Choose Alternative A | ☐ Choose Alternative B | ☐ Choose Alternative C |

**Figure 1** Comparison task example

*Data Collection*

The survey was conducted in Korea in April of 2018, via a Korean online survey service provider. Korea is an attractive setting for the topic of our analysis. There are currently many

“VR Experience Zones” in Korea, where people can experience VR HMDs at a hourly rate of 3,000 KRW which is approximately 3 USD. Thus, it is possible for Korean consumers to experience the device at an affordable price before making purchase decisions. This can lead to a more accurate assessment of the proposed attributes.

The sample of the survey was controlled based on age, VR HMD experience, and future purchase intentions. The lower age was limited to 18, considering that the price range of VR HMDs are high and adolescents may rarely make purchase decisions of that price range. The sample was also limited to respondents that have prior experience of VR HMDs. Consumers that do not have the experience may lack in understanding and assessing the proposed attributes, compared to those who are experienced. Thus, unexperienced consumers may be unable accurately assess the utility that is generated from the attributes. Finally, people that do not have any future purchase intentions have been exempted from the survey due to the fact that for those who have no purchase intentions, the willingness-to-pay will always be zero and their responses may deter the analysis.

Total of 600 completed responses were gathered. Among these a screening process was done using the holdout tasks to assess the reliability of the responses. After screening, total of 530 responses remained for the analysis.

*Random Utility Model*

In order to measure the MWTP for the attributes, multinomial logit model with the random utility theory was implemented. Developed by McFadden (1973), this method has been widely used in the research area to measure the MWTP of product or service attributes (Kwak & Yoo, 2012; Kim et al., 2017; Kim, Kim, Hwang, Kim & Kim, 2017).

The indirect utility function ($U_{ij}$) of respondent i choosing alternative j can be expressed like the following.

$$U_{ij} = V_{ij}(Z_{ij}, S_i) + e_ij \quad (1)$$

Here, $V_{ij}$ is the deterministic component of the indirect utility and is a function comprised of the attribute vector $Z_{ij}$ and the characteristic of respondent i ($S_i$). Since this study focus on the attributes of the product and not on the characteristics of the respondents, $S_i$ will be omitted and the function $V_{ij}$ is expressed in Eq. (2) where $\beta_m$ denotes the coefficient of attribute m.

$$V_{ij} = \sum_{m=1}^{M} \beta_m Z_{ijm} \quad (2)$$

Since respondent i will choose alternative j only when the utility of alternative j is higher than all the other alternatives given in a choice set $H_l$, the probability of respondent i choosing alternative j can be expressed like the following.

$$P_{il}(j|H_l) = P(V_{ij} + e_{ij} > V_{ik} + e_{ik}) = P(V_{ij} - V_{ik} > e_{ik} - e_{ij}) \quad (3)$$

Where, $U_{ij} > U_{ik} \ \forall \ j, k \in H_l \ (j \neq k)$.

The multinomial logit model assumes that the error terms for the utilities are independently and identically distributed. From this assumption, the probability function can be derived as shown in Eq. (4).

$$P_{il}(j|H_l) = \frac{\exp(V_{ij})}{\sum_{k \in H_l} \exp(V_{ik})} \quad (4)$$

The parameters of Eq.(2) can be estimated using the maximum likelihood estimation method using Eq. (4). Then, the estimated coefficients can be used to derive the MWTP of attribute k,

which is expressed in Eq. (5).

$$\mathrm{MWTP}_{Z_k} = -\frac{\frac{dV}{dZ_k}}{\frac{dV}{dZ_{Price}}} = -\frac{\beta_k}{\beta_{price}}$$

# Empirical Results

The coefficients of the attributes were estimated using the XLSTAT program. Table 2 shows the overall statistical significance of the model. Both log-likelihood and the Wald-Statistic shows significance at the 1% level indicating that the null hypothesis of all attribute coefficients are zero can be rejected.

**Table 2**
Model Statistics

| Statistic | Number of Observations | $R^2$ (Cox and Snell) | $R^2$ (Nagelkerke) | Log-Likelihood | Wald-Statistic |
|---|---|---|---|---|---|
| Result | 6367 | 0.121 | 0.161 | 818.108 (0.0001) | 717.371 (0.0001) |

Table 3 shows the estimation results and the calculated MWTPs for the attributes. For simplicity, the MWTPs were denoted in USD. Observing the p-values of the attributes shows that the ergonomic design and number of contents attributes showed weak statistical significance. The ergonomic design attribute $(\beta = .107, p = .046)$, was significant at the 5% level, but insignificant at the 1% level and the number of contents attribute $(\beta = .067, p = .062)$ was insignificant for both levels. Meanwhile, the remaining attributes were all significant at the 1% level. All the coefficients were positive, meaning that as the level of the attribute improves, the utility of the respondents increase. Meanwhile, the price coefficient is negative meaning that increase in price will lead to decrease in utility.

**Table 3**
Attribute coefficients and MWTP

| Attributes | Visualization | Accessories | Number of contents | Weight | Ergonomic Design | Price |
|---|---|---|---|---|---|---|
| Estimated Beta (β) | 0.2406 | 0.1819 | 0.0668 | 0.7001 | 0.1074 | - 0.0052 |
| MWTP (USD) | 46.4578 | 35.1215 | 12.8947 | 135.1944 | 20.7331 | |
| Relative Importance | 18.55% | 14.03% | 5.15% | 53.99% | 8.28% | |
| p-value | 0.0001 | 0.0007 | 0.0616 | 0.0001 | 0.0459 | 0.0001 |

MWTP was the highest for the weight attribute with 135.19 USD followed by visualization (46.46 USD), accessories(35.12 USD), design (20.73 USD) and number of contents (12.89 USD) respectively. Especially, the weight attribute accounted for more than 50% of the total willingness to pay. The total willingness to pay for the VR HMD was 250.40 USD. Thus, consumers are willing to pay up to 250.40 USD for a premium VR HMD that has ultra-high resolution with very low latency, includes basic and performance enhancing accessories, offers high number of contents, and highly comfortable with very light weight and good ergonomic design.

## Discussion and Conclusion

The VR industry is currently perceived to have exponential growth potential. In order to develop a healthy ecosystem and achieve sustainable growth, the diffusion of VR HMDs is crucial. In order to provide developmental directions for VR HMDs, this paper investigated the key attributes of premium VR HMDs and empirically examined the consumers' perspectives by deriving the MWTPs for each attribute.

Through in depth analysis of the premium VR HMD products and literature, this study identified five key attributes, of which are number of contents, visualization, accessories, weight and ergonomic design. Among these attributes, weight was the most important with a relative importance of more than 50%. This may be due to the fact that since the sample of the survey were limited to those who have experience with the VR HMDs, the respondents may have felt high discomfort due to the weight, during the experience. The average weight of the top selling HMDs is approximately 500g for both premium and mobile versions[4]. Mounting a device on the head with such weight increases the load on the neck by 5 times, compared to normal situations (Lee, 2016 January 11). Summing up, it seems that in order to reach mass adoption, the priority of VR HMD manufacturers should be on reducing the weight of the devices.

In extension, consumers' perspective on VR HMDs seem to be focused on the wearable aspect of the device. The total relative importance of the attributes related to the wearable aspect came to be 62.27 % while the total was 32.58% for attributes related to the virtual reality elements and only 5.15% for the platform related attribute. This could imply that consumers are currently more focused on the safety, comfortability and ease of usage of VR HMDs rather than the quality of experience or the richness of the available software. Thus, it is advisable for firms to recognize the importance of the wearable aspect of the device and focus on further developments of this aspect.

An interesting result was the insignificance of the number of contents attribute. In other

[4] The weight of the mobile HMD itself is much lighter compared to the premium versions. However, since mobile versions needs smartphones to be attached to the HMD, the combined weight of HMD and smartphone averaged to be 500g.

words, the increase in the number of contents does not have a significant effect on the purchase intentions of the consumers. This result is especially surprising since currently, the usage of VR HMDs are primarily for entertainment purposes with the media and gaming applications dominating the market. Past literature have empirically shown the importance of the number of contents in the adoption of entertainment based platforms (Steiner et al., 2016). Meanwhile, Hagiu (2009) empirically investigated that the consumer demand for the variety of software is significantly lower for computing platforms compared to entertainment based platforms. Thus, the result of this study may imply that consumers may share the perception of industry analysts of the VR becoming the next generation computing platform. Therefore, focus on computing software could help enrich the VR ecosystem and help the industry grow.

Finally, the overall willingness-to-pay for a premium VR HMD with all the attributes at the top level is 250.40 USD. Currently, the market average price for premium HMD is around 400 USD and all the devices lack in at least one of the attributes. This shows that the current prices for the device may be too expensive. Among the market leaders of the premium HMDs, only Sony provides the devices at this price range but the product (Playstation VR) lacks in many attributes, such as visualization, accessories and weight. Other products like the Oculus Rift and HTC Vive are at a much higher price range, with the Oculus Rift being around 400 USD and HTC Vive at 500 to 550 USD. Even these products do not provide the best option for all the attributes. Price is an important attribute in the purchase decision of new products and currently, firms are failing to meet consumers price expectations. Thus, it is crucial for these firms and future entrants to offer a significantly lower price than the current average.

This paper contributes to the literature by analyzing the consumers' perspective on the VR HMDs. Since the current literature related to VR is highly focused on the technological aspects,

providing a social scientific viewpoint on the matter could help enrich the literature. Also, the results of this paper can provide implications for various players related to the VR industry. For the management, the results of this paper can provide meaningful insight regarding the future development directions of their product and aid in the pricing strategies. For the policymakers, many regulations or promotional policies could be made based on the results of this paper in order to help the domestic industry to maintain a sustainable growth.

Meanwhile, this paper has some limitations. First, the survey was limited to Korean respondents. Although the Korean respondents has the potential to provide meaningful insights related to the consumer perception on VR HMDs, generalization of the results may be limited. Consumers from different parts of the world, where the culture and social environment is highly different, could provide different perceptions. Also, although the key attributes were carefully identified in this study, there lies the possibility that other important attributes may be present which could affect the purchase intentions of the consumers. Thus, further studies may be needed in order to fully understand the consumer perceptions on VR HMDs.

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