공학석사 학위논문

Cross-cultural difference in product preference in consumer review-based text mining methods : A case study on smart band

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2020 년 8 월

서울대학교 대학원

산업공학과

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Abstract

Cross-cultural difference in product preference in consumer review-based text mining methods : A case study on smart band

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The aim of this study is to prove that the consumer review-based text mining methods proposed in the paper for cross-cultural design are effective. To prove it, we took Mi band 3 as a case study where we compared the cross-cultural differences in product preference of users from different cultural regions with this method.

With the development of global market, more and more products and services are sold across the globe. Users from different cultures have different behaviors, cognitive styles, and value systems. Therefore, product should be designed to meet the needs and preferences of users from different cultural groups. In the field of cross-cultural design, existing studies are mainly focused on traditional usability and UX research methods. However, these methods expose some disadvantages when applied into cross-cultural design contexts.

E-commerce websites provide a large volume of product reviews and it is easy to collect review data online. There is no need to employ foreign participants or make a survey onsite or remotely, which will save much more cost and time. There is a new trend that customer reviews are examined to know consumer opinions. Neverlessness, there are not many studies by analyzing online reviews in the field of cross-cultural design.

Thus, my research proposed consumer review-based text mining methods for cross-cultural design, which consist of aspect-level opinion mining, sentiment analysis, and semantic network analysis.

We collected review data from the following three websites: Naver of South Korea, Jingdong of China, and Amazon of the United States. Text mining methods including opinion mining, sentiment analysis, and semantic network analysis were performed. Firstly, product aspects were extracted from reviews according to word frequency. This indicates how much users are paying attention to different aspects of the product. Aspect-level sentiment analysis was conducted to find out customer satisfaction with different product aspects. Then, the words most associated with each product aspect were listed. Cluster analysis was conducted and the topic of each cluster was summarized. Data visualization of each dataset was done. Lastly, cross-cultural difference among three countries from the results was observed and discussed.

Though there exist similar issues in product preferences of users from South Korea, China, and the United States, cross-cultural differences about Mi band 3 are shown in many product aspects.

Korean tend to take Mi band as a fashionable, cool, yet not useful wearable device. They often buy it as a nice gift. They are interested in the appearance of the strap and often buy straps of different colors and materials. Korean do not enjoy outdoor activities as much as American. And the function of NFC is not prevalent in Korea. Thus, the smart band is not useful to Korean. These can explain why Korean do not care about quality of the smart band and do not want to buy Mi band at a high price.

Korean think that the language of Korean on the display, application, and manual is the most important feature. The length of Korean texts is longer than Chinese to convey the same information. On the other hand, Korean prefer to check message notification on smart band rather than call notification. Therefore, Korean need a larger size for screen.

Chinese are more concerned about different kinds of functions including fitness tracker (step counting, heart rate monitoring, and sleep monitoring), notification, and NFC. These different functions are all important and practical to Chinese.

American enjoy outdoor activities and tend to use smart band mostly as activity tracker. They care more about activity tracker function including heart rate monitoring and step counting than Korean and Chinese. They have a higher requirement about the accuracy of measured data and have more negative reviews on activity tracker function than Korean and Chinese. Besides, they need the mode for swimming. Because American usually use the smart band for outdoor activities, they complain a lot that the screen is prone to scratches and is invisible under the outdoor sunlight. Also, they pay attention to the quality of screen and strap, expecting the material make the screen and strap durable. Besides, battery is the most significant aspect to American. They always try to test each function to find which function makes battery life short.

The results of the case study prove that the consumer review-based text mining method proposed in the paper can generate cross-cultural difference in product preference effectively, which is helpful to cross-cultural design research. And this method is relatively easy and fast compared to other conventional methods.

Keywords: Text mining, Sentiment analysis, Cross-cultural design, Consumer reviews, Wearable device, Smart band

Student Number: 2017-20727

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Chapter 1. Introduction

1.1 Background and Motivation

With the development of global market, more and more products and services are sold around the world. Users from different cultural groups have different behaviors, cognitive styles, and value systems (Jeong et al., 2010), and they have different preferences that reflect their own cultural factors when using certain product. Different strategies should be made for global market for each different cultural group to meet their needs.

In the field of cross-cultural design, existing studies are mainly focused on traditional usability and UX research methods. However, these methods expose some disadvantages when applied into cross-cultural design contexts. Most commonly-used UX methods developed in Europe and North America, so it is possible that they are not suitable for other cultures (Lee et al, 2009). Without extensive local knowledge, it is difficult to perform firsthand onsite research (Putnam et al., 2009). Proper focus group interview is hard to be conducted due to the language barrier (Lee et al., 2009). Although remote survey is frequently performed, it still cost much more expense and time to employ foreigners as participants and interviewees.

E-commerce websites provide a large volume of product reviews and it is easy to collect review data online. There is no need to employ foreign participants or make a survey onsite or remotely, which will save much more cost and time. There is a new trend that customer reviews are examined to know consumer opinions. However, there are not many studies by analyzing online reviews in the field of cross-cultural design.

Cultural differences in game appreciation were found by looking at words from player game reviews based on word frequency (Zagal and Tomuro, 2013). Rather than providing isolated words in the order of word frequency, users tend to compare specific product features of products.

Thus, my research proposed aspect-based text mining methods for cross-cultural design, which consists of aspect-level opinion mining, sentiment analysis, and semantic network analysis. Aspect-level opinion mining and sentiment analysis are suitable for comparing product preference in different product aspects, which includes product aspect extraction and aspect-based sentiment analysis (Liu, 2012). In semantic network analysis, the centrality of a ‘noun word’ node indicates the importance of the product aspect. The ultimate needs of consumers can be derived from the relationships among nodes (Schnegg et al., 1996). Community detection enhances

understanding of topics of consumer opinions generated from different clusters.

The first goal of the study is to compare the cross-cultural differences in product preference among users from different countries, taking Mi band 3 as a case study. The second goal is to prove that the consumer review-based text mining methods proposed in the paper for cross-cultural design are effective by the case study.

1.2 Research Objective

With a huge development in wearable computing, the number of users using wearable devices has increased annually. Wearable devices are used in everyday life, so it is highly susceptible to user's lifestyle and local environment (Choi et al., 2005). Among different wearable types, smart band is used prevalently, and Mi band is a typical product of smart band. Mi band has been promoted in the international market, and a large quantity of consumer reviews from different counties can be crawled. Therefore, Mi band 3 is chosen as object of the case study.

These three countries are global leaders in the wearable device market. According to IDC (International Data Corporation) 2019, worldwide top 5 wearable companies in market share is Apple, Xiaomi, Huawei, Fitbit, and Samsung, which are from the United States, China, and South Korea.

1.3 Organization of the Thesis

Chapter 2 reviews about the background of cross-cultural design, opinion mining and sentiment analysis, and semantic analysis. Chapter 3 introduces the methodology of the research including data collection, data processing, and cross-cultural discussion. Chapter 4 shows the results of opinion mining, sentiment analysis, and semantic network analysis. And it also illustrates the results based on each product aspect and discusses on cross-cultural difference based on the results. In Chapter 5, we present the findings of the research and future research.

Chapter 2. Literature Review

2.1 Cross-Cultural Design

2.1.1 Definition

Cross-cultural design aims to ensure good usability and UX (user experience) across cultural boundaries. Two types of issues related to cross-cultural design consist of objective issues (language, format conventions, text directionality, etc.) and subjective issues (cognitive styles, value systems, behavioral and intellectual system, interaction with computers, etc.) (Hoft, 1996; Smith, 2005). Cross-cultural design is not only related to language issue, but also related to all sides of the design.

Cultural models are often used to enhance the understanding of the impact of specific culture on the results. Hofstede's cultural model is of the most influence (Steenkam, 2001). Geert Hofstede (2001) studied more than 50 countries and proposed a conceptual and theoretical framework in the cultural study. There were five value dimensions in Hofstede's cultural model, labeled with "Power Distance", "Uncertainty Avoidance", "Individualism versus Collectivism", "Masculinity versus Femininity" and "Long-term versus Short-term Orientation" respectively.

2.1.2 Necessity

With the development of global market, more and more products and services are sold across the globe. Social norms and background culture have a significant influence on cognitive reasoning (Ito, 1996). Users from different cultural groups have different behaviors, cognitive styles, and value systems (Jeong et al., 2010), and they have different preferences that reflect their own cultural factors when using certain product.

It is unrealistic for designers to depend only on personal intuition or experience to ensure good user experience in cross-cultural contexts because of cultural diversity (Smith, 2005). The outcome of cross-cultural research is helpful for designers to better understand the needs and preferences of international users. It is necessary for product marketing staff to know concerns and appreciations of consumers from different cultural regions to create global marketing programs. Marketing based on the above analysis can appeal to more customers, and sales volume can be improved. To sum up, cross-cultural design research benefits design and development of a product in global market. Only products or services that have a good understanding of users from different cultures can have success in international markets (Aykin, 2005).

2.1.3 Method

There are two approaches to cross-cultural design: one is studying existing theories of the target market cultures, and another is performing usability and UX research methods in the specific cultural regions.

The most efforts have focused on questionnaire survey (Baron and Segerstad, 2010; Ji et al, 2010; Sun et al, 2013 Lim et al, 2014; Lee et al, 2014). By questionnaire survey, Lim et al. (2014) investigated cultural differences in mobile app user behavior, and Lee et al. (2014) found culturally variable factors that had influence on user conceptions and evaluations of robots. What's more, a questionnaire survey was conducted to find out the cross-cultural differences of user experience on mobile Video on Demand service (Sun et al, 2013). A remote online sentence completion survey was designed to collect international user data (Walsh et al, 2010).

Interview is frequently used in cross-culture design field. A series of street interviews in 11 cities on 4 continents were performed to find out the main phone carrying options and how these options influenced UX in interaction with the phone in different cultures (Cui et al., 2007). Mobile data service design attributes that users from different cultures value were obtained by means of long-interview (Lee et al., 2005).

Other user-centered design methods are also conducted for cross-cultural studies. A laboratory experiment was conducted to investigate the effects of culture on human-robot interaction (Li et al., 2010). Clemmensen (2011) suggested templates for cross-culturally and culturally specific usability testing. To collect cross-cultural user data, an internationalized remote online storyboard survey was designed (Walsh et al., 2011). Five cultural viewpoint metaphors were proposed to explore cultural perspective in cross-cultural design (Salgado et al, 2011).

Sometimes, mixed approaches were taken to achieve a more reliable result. Color appeal in website design within and across cultures was evaluated by multiple means including laboratory experiment, survey and interview (Cyr et al., 2009). Cultural difference in learning how to use cellphone was identified in the method of focus group interview, questionnaire survey, and usability testing (Honold, 1999).

In summary, existing studies are mainly focused on conventional usability and UX research methods. However, these methods expose some disadvantages when applied into cross-cultural design contexts. Most commonly-used UX methods developed in Europe and North America, so it is possible that they are not suitable for other cultures (Lee et al, 2009). For instance, since it is reluctant for Indians to make negative comments on test products, traditional ways of usability tests do not work out (Chayan, 2005).

Without extensive local knowledge, it is difficult to perform firsthand onsite research (Putnam et al., 2009). Proper focus group interview is hard to be conducted due to the language barrier (Lee et al., 2009). Although remote survey is frequently performed, it still cost much more expense and time to employ foreigners as participants and interviewees.

2.2 Opinion Mining and Sentiment Analysis

Opinion mining and sentiment analysis (Pang et al., 2008; Liu, 2012) was firstly proposed in early this century and has become an active research area gradually. Sentiment is an attitude, thought, or judgment prompted by feeling. Opinion mining and sentiment analysis aim to extract the sentiment orientation of given texts.

2.2.1 Aspect Level Opinion Mining

Based on the unit of the text, there are three levels of sentiment polarity categorization, consisting of the document level, the sentence level, and the aspect level opinion mining (Liu, 2012). The document level sentiment analysis determines whether the document expresses negative, neutral, or positive sentiment, while the sentence level deals with each sentence's sentiment. The aspect level opinion mining can generate aspects and the sentiment polarities related to the aspects (Yu et al., 2011).

Aspect-level opinion mining discovers the first three components: entity, aspect and sentiment. For an online product review, the entity is explicit and several aspects of this entity with the corresponding opinions would be mentioned. The objective of aspect-level opinion mining is to discover the specific aspects and the corresponding sentiment polarities. Aspect-level opinion mining can be divided into two sub-tasks: aspect extraction and sentiment classification.

There are variety of differences among consumers from different cultural groups, who usually focus on different aspects of products and show different attitudes towards the same aspect. Thus, it is necessary to conduct aspect-level sentiment analysis (Liu, 2012), which is suitable for comparing product preference in different product aspects. People talk more about things that they pay more attention to. The product aspect with high word frequency indicates the aspect that consumers care much about (Zagal and Tomuro, 2010). So, aspects are extracted based on word frequency.

2.2.2 Cross-Lingual Opinion Mining

Cross-lingual opinion mining was proposed to identify sentiment polarities of texts in the target language by the resources in the source language. Banea et al. (2008) adopted the Machine Translation (MT) technique to produce pseudo-corpora in the target language instead of relying on the manually translated parallel corpora.

So far, MT becomes an important technique in cross-lingual opinion mining. Duh et al. (2011) made a conclusion that MT is ripe for cross-lingual opinion mining by analyzing instance mismatches and labeling mismatches in MT-based methods. To use the existing tools when performing opinion mining analysis on cross-lingual natural language content, MT techniques catch a lot of attention (Hogenboom et al., 2014). Google translator, Bing translator, and Microsoft translator are

commonly used translation engines, which can provide APIs convenient to access.

2.3 Semantic Network Analysis

Semantic network analysis develops from identifying the network of association and cooccurrence between specific words in text (Doerfel, 1998). The network is constituted in terms of nodes and edges. Each word in the network is expressed by a node, and connection between words is represented by the edge between nodes. In semantic network analysis, density indicates the interconnectedness of nodes, which is measured by the proportion of existing edges over all possible edges (Wasserman et al.,1994). Diameter shows the compactness of the network, which is a measure of the longest path among all node pairs.

Centrality reflects the location, importance, or prominence of a word within the semantic network (Knoke, 2008). Degree centrality is measured by the number of connections between node pairs, showing how connected a node is to other nodes. Closeness centrality is calculated by the total of the shortest distance from a node to all others. Betweenness centrality is a measure of the frequency of the shortest paths that pass a certain node. The node with big betweenness centrality has strong power on connection to other nodes. At last, eigenvector centrality provides a more complex measure of both number and significance of the connected nodes (Freeman, 1978; Wasserman et al.,1994; Raad, 2014; Heymann, 2014).

Semantic network allows extraction of useful information about topics from identifying clusters (Doerfel, 1998). Community detection is a

network clustering analysis algorithm (Newman et al, 2004), which can be used to detect cohesive groups in the network (Fortunato, 2010). Community can be interpreted as a collection of nodes with similar characteristics. Modularity is put forward to evaluate community detection, and it refers to the difference between a network under certain community detection and a random network.

Based on consumer reviews, semantic network analysis can yield insights on product or service (Bonato, 2008). The centrality of a 'noun word' node indicates the importance of the product aspect. The ultimate needs of consumers can be derived from the relationships among nodes (Schnegg et al., 1996). Community detection enhances understanding of topics of consumer opinions generated from different clusters.

Chapter 3. Methodology

3.1 Data Collection

According to IDC (International Data Corporation) 2019, worldwide top 5 wearable companies in market share is Apple, Xiaomi, Huawei, Fitbit, and Samsung, which are from the United States, China, and South Korea. And one of the biggest e-commerce websites of these three counties are Amazon, Jingdong, and Naver.

Online reviews of Mi band 3 were collected from three e-commerce websites: Naver of South Korea, Jingdong of China, and Amazon of the United States, respectively.

3.2 Data Processing

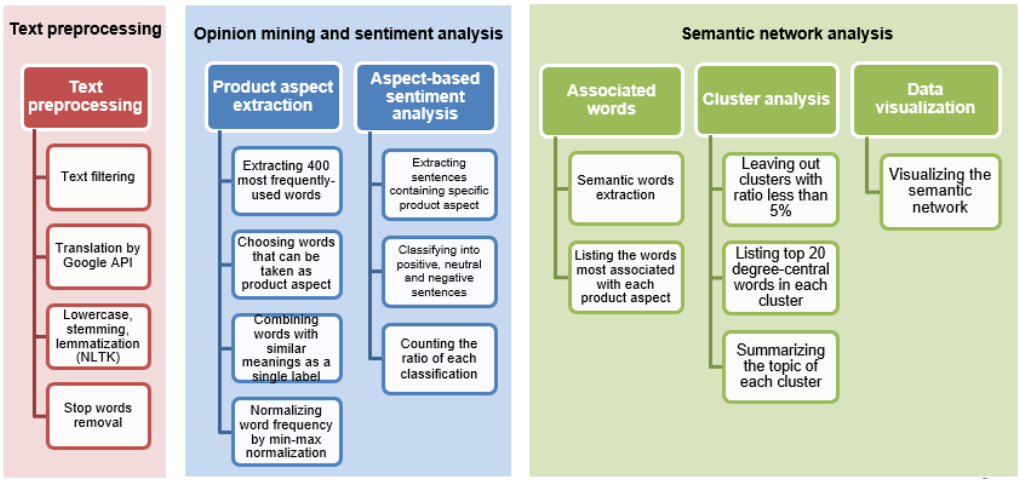

Figure 1. The flowchart of data processing

The whole process of the data processing is illustrated in Figure 1 including text preprocess, opinion mining and sentiment analysis, and semantic analysis.

3.2.1 Text Preprocessing

Text preprocessing was conducted with library NLTK (Natural Language Toolkit). Invalid reviews were removed firstly, including short, duplicate, and reviews with garbled texts. Korean and Chinese reviews were translated into English by Google translation API. Then, lowercase, lemmatization, and stop words removal were performed.

3.2.2 Opinion Mining and Sentiment Analysis

We tried to extract product aspects from reviews according to word frequency. Firstly, 400 most frequently-used words or phrases were

extracted respectively from three review datasets. UX experts chose the words that can be taken as product aspect label from 400 words and most of them were nouns. Words with similar meanings were combined as a single label by the experts. Min-Max Normalization was used to normalize the word frequency by the equation (1). The frequently appeared nouns that consumers talk more about in reviews would indicate the important aspects of the product that users pay attention to.

$$x' = (x - X\_min) / (X\_max - X\_min) \quad (1)$$

Aspect-level sentiment analysis was done by TextBlob library. Sentences containing specific product aspect were extracted. Based on sentiment polarity (SP) score, we classified the sentences into positive ($0 < SP \leq 1$), neutral ($SP = 0$) and negative ($-1 \leq SP < 0$) sentences and we observed each ratio. We paid closer attention to negative reviews in order to find out product features that the users are unsatisfied with.

3.2.3 Semantic Network Analysis

Only words with semantic meaning including nouns, adjectives, and verbs were extracted and assigned to nodes. Degree centrality were measured. The words most associated with each product aspect were listed.

Then, cluster analysis was performed with community detection algorithm. The clusters with ratio less than 5% were left out. The top 20 degree-central words in each cluster were extracted and the topic of each cluster was summarized from these words by the UX experts.

Data visualization of each dataset was done. Different colors of labels and edges represented different clusters. The size of label showed the degree centrality of the word.

3.2.4 Result Sample

A sample of result on product aspect ‘battery’ is illustrated in Table 2. The frequently appeared nouns that consumers talk more about in reviews would indicate the important aspects of the product that users pay attention to. The rank of frequency and normalized frequency show the importance of the product aspect. The ratio of positive, neutral and negative reviews indicates the satisfaction with the aspect. The words associated with the aspect can generate more insights on the aspect by aspect-opinion pairs. Lastly, the list of positive, neutral, and negative reviews provides more information in detail.

Table 1. Sample of the result of aspect 'battery'

	Korea	China	U.S.
Rank	4	5	1
Normalized frequency	0.34	0.44	1.00
Positive	37%	48%	53%
Neutral	38%	33%	30%
Negative	26%	19%	17%
Associated words	long, good, charge, light, check, phone, like, best, message, alarm	good, durable, easy, charge, quality, bad, full, satisfied, function	good, heart rate, charge, backup, drain, great, poor, awesome, feature, notification, quality, monitor, screen, bad
Cluster	○	/	○
Positive reviews	(1) I am very satisfied that the battery has been on for a long time (2) ……	(1) The battery can be used for more than 20 days (2) ……	(1) The battery life is excellent when the heart rate monitor is switched off (2) ……
Neutral reviews	(1) The alarm was turned on and the battery was fully charged (2) ……	(1) Battery life remains to be seen (2) ……	(1) The battery lasts me for 12-15 days (2) ……
Negative reviews	(1) The battery is not so long compared to 2 (2) ……	(1) Battery life is not so long (2) ……	(1) the battery hardly lasts for a week with heart rate monitor (2) ……

Finally, we tried to explain differences in the method that is somewhat informal, depending on the knowledge of everyday practice to avoid cultural stereotypes (Baron et al., 2010).

Chapter 4. Result

4.1 Overview

In total, we collected 5,146 reviews from Naver, 3,994 reviews from Jingdong, and 4,990 reviews from Amazon. After review filtering, 4,215 reviews from Naver, 3,874 reviews from Jingdong, and 4,499 reviews from Amazon were collected (Table 3).

Table 2. Statistics on online reviews

Website	Country	Number of reviews
Naver	South Korea	4,215
Jingdong	China	3,874
Amazon	The United States	4,499

Words of similar meanings were combined as the same product aspect. Among the 400 most frequent words, 49 extracted product aspects from Naver, 53 extracted from Jingdong, 39 extracted from Amazon were used as a result.

Table 3. The words that represent the same product aspect

Product Aspect	Words
children	children, kids
exercise	exercise, activity, workout, sports
heart rate	heart rate, heartbeat
Korean	Korean, Hangul
notification	notification, notifier, reminder, alert
price	price, money, budget, value for money, cost-effectiveness
screen protector	protector, guard, film
SNS	Kakao talk, Wechat, Whatsapp
step counting	step counting, pedometer
waterproof	waterproof, water resistant

Table 4. Statistics on product aspects

Website	Number of aspects	Max		Min	
		Aspect	Freq.	Aspect	Freq.
Naver	49	Korean	507	birthday	16
Jingdong	53	function	1006	shape	30
Amazon	39	battery	2495	gift	37

4.2 Opinion Mining and Sentiment Analysis

4.2.1 Normalized Frequency

According to normalized frequency in total of three countries, top 20 product aspects are listed in Figure 2 and Figure 3. The product aspects that rank within top 10 in all three countries are battery, price, step count, and sleep monitoring. Users from all the three countries pay much attention to these attributes.

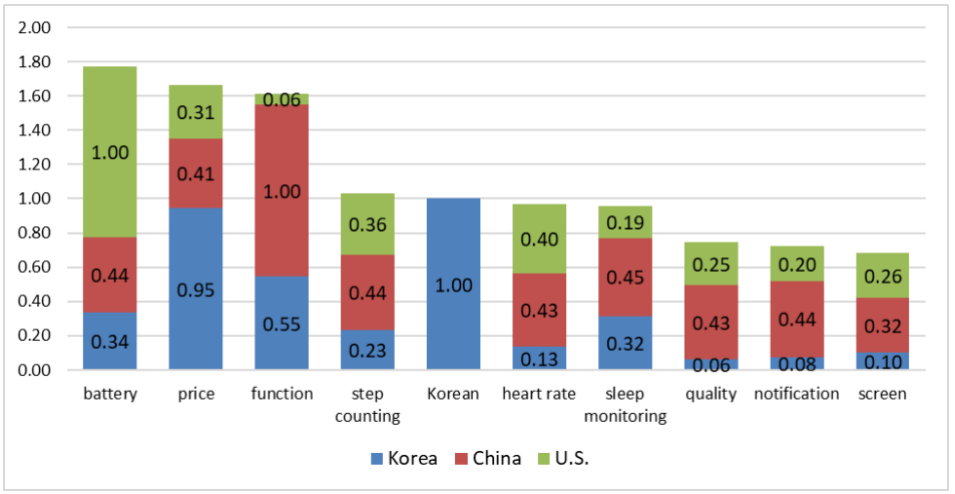

Figure 2. Top 10 aspects based on total normalized frequency

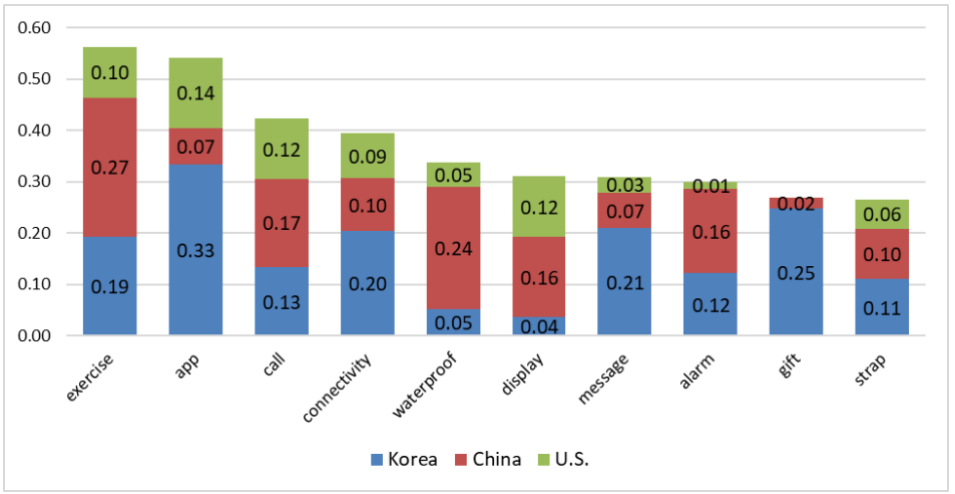

Figure 3. Top 11-20 aspects based on total normalized frequency

4.2.2 Sentiment Analysis

We classified the sentences into positive, neutral, and negative sentences and we observed each ratio. The sentiment analysis of top 20 product aspects is listed in the table.

The product aspects that consumers have many negative reviews on are ‘battery’, On the other hand, the product aspects that consumers have many positive reviews on are ‘price’. American take a more negative attitude than Korean and Chinese in the aspect ‘step counting’ and ‘heart rate’.

Table 5. Sentiment analysis of top 10 product aspects

Aspect	Sentiment	Ratio		
		Korea	China	U.S.
battery	Positive	0.37	0.48	0.53
	Neutral	0.38	0.33	0.30
	Negative	0.26	0.19	0.17
price	Positive	0.67	0.68	0.73
	Neutral	0.28	0.30	0.20
	Negative	0.05	0.02	0.07
function	Positive	0.45	0.61	0.61
	Neutral	0.46	0.33	0.26
	Negative	0.08	0.06	0.14
Korean	Positive	0.42	/	/
	Neutral	0.49	/	/
	Negative	0.09	/	/
step counting	Positive	0.37	0.38	0.42
	Neutral	0.56	0.59	0.41
	Negative	0.08	0.03	0.17
heart rate monitoring	Positive	0.33	0.34	0.42
	Neutral	0.60	0.63	0.43
	Negative	0.07	0.04	0.16
sleep monitoring	Positive	0.36	0.31	0.47
	Neutral	0.55	0.62	0.46
	Negative	0.09	0.07	0.08
quality	Positive	0.46	0.68	0.77
	Neutral	0.42	0.30	0.14
	Negative	0.13	0.02	0.09
notification	Positive	0.30	0.32	0.38
	Neutral	0.65	0.65	0.51
	Negative	0.06	0.03	0.11
screen	Positive	0.35	0.53	0.54
	Neutral	0.48	0.39	0.31
	Negative	0.17	0.08	0.15

Table 6. Sentiment analysis of top 11-20 product aspects

Aspect	Sentiment	Ratio		
		Korea	China	U.S.
exercise	Positive	0.37	0.42	0.41
	Neutral	0.58	0.52	0.44
	Negative	0.05	0.06	0.14
app	Positive	0.45	0.74	0.66
	Neutral	0.46	0.19	0.25
	Negative	0.09	0.07	0.05
call	Positive	0.47	0.70	0.47
	Neutral	0.46	0.23	0.41
	Negative	0.08	0.07	0.12
connection	Positive	0.54	0.78	0.49
	Neutral	0.35	0.19	0.37
	Negative	0.11	0.03	0.14
waterproof	Positive	0.68	0.77	0.57
	Neutral	0.17	0.19	0.35
	Negative	0.15	0.04	0.08
display	Positive	0.46	0.80	0.59
	Neutral	0.43	0.14	0.24
	Negative	0.11	0.06	0.17
message	Positive	0.58	0.83	0.43
	Neutral	0.32	0.16	0.50
	Negative	0.09	0.01	0.07
alarm	Positive	0.51	0.78	0.63
	Neutral	0.43	0.18	0.35
	Negative	0.06	0.04	0.01
gift	Positive	0.45	0.78	/
	Neutral	0.52	0.18	/
	Negative	0.03	0.04	/
strap	Positive	0.51	0.81	0.59
	Neutral	0.43	0.10	0.21
	Negative	0.06	0.09	0.20

4.3 Semantic Network Analysis

4.3.1 Associated Words

Table 7. The words associated with product aspects

Product Aspect	Associated Words		
	Korea	China	U.S.
battery	long, good, charge, light, check, phone, like, best, message, alarm	good, durable, easy, charge, quality, bad, full, satisfied, function	good, heart rate, charge, backup, drain, great, poor, awesome, feature, notification, quality, monitor, screen, bad, excellent
price	good, value, cheap, satisfy, best, performance, product, quality, compare, easy, like	good, value, quality, high, easy, expensive, function, official, second, jingdong, cheap	best, good, value, overall, great, product, nice, worth, battery, waste, fitness, excellent, feature, range, awesome, everything, perfect, much, quality
function	good, use, step, easy, compare, lot, design, alarm, simple, like, various, necessary, satisfy	good, xiaomi, use, easy, lot, many, generation, nfc, practical, convenient, powerful, step, alarm	battery, good, use, work, heart rate, great, lot, nice, sleep, app, expect, money, useful, best, complete

step counting	function, good, check, heart rate, like, sleep, number, clock, money, pattern, easy, waterproof, satisfied	good, accurate, number, easy, heart rate, sleep, function, bad, convenient, small, time, alarm, detection, weather	heart rate, battery, walk, sleep, travel, accuracy, drive, track, wrong, inaccurate, time, bus, car, increase, vehicle
Korean	good, easy, support, version, patch, update, iphone, download, convenient, difficult, app, manual	/	/
heart rate	check, good, step, sleep, money, analysis, compare, sorry, number, exercise	good, easy, step, exercise, sleep, detection, time, function, accurate, phone, money, feel, addition	accurate, step, good, time, day, feature, sleep, nice, continuous, inaccurate, automatic, best
sleep monitoring	check, good, deep, set, see, step, activity, heart rate, number, fun, analysis, useful, best	good, easy, detection, step, quality, night, heart rate, function, day, record	accurate, good, step, track, battery, feature, heart rate, time, wake, analysis, night
quality	money, good, delivery, korean, walk, fast, satisfied, big, battery	good, band, delivery, speed, logistics, satisfied, appearance, money, sleep, easy, value, service, battery	screen, good, material, bad, battery, product, strap, best, great, nice, excellent, feature, overall, money

notification	set, message, click, iphone, easy, phone, receive, app, connect	good, message, call, easy, phone, practical, function, sedentary, time, convenient	battery, call, good, feature, best, app, display, phone, heart rate, message, nice, screen
screen	big, small, good, message, function, nice, inconvenient, edge, problem	good, touch, function, clear, appearance, feel, large, easy, display, big, message, bad, comfortable	good, quality, scratch, battery, sunlight, touch, see, day, light, brightness, nice, visible, time, look, great, outdoor, sun, prone, protector
exercise	good, check, phone, interesting, clock, best, heart rate, convenient, treadmill, record, time, useful	good, heart rate, easy, time, new, satisfied, function, mode, running, wrist	battery, good, mode, track, best, feature, heart rate, sleep, app, great, option, accurate, light
app	download, buy, korean, connect, install, good, iphone, money, set, nice, easy, upgrade, update	good, download, notification, easy, message, function, phone, plan, express, feel, exercise, new, screen, practical, connect	good, notification, battery, mifit, call, connect, lot, time, exercise, pro, sleep
call	tell, good, phone, know, convenient, vibration, alert, receive, great, like, reject	good, notification, convenient, function, information, phone, easy, mobile, miss, addition, time	notification, battery, feature, good, time, option, best, app, vibrate, phone, message, great, many, reject, whatsapp, screen, silent, useful

connectivity	iphone, app, difficult, firewire, korean, phone, update, able, check, delete	phone, good, mobile, bluetooth, express	battery, mobile, last, day, device, phone, time, app, heart, notification
waterproof	good, light, easy, check, step, alarm, nice, install	good, function, bath, wear, time, effect, battery, problem, generation, practical, swimming	shower, good, bath, day, dust, great, test, time, wear, best, feature
display	time, neat, update, delay, reflect, design, problem	good, screen, practical, function, heart, quality, easy, sleep, information, call, wrist	good, sunlight, battery, screen, bright, sun, product, time, notification, touch, best
message	check, see, good, phone, easy, convenient, message, click, notification, screen, battery	notification, good, phone, screen, practical, function, battery, easy, app, see	show, notification, call, battery, whatsapp, display, able, good
alarm	function, good, vibration, convenient, turn, battery, set, phone, nice, possible, like, time, easy, waterproof	clock, good, function, set, easy, step, need, time, wake, quality, measure, worry	battery, set, silence, need, phone, add, basic, best, feature, good, like, notification, vibrate
gift	buy, give, like, children, father, good, satisfy, love, happy, receive, husband, son	good, buy, like, father, give, company, girlfriend, practical, family, daughter	/

strap	use, buy, basic, disadvantage, different, lot, additional, metal, white	good, comfortable, black, buy, function, original, wear, use, wrist, bad, hand, fell, practical, orange	good, quality, material, battery, charge, lock, screen, need, problem, remove, cheap, comfortable, durable, skin, soft

4.3.1 Cluster Analysis

Cluster analysis was performed with community detection algorithm. The clusters with ratio less than 5% were left out. The top 20 degree-central words in each cluster were extracted and the topic of each cluster was summarized from these words by the UX experts.

Reviews from Naver can be generated into 6 clusters, with the topic ‘price’, ‘purchase’, ‘battery’, ‘Korean’, ‘delivery’, and ‘screen size’.

Table 8. Cluster analysis based on Naver reviews

Cluster	1	2	3	4	5	6
Ratio	27.0%	19.5%	18.0%	11.6%	11.3%	6.6%
Topic	price	purchase	battery	Korean	delivery	size screen
Words	buy good think price check like write seem function watch purchase feel sleep best satisfied light design wear worry find	want know get go phone see make work charge able take set screen call alarm problem possible turn message say	use band time battery try first come look change long lose smart mi strap basic fit xiaomi size week color	korean easy need nice iphone convenient app version update difficult connect support download search manual firmware mobile install chinese inconvenient	delivery product shipping receive order satisfy day fast send satisfactory thank small arrive item connection next feeling today leave late	small little big wrist bit liquid spend genuine original line worried crystal enough place stick woman something show hole heavy

Reviews from Jingdong can be generated into 5 clusters, with the topic ‘good band’, ‘delivery’, ‘appearance and gift’, ‘convenience’, and ‘screen’.

Table 9. Cluster analysis based on Jingdong reviews

Cluster	1	2	3	4	5
Ratio	38.0%	20.3%	19.7%	15.3%	6.3%
Topic	good band	delivery	appearance gift	convenience	screen
Words	good band xiaomi buy function thing take time feel quality first day second phone look bad satisfied wear appearance battery	goods jingdong logistics receive delivery express praise speed customer next give order courier arrive service come official store grab fast	hope say get wristband black new original packaging send strap authentic start suitable perfect let nice friend wife experience help	use easy convenient nfc see super need addition go bus open card wait support try change fact company subway add	mobile screen alarm set touch wrist clock worry lift sensitive vibration everything accord favorite raise key misoperation highend delay slide

Reviews from Amazon can be generated into 6 clusters, with the topic ‘battery’, ‘purchase’, ‘fitness’, ‘notification’, ‘screen’, and ‘price’.

Table 10. Cluster analysis based on Amazon reviews

Cluster	1	2	3	4	5	6
Ratio	26.4%	26.0%	14.9%	13.3%	12.2%	5.0%
Topic	battery	purchase	fitness	notification	screen	price
Words	battery	band	heart	feature	screen	best
	good	mi	step	watch	display	money
	use	buy	time	notification	quality	fitness
	product	work	sleep	pro	problem	tracker
	get	thing	show	call	issue	worth
	day	look	rate	come	see	value
	charge	need	count	find	strap	range
	life	go	accurate	device	touch	consider
	nice	like	keep	many	material	doubt
	great	app	track	make	scratch	available
	overall	want	wear	phone	light	cost
	give	first	monitor	lot	water	cheap
	last	love	sensor	connect	much	waste
	everything	purchase	accuracy	option	little	market
	think	try	walk	update	sunlight	pay
	exercise	know	check	let	put	anyone
	take	please	sure	set	bit	part
	receive	fit	help	useful	build	impressive
	say	feel	travel	read	big	affordable
	bad	compare	seem	add	low	date

4.3.1 Data Visualization

Data visualization of each dataset was done. Different colors of labels and edges represented different clusters. The size of label showed the degree centrality of the word.

Figure 4. Visualization of Naver reviews

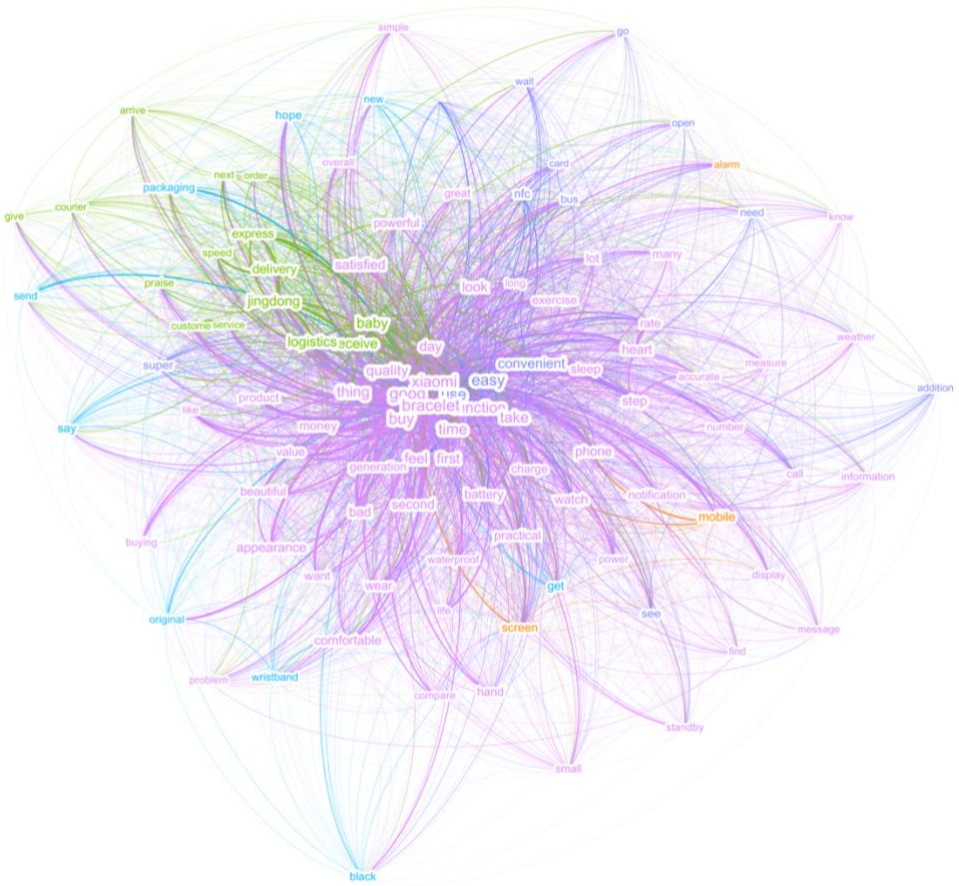

Figure 5. Visualization of Jingdong reviews

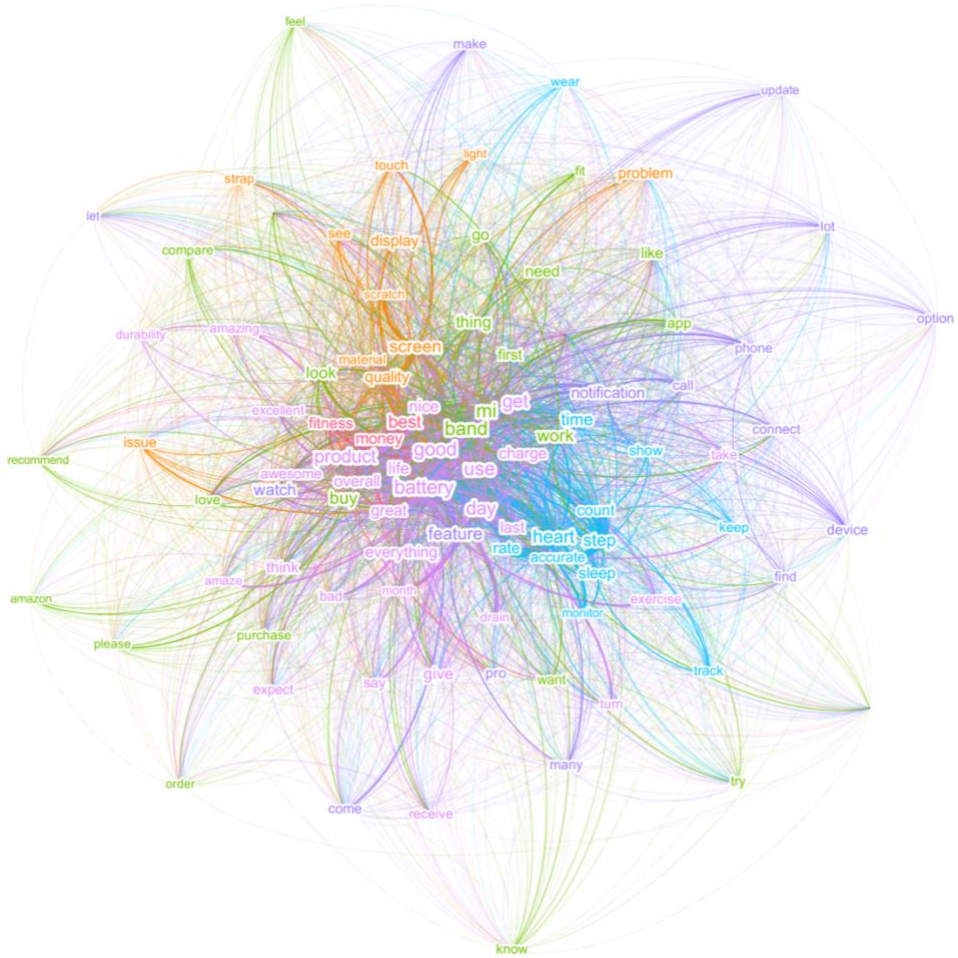

Figure 6. Visualization of Amazon reviews

4.4 Results based on Aspects

4.4.1 Battery

Table 11. The result of aspect 'battery'

	Korea	China	U.S.
Rank	4	5	1
Normalized frequency	0.34	0.44	1.00
Positive	37%	48%	53%
Neutral	38%	33%	30%
Negative	26%	19%	17%
Associated words	long, good, charge, light, check, phone, like, best, message, alarm	good, durable, easy, charge, quality, bad, full, satisfied,	good, heart rate, charge, backup, drain, great, poor, awesome, notification, quality, monitor, screen, bad
Cluster	○	/	○
Positive reviews	(1) I am very satisfied that the battery has been on for a long time (2) ……	(1) The battery can be used for more than 20 days (2) ……	(1) The battery life is excellent when the heart rate monitor is switched off (2) ……
Neutral reviews	(1) The alarm was turned on and the battery was fully charged (2) ……	(1) Battery life remains to be seen (2) ……	(1) The battery lasts me for 12-15 days (2) ……
Negative reviews	(1) The battery is not so long compared to 2 (2) ……	(1) Battery life is not so long (2) ……	(1) The battery hardly lasts for a week with heart rate monitor (2) ……

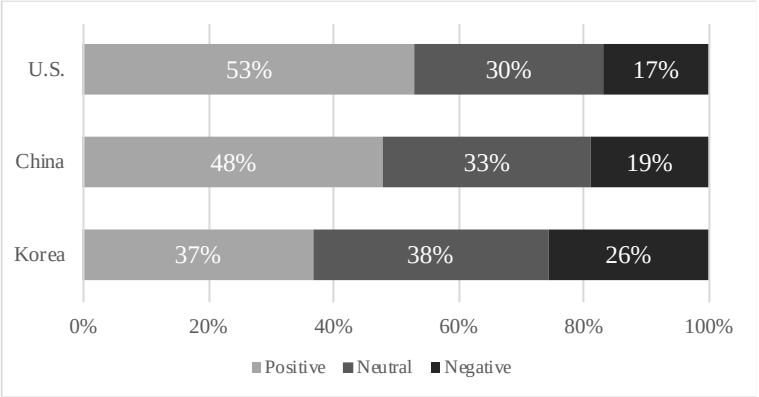

Figure 7. Sentiment analysis result of the aspect 'battery'

Battery is the aspect that users are most concerned about, and American pay most attention on battery (1st). However, users, especially users from Korea (25.6%), have much negative comments on battery. Many users complain that the battery life is shorter than they are advertised. Users from the United States complain that heart rate measurement and notification consumers too much of the power according to the associated word 'heart rate' and 'notification'.

4.4.2 Price

Figure 8. The result of aspect 'price'

	Korea	China	U.S.
Rank	2	8	4
Normalized frequency	0.95	0.41	0.31
Positive	67%	68%	73%
Neutral	28%	30%	20%
Negative	5%	2%	7%
Associated words	good, cheap, satisfy, best, performance, product, quality, compare, easy, like	good, quality, high, easy, expensive, function, official, second, jingdong, cheap	best, good, overall, great, product, nice, worth, battery, waste, fitness, excellent, feature, range, awesome
Cluster	○	/	○
Positive reviews	(1) I got really good at the lowest price (2) ……	(1) The price is reasonable and it is very beautiful to wear (2) ……	(1) Not the best band in the market but the best value for money buy (2) ……
Neutral reviews	(1) I do not have a lot of money to buy a band (2) ……	(1) The price is almost the same (2) ……	(1) I have used it for about one month and it's a value for money product (2) ……
Negative reviews	(1) I do not recommend it for the price (2) ……	(1) The price is expensive (2) ……	(1) I don't like this, it is not value for money (2) ……

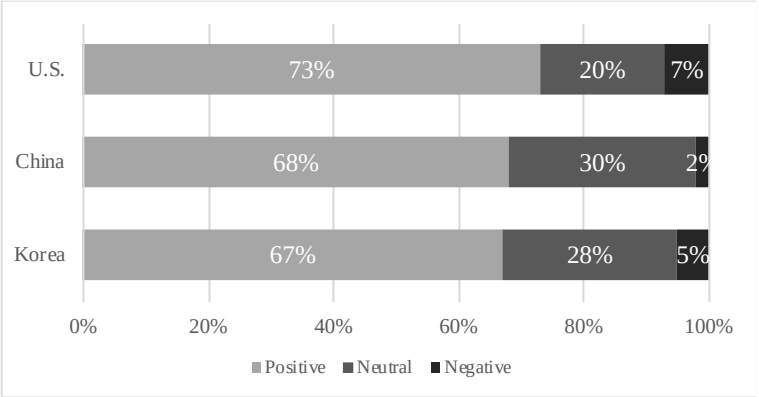

Figure 9. Sentiment analysis result of the aspect 'price'

Most reviews about price are positive (Korea: 67%, China: 68%, U.S.: 73%). Most consumers are satisfied with the price. Korean care more about price (2nd) than Chinese (8th) and American (4th). Chinese can use practical function NFC, American enjoy outdoor activities and often use fitness tracker, however, Mi band is not that useful to Korean. Thus, Korean do not want to spend a lot of money to buy a smart band.

4.4.3 Function

Figure 10. The result of aspect 'function'

	Korea	China	U.S.
Rank	3	1	15
Normalized frequency	0.55	1.00	0.06
Positive	45%	61%	61%
Neutral	46%	33%	26%
Negative	8%	6%	14%
Associated words	good, use, step counting, easy, compare, lot, design, alarm, simple, like, various, necessary, satisfy	good, xiaomi, easy, many, generation, nfc, practical, convenient, powerful, step counting, alarm	battery, good, use, work, heart rate, monitoring, great, lot, nice, sleep monitoring, app, expect, price, useful, best, complete
Cluster	/	/	/
Positive reviews	(1) The design is beautiful and the function is good (2) ……	(1) The function of NFC is very practical (2) ……	(1) All features are quite satisfactory and functional at this budget but the most concerning part is battery life (2) ……
Neutral reviews	(1) I do not need to say anything about the touch function and performance (2) ……	(1) the weather function has been added (2) ……	(1) Battery lasts for 8-10 days with Heart beat function off (2) ……
Negative reviews	(1) I did not use other functions because it is not a smartphone (2) ……	(1) The function inside is not useful to me (2) ……	(1) Battery hardly lasts for 5 days with just the basic functions (2) ……

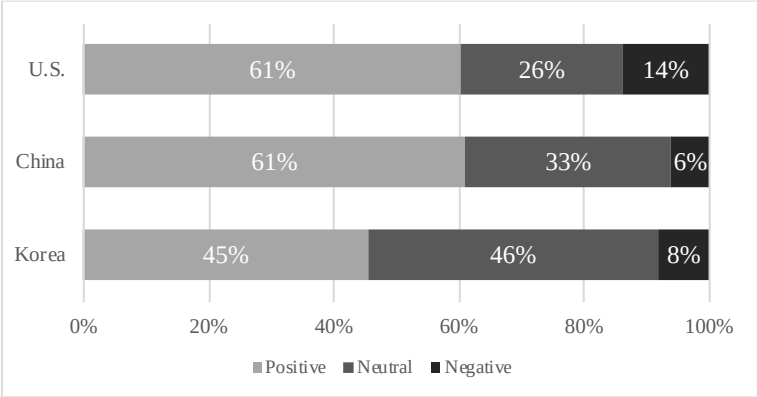

Figure 11. Sentiment analysis result of the aspect 'function'

Chinese pay most attention on function (1st). The 'practical' functions make life 'convenient'. Among the functions, the word 'nfc' is most associated with 'function'. NFC (Near-Field Communication) and its applications including keycard and transportation card for subway and bus only appear in Chinese reviews. Mi band 3 sold in China has an NFC version. However, in Korea or in U.S., Mi Band NFC version is not as prevalent and NFC based transportation transaction technology is mostly incompatible. On the other hand, American are concerned about what functions make battery poor, with the associated word 'battery'.

4.4.4 Step Counting

Figure 12. The result of aspect 'step counting'

	Korea	China	U.S.
Rank	8	4	3
Normalized frequency	0.23	0.44	0.36
Positive	37%	38%	42%
Neutral	56%	59%	41%
Negative	8%	3%	17%
Associated words	good, like, number, clock, price, pattern, easy, waterproof, satisfied	good, accurate, number, easy, sleep, bad, convenient, small, alarm, detection, weather	battery, walk, travel, accuracy, drive, track, wrong, inaccurate, bus, car, increase, vehicle
Cluster	/	/	/
Positive reviews	(1) I bought it because of the step count and I am very satisfied with it (2) ……	(1) The step-by-step function of the bracelet gives me the motivation to go out and walk (2) ……	(1) I set 12000 steps a day target and its proving very good (2) ……
Neutral reviews	(1) I can see the weather and I also have a step count (2) ……	(1) I use it to see the time and count the steps (2) ……	(1) Showing step counting when you are traveling (2) ……
Negative reviews	(1) The number of footsteps is a little different from the phone (2) ……	(1) The step detection is not accurate (2) ……	(1) The steps will count even if you are driving or riding which is useless (2) ……

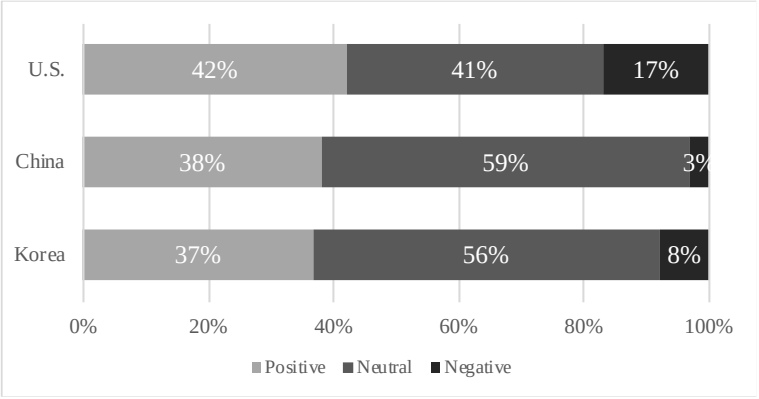

Figure 13. Sentiment analysis result of the aspect 'step counting'

American (3rd) are more concerned with 'step counting' than Korean (8th) and Chinese(4th). The proportion of negative reviews in American reviews (17%) are much higher than those in Korean (8%) and Chinese (3%) reviews. English reviews complain that the step counting function is inaccurate and it continues to work when riding bike or driving car and not walking or running, based on associated words 'walk', 'drive', 'bus', 'car', 'vehicle' and 'inaccurate'.

4.4.5 Korean

Table 12. The result of aspect 'Korean'

	Korea	China	U.S.
Rank	1	/	/
Normalized frequency	1.00	/	/
Positive	42%	/	/
Neutral	49%	/	/
Negative	9%	/	/
Associated words	good, easy, support, version, patch, update, iphone, download, convenient, difficult, app, manual	/	/
Cluster	○	/	/
Positive reviews	(1) It is nice that the screen is larger than the US band 2 version and Korean is also supported (2) It is completely neat and Korean update is also available soon ~ Satisfaction ~ (3) ……	/	/
Neutral reviews	(1) It will be displayed in Korean (2) It seems that it took about 15 minutes to update the fonts and resources (3) ……	/	/
Negative reviews	(1) It is very difficult to make Korean version on iPhone (2) Difficult to translate Korean because there is no Korean manual (3) ……	/	/

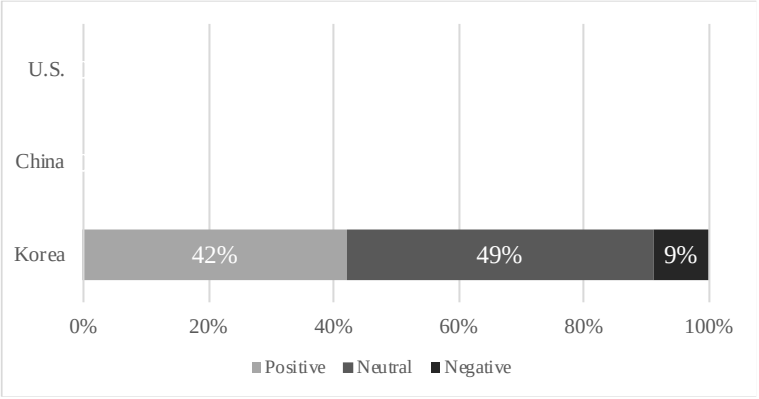

Figure 14. Sentiment analysis result of the aspect 'Korean'

Language-related word including 'Korean', 'Chinese', and 'English' rank 1st, 23rd, and 36th respectively in Korean reviews according to the amount of word frequency. However, it turns out that Chinese and American do not refer to language-related words as often in the reviews.

In Korean reviews, 9% showed negative attitude about Korean language aspect of the product, saying that Chinese or English language occasionally appears on the display, application, or manual instead of Korean language as preferred in the setting. In cluster analysis, the ratio of 11.6% discuss on the topic of Korean.

4.4.6 Heart Rate Monitoring

Table 13. The result of aspect 'heart rate monitoring'

	Korea	China	U.S.
Rank	14	7	2
Normalized frequency	0.13	0.43	0.40
Positive	33%	34%	42%
Neutral	60%	63%	43%
Negative	7%	4%	16%
Associated words	check, good, price, analysis, number, exercise	good, easy, exercise, detection, accurate, phone	accurate, good, nice, continuous, inaccurate, automatic, best
Cluster	/	/	/
Positive reviews	(1) My heart rate is synchronized with my app and I am feeling good (2) ……	(1) Real-time heart rate is very accurate (2) ……	(1) I'm also impressed with the heart rate sensor of the device compared to the budget price tag (2) ……
Neutral reviews	(1) I used my cellphone to check my heart rate (2) ……	(1) You can use the alarm clock and record the heart rate steps (2) ……	(1) I have switched off automatic heart beat and notification (2) ……
Negative reviews	(1) It is annoying and the heart rate function is not accurate (2) ……	(1) The function of heart rate bought for my parents is really not practical (2) ……	(1) Only problem with this is heart sensor which is inaccurate (2) ……

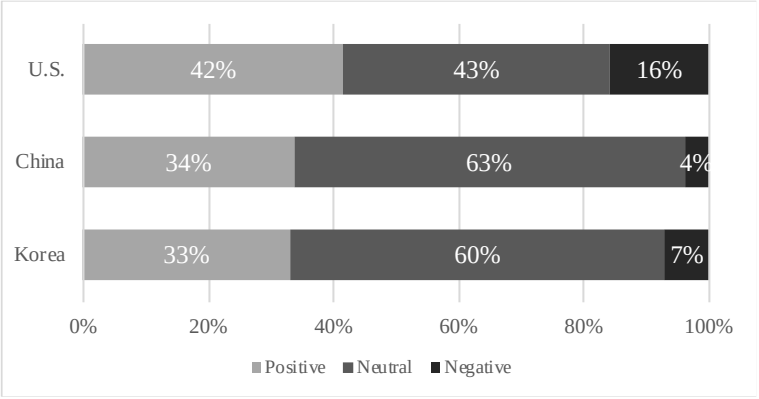

Figure 15. Sentiment analysis result of the aspect 'heart rate monitoring'

American (2rd) are more concerned with 'heart rate monitoring' than Korean (14th) and Chinese(7th). The proportion of negative reviews in American reviews (16%) are much higher than those in Korean (7%) and Chinese (4%) reviews. American care about the accuracy of the heart rate monitoring and many complain that the heart rate monitoring is inaccurate.

4.4.7 Sleep Monitoring

Table 14. The result of aspect 'sleep monitoring'

	Korea	China	U.S.
Rank	6	2	8
Normalized frequency	0.32	0.45	0.19
Positive	36%	31%	47%
Neutral	55%	62%	46%
Negative	9%	7%	8%
Associated words	check, good, deep, fun, analysis, useful, best	good, easy, detection, quality, night, day, record	accurate, good, track, battery, time, wake, analysis, night
Cluster	/	/	/
Positive reviews	(1) I bought it because of the step count and I am very satisfied with it (2) ……	(1) Have a sleep quality test to easily understand the sleep situation of the previous day and remind yourself to fall asleep (2) ……	(1) Wake up sleep time is pretty much correct and the transition of deep sleep and light sleep also feels genuine (2) ……
Neutral reviews	(1) I checked my sleeping mode last night and I checked my sleep mode for a deep sleep (2) ……	(1) The band was bought mainly to monitor the quality of sleep at night (2) ……	(1) The only thing which I have activated on my mi band is Phone alert (only calls) and sleep analysis (2) ……
Negative reviews	(1) It was a shock that my quality of sleep was bad (2) ……	(1) It is felt that sleep monitoring is not particularly accurate (2) ……	(1) Coz it doesn't monitor on day time sleep (2) ……

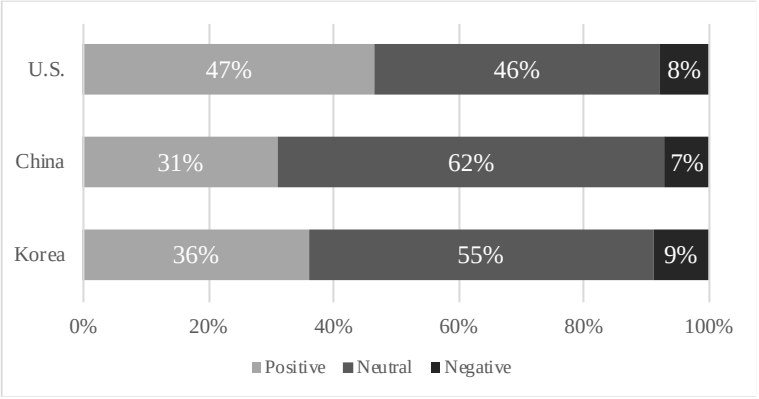

Figure 16. Sentiment analysis result of the aspect 'step monitoring'

All the three countries care about the function of sleep monitoring (Korea: 6th, China: 2nd, U.S.: 8th), especially China. The associated words 'check', 'deep', 'fun', 'analysis', and 'useful' show that Korean think it is fun and useful to check the deep or light sleep analysis. American enjoy the function of sleep 'analysis'. They pay attention to the accuracy of the sleep monitoring, with associated word 'accurate'. Some of American point out the problem that Mi band only monitors night time sleep, but it does not monitor day time sleep.

4.4.8 Quality

Table 15. The result of aspect 'quality'

	Korea	China	U.S.
Rank	28	6	6
Normalized frequency	0.06	0.43	0.25
Positive	46%	68%	77%
Neutral	42%	30%	14%
Negative	13%	2%	9%
Associated words	price, good, satisfied,	good, satisfied, price, sleep monitoring, service	screen, good, material, bad, product, strap, best, great, nice, excellent, overall, price
Cluster	/	/	/
Positive reviews	(1) Good function and good quality - heart rate measurement and step count function is really useful (2) ……	(1) The quality is very good and the logistics is very satisfactory (2) ……	(1) Screen quality is awesome (2) ……
Neutral reviews	(1) I bought it because there was a sleep quality check (2) ……	(1) There is also the quality of sleep at night (2) ……	(1) I tried to track my sleep quality 3 times in a day (2) ……
Negative reviews	(1) The additional strap I bought is really poor quality (2) ……	(1) The quality of the alternate blue strap is too bad (2) ……	(1) The screen is useless and the band quality is too bad (2) ……

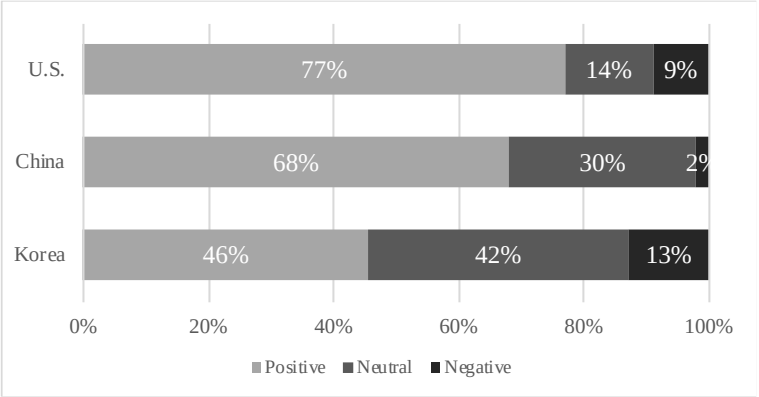

Figure 17. Sentiment analysis result of the aspect 'quality'

The rank of 'quality' in Chinese (6th) and English (6th) reviews are much higher than Korean (28th) reviews. The word most closely associated with 'quality' in Korean reviews is 'price', which means that Korean are satisfied with the quality at a very low price. Chinese also think the quality of the product is good with low price. At the same time, Chinese are concerned about the sleep quality monitoring and service quality. American put emphasis on the quality of many aspects like 'screen', 'material', and 'strap', and they are unsatisfied with them.

4.4.9 Notification

Table 16. The result of aspect 'notification'

	Korea	China	U.S.
Rank	24	3	7
Normalized frequency	0.08	0.44	0.20
Positive	30%	32%	38%
Neutral	65%	65%	51%
Negative	6%	3%	11%
Associated words	message, click, iphone, easy, phone, receive, app, connect	good, message, call, easy, phone, practical, function, sedentary, convenient	battery, call, good, best, app, display, phone, message, nice, screen
Cluster	/	/	○
Positive reviews	(1) It is better to have notifications on the wrist when you are working (2) ……	(1) Call notification and other functions are also very practical (2) ……	(1) And the ability to get call and message notifications is a great feature (2) ……
Neutral reviews	(1) You will see the error message on the app notification page (2) ……	(1) Call notifications average about four or five per day (2) ……	(1) You can see notifications according to your choices (2) ……
Negative reviews	(1) We cannot check the sender if you do not see the message notification when it comes in (2) ……	(1) It is very strange that it is faster than the mobile phone notification (2) ……	(1) Sadly the vibration stopped working after 2 months so now I can't make out when any notifications happen (2) ……

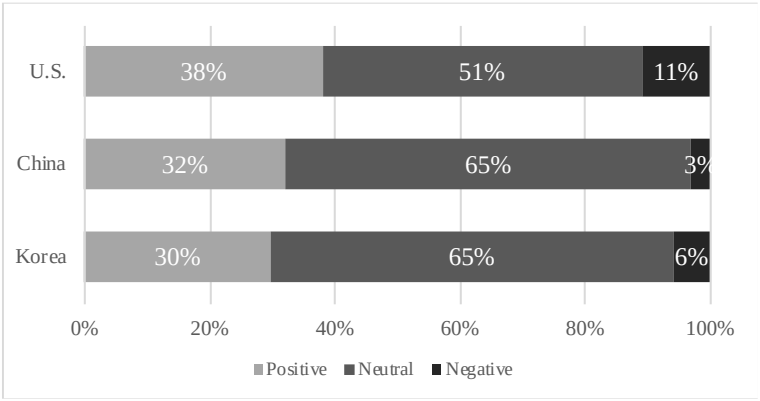

Figure 18. Sentiment analysis result of the aspect 'notification'

The rank of 'notification' in Chinese (3rd) and English (7th) reviews are much higher than Korean (24th) reviews. There are different kinds of notifications, such as call, message, app, and sedentary notification. The users from different counties have their own preference according to the associated words with 'notification'. Korean are used to check message and app notifications rather than call notifications on smart band, Chinese tend to check message, call, and sedentary notifications on Mi band, while American prefer to be notified by call than by message.

4.4.10 Screen

Table 17. The result of the aspect 'screen'

	Korea	China	U.S.
Rank	20	9	5
Normalized frequency	0.10	0.32	0.28
Positive	35%	53%	54%
Neutral	48%	39%	31%
Negative	17%	8%	15%
Associated words	big, small, good, message, function, nice, inconvenient, edge, problem	good, touch, function, clear, appearance, feel, large, easy, display, big, message, bad, comfortable	good, quality, scratch, battery, sunlight, touch, see, day, light, brightness, nice, visible, time, look, great, outdoor, prone, protector
Cluster	○	○	○
Positive reviews	(1) It is nice that the screen is larger than the 2 version (2) ……	(1) The touch screen is also very sensitive and has many functions (2) ……	(1) Amazing product of mi band 3 screen quality is superb (2) ……
Neutral reviews	(1) The part of the screen is slightly curved (2) ……	(1) Raise your hand to brighten the screen (2) ……	(1) The battery life and the screen are same as band 2 (2) ……
Negative reviews	(1) but the message on the screen is too small (2) ……	(1) The bad thing is that the screen can't be seen clearly under the strong sunlight (2) ……	(1) the only issue is screen is not bright enough in sunlight (2) ……

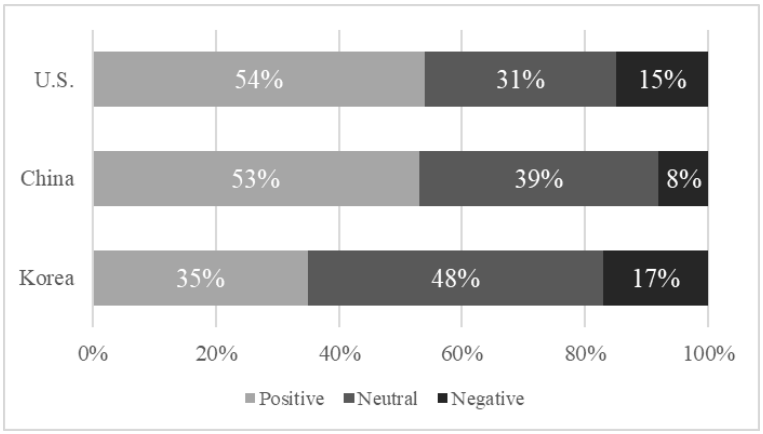

Figure 19. Sentiment analysis result of the aspect 'screen'

Screen is another product aspect that users have many negative comments on in all three countries including South Korea (17%), China (8%), and the United States (15%). Korean are concerned about the size of screen, with associated word 'big' and 'small'. Korean (9th) are more frequently check message than Chinese (25th) and American (22nd). The associated word 'message' also reveals that Korean care about the size of screen due to the need of checking message on smart band. Moreover, the length of Korean texts is longer than Chinese to convey the same information. Therefore, Korean need a larger size for screen than Chinese to some extent.

American care about screen (5th). They point out two problems of screen. The first one is that the screen is prone to scratches, and another is that the screen is invisible under sunlight in the outdoor. The possible reason is that American enjoy outdoor activities much more than Korean and Chinese do.

4.4.11 Exercise

Table 18. The result of aspect 'exercise'

	Korea	China	U.S.
Rank	11	10	13
Normalized frequency	0.19	0.27	0.10
Positive	37%	42%	41%
Neutral	58%	52%	44%
Negative	5%	6%	14%
Associated words	good, check, phone, interesting, clock, best, heart rate monitoring, convenient, treadmill, record, time, useful	good, heart rate monitoring, easy, new, satisfied, function, mode, running, wrist	battery, good, mode, track, best, heart rate, sleep monitoring, app, great, option, accurate, light
Cluster	/	/	/
Positive reviews	(1) It helps a lot in exercise and everyday life (2) ……	(1) Always buy the Mi band is very suitable for people who love exercise (2) ……	(1) The exercise feature can provide a good analysis of various specific activities like jogging (2) ……
Neutral reviews	(1) I bought it for exercise (2) ……	(1) Dad said that he wanted to buy an exercise bracelet for a long time (2) ……	(1) Battery consumes about 20% per hour in exercise mode (2) ……
Negative reviews	(1) And after purchasing will make exercise a bit harder (2) ……	(1) 40% of the battery is the reason why I have less exercise (2) ……	(1) Batter life is not so good if u use it on exercise mode it will last u just for 2 or 3 days (2) ……

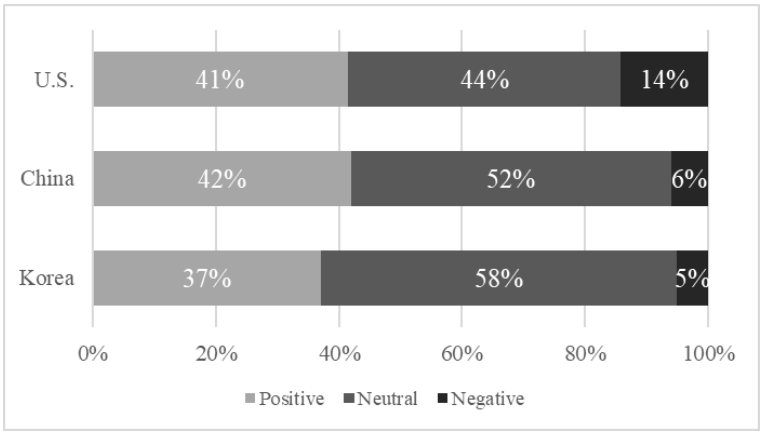

Figure 20. Sentiment analysis result of the aspect 'exercise'

The proportion of negative reviews from American (14%) is larger than that from Chinese (6%) and American (5%). They are most unsatisfied with the fact that the battery drains fast if exercise mode is on.

4.4.12 App

Table 19. The result of aspect 'app'

	Korea	China	U.S.
Rank	5	24	9
Normalized frequency	0.33	0.07	0.14
Positive	45%	74%	66%
Neutral	46%	19%	25%
Negative	9%	7%	5%
Associated words	download, buy, korean, connect, install, good, iphone, set, nice, easy, upgrade, update	good, download, notification, easy, message, phone, plan, exercise, new, screen, practical, connect	good, notification, battery, mifit, call, connect, lot, exercise, pro, sleep
Cluster	/	/	/
Positive reviews	(1) It seems to be a good product because I use the app well (2) ……	(1) The connection app is very fast, and there is no delay in the display of the wrist (2) ……	(1) It has an amazing mi fit app and the step count and distance tracker were really close to the actual distance and steps (2) ……
Neutral reviews	(1) Now it support Korean at mi fit and download the app from the Google store and finish the installation (2) ……	(1) Time photos, weather, find phone, timing, phone notifications, app notifications, I use these features (2) ……	(1) Band doesn't have GPS but app uses phone's GPS and tracks you (2) ……
Negative reviews	(1) I tried the Korean app for the first time but it was not good (2) ……	(1) Standby is acceptable, open app notification, to-do notification, alarm clock, unhappy rate, down 9% in 1 day (2) ……	(1) band vibrates 2 times for each app notification which is annoying (2) ……

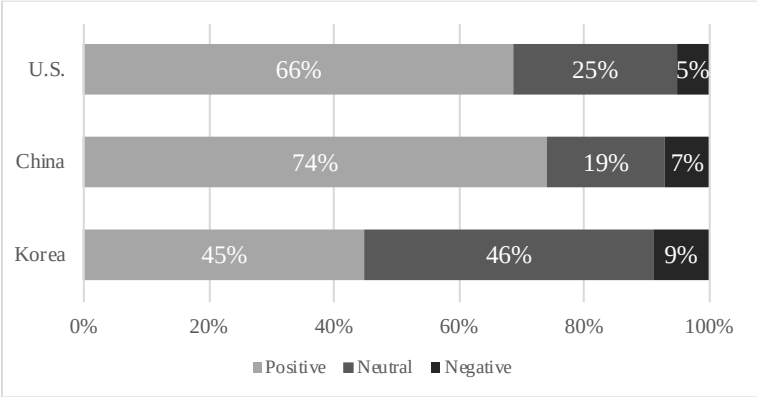

Figure 21. Sentiment analysis result of the aspect 'app'

Korean (5th) pay more attention to the aspect of 'app' than Chinese (24th) and American (9th). The ratio of negative reviews from Korean (9%) is bigger than Chinese (7%) and American (5%). And the ratio of positive reviews from Korean (45%) is smaller than Chinese (74%) and American (66%). The associated verbs 'download', 'connect', 'install', 'set', 'upgrade' and 'update' in Korean reviews conflicts that Korean pay attention to if the apps are easy to operate. Moreover, some apps need to be updated or upgraded into Korean.

4.4.13 Call

Table 20. The result of aspect 'call'

	Korea	China	U.S.
Rank	15	13	11
Normalized frequency	0.13	0.17	0.12
Positive	47%	70%	47%
Neutral	46%	23%	41%
Negative	8%	7%	12%
Associated words	good, phone, convenient, vibration, alert, receive, great, like, reject	good, notification, convenient, phone, easy, miss	notification, good, option, best, vibrate, phone, message, great, reject, SNS, screen, silent, useful
Cluster	/	/	/
Positive reviews	(1) It is a great advantage to be able to receive important phone calls too (2) ……	(1) When a phone calls in, it vibrates, so it is much more convenient to go to work (2) ……	(1) Rejecting the calls directly on the band is what comes extremely handy (2) ……
Neutral reviews	(1) When You receive a message and receive a call, You will be notified of the vibration (2) ……	(1) I tried it and it will vibrate when I call (2) ……	(1) The band vibrates for notification and nonstop vibration for calls (2) ……
Negative reviews	(1) I just do not know how to make a call, but it sounds annoying when I set it up (2) ……	(1) I don't know if I opened the call notification (2) ……	(1) There is no call pickup option available, the person who is calling not available3 (2) ……

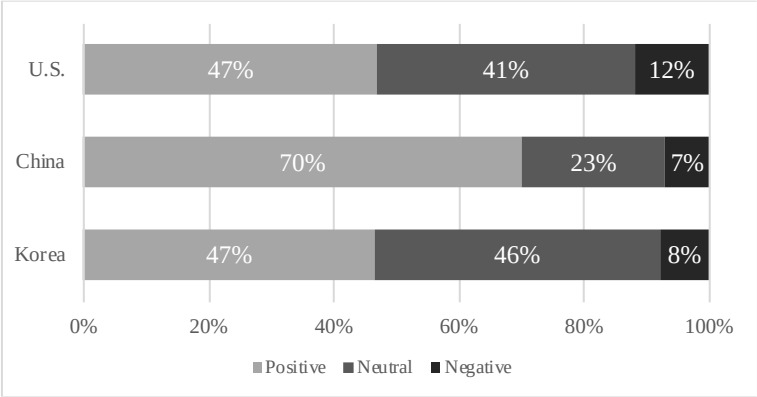

Figure 22. Sentiment analysis result of the aspect 'call'

Chinese (70%) take a more positive attitude to the aspect of 'call' than Korean (47%) and American (47%). They think the function of call notification is 'easy' and 'convenient' to use and they will not 'miss' the call.

The ratio of negative reviews from American (12%) is bigger than Korean (8%) and Chinese (7%). The associate words 'option', 'reject', and 'silent' in English reviews conveys that sometimes there is no option to reject or receive a call, or make the call silent for American.

4.4.14 Connection

Table 21. The result of aspect 'connection'

	Korea	China	U.S.
Rank	10	21	14
Normalized frequency	0.20	0.10	0.09
Positive	54%	78%	49%
Neutral	35%	19%	37%
Negative	11%	3%	14%
Associated words	iphone, app, difficult, firewire, korean, phone, update, check, delete	phone, good, bluetooth, express	battery, device, phone, app, heart rate, notification
Cluster	/	/	/
Positive reviews	(1) Korean is well recognized and Bluetooth connection is very good (2) ……	(1) Very easy to use, Bluetooth connection is also very convenient (2) ……	(1) No disruption of Bluetooth connection, all notifications directly come to this device (2) ……
Neutral reviews	(1) I got a way to do it in Korean because of the Internet connection (2) ……	(1) After Bluetooth connection, you need to upgrade to use (2) ……	(1) The battery is hood but draining 8-10% daily with Bluetooth connection without run for 20 days (2) ……
Negative reviews	(1) I do not have a good connection at first and I think the bluetooth distance is shorter than I thought (2) ……	(1) If you don't open the Bluetooth connection, the standby time is very long (2) ……	(1) While cycling almost everytime the connection to the mobile is lost and all your exercise data is lost along with that (2) ……

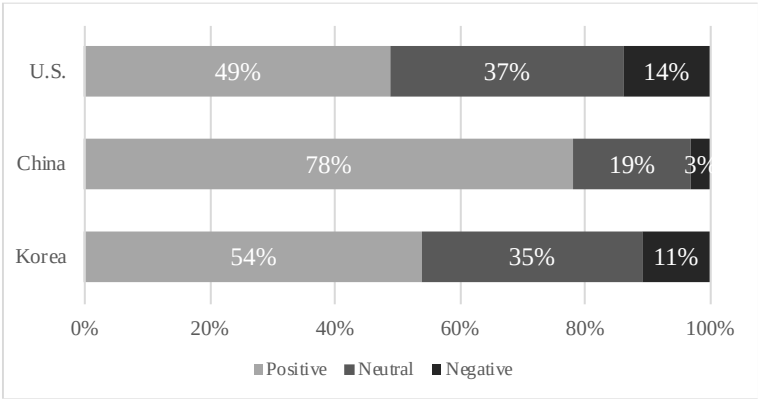

Figure 23. Sentiment analysis result of the aspect 'connection'

American care about whether the connection with mobile phone by Bluetooth makes the battery life much shorter.

4.4.15 Waterproof

Table 22. The result of aspect 'waterproof'

	Korea	China	U.S.
Rank	30	12	19
Normalized frequency	0.05	0.24	0.05
Positive	68%	77%	57%
Neutral	17%	19%	35%
Negative	15%	4%	8%
Associated words	good, light, nice	good, bath, generation, practical, swim, meter	shower, good, bath, great, test, best
Cluster	/	/	/
Positive reviews	(1) The waterproof is good, the response is quick, and the alarm sounds well (2) ……	(1) It is really waterproof and practical (2) ……	(1) Apart from this, it is very durable and I have used it in shower, swimming etc and its completely waterproof (2) ……
Neutral reviews	(1) I bought a waterproof smart band (2) ……	(1) I use it to see the time and count the steps (2) ……	(1) Tested for water resistant feature after putting under the tap (2) ……
Negative reviews	(1) The product went to the water and it was broken (2) ……	(1) The step detection is not accurate (2) ……	(1) It is water resistant but no swimming feature (2) ……

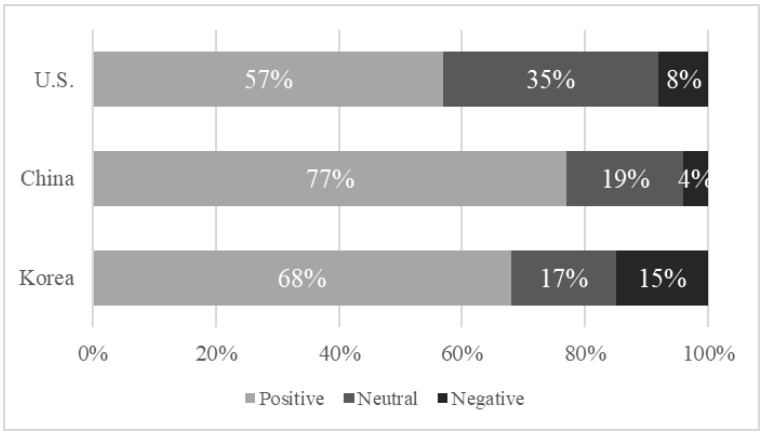

Figure 24. Sentiment analysis result of the aspect 'waterproof'

Chinese are impressed by the 50-meter water resistance from the advertisement. They are concerned if the smart band is waterproof when having bath and swimming. And the new generation of Mi band performs better in water resistance.

American like doing some tests to check if the smart band is waterproof. They often take a shower or have bath with smart band and find the smart band water resistant. They complain that there is no mode for swimming though the smart band is waterproof.

4.4.16 Display

Table 23. The result of aspect 'display'

	Korea	China	U.S.
Rank	34	16	10
Normalized frequency	0.04	0.16	0.12
Positive	46%	80%	59%
Neutral	43%	14%	24%
Negative	11%	6%	17%
Associated words	time, neat, update, delay, reflect, design, problem	good, screen, practical, function, heart rate, quality, easy, sleep, information, call, wrist	good, sunlight, battery, screen, bright, sun, product, notification, touch, best
Cluster	/	/	/
Positive reviews	(1) I think the display is much better than band 1 (2) ……	(1) The display is perfect (2) ……	(1) Look wise very good with digital display (2) ……
Neutral reviews	(1) When the night mode is turned off, the brightness of the display is high (2) ……	(1) The picture on the display looks blue (2) ……	(1) So if u driving a car and want to see the time Don't look at this and keep waiting for display to work (2) ……
Negative reviews	(1) Time display due to wrist movement may not be recognized well, and it takes time to display time after recognition (2) ……	(1) The hand-up display is slightly slower, but it is completely acceptable (2) ……	(1) Though I like this band but I hate its curved display (2) ……

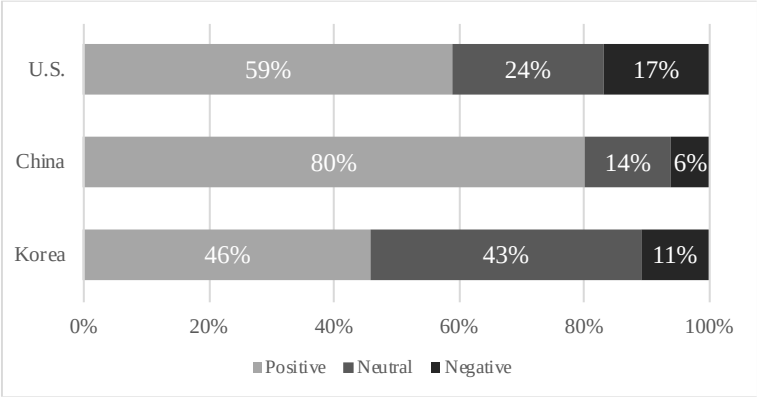

Figure 25. Sentiment analysis result of the aspect 'display'

According to associated word 'time', Korean need the function that the display turns on and shows time when hand is raised. However, some reviews conflict that the display takes time to be bright or even does not work when users lifting up hands.

4.4.17 Message

Table 24. The result of aspect 'message'

	Korea	China	U.S.
Rank	9	25	22
Normalized frequency	0.21	0.07	0.03
Positive	58%	83%	43%
Neutral	32%	16%	50%
Negative	9%	1%	7%
Associated words	good, phone, easy, convenient, click, notification, screen, battery	notification, good, phone, screen, practical, battery, easy	notification, call, battery, SNS, display, good
Cluster	/	/	/
Positive reviews	(1) Compatibility with the iPhone is also good, especially when fishing, it is easy to check the message (2) ……	(1) Message notification is practical, in many cases, you don't have to pull out your phone (2) ……	(1) Mi Band 3 also provides you weather report you can get all the call, message and more things notification (2) ……
Neutral reviews	(1) When You receive a message and receive a call, you will be notified of the vibration (2) ……	(1) The message on the mobile phone can also vibrate the notification in real time (2) ……	(1) I am using it for every exercises plus phone calls and messages notifications (2) ……
Negative reviews	(1) It is also convenient to see the old message after the time is past (2) ……	(1) However, receiving the message is just a notification, you can't see the content (2) ……	(1) Plus it can't show any emojis, so emoji messages just show as question marks, which can be annoying sometimes (2) ……

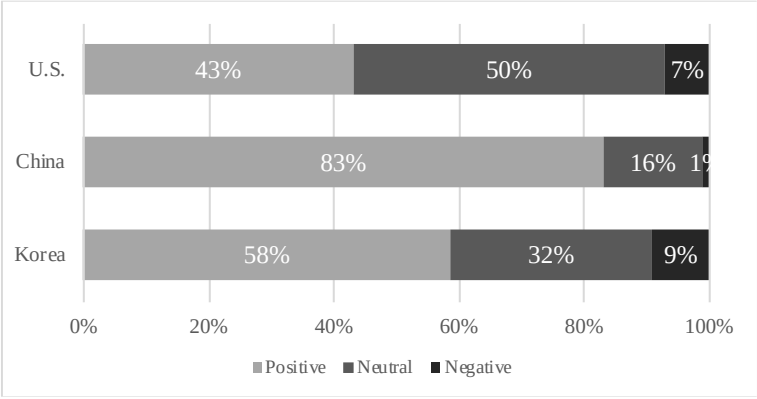

Figure 26. Sentiment analysis result of the aspect 'message'

Korean (9th) talk more about message than Chinese (25th) and American (22nd). Korean say that it is easy and convenient to check messages with the smart band. Chinese conveys that the function of message notification is good. The screen is big enough and it is easy to read the message on the screen.

4.4.18 Alarm

Table 25. The result of aspect 'alarm'

	Korea	China	U.S.
Rank	16	15	28
Normalized frequency	0.12	0.16	0.01
Positive	51%	78%	63%
Neutral	43%	18%	35%
Negative	6%	4%	1%
Associated words	good, vibration, convenient, battery, set, phone, nice, like, time, easy	good, set, easy, time, wake, worry	battery, set, silence, phone, good, like, notification, vibrate
Cluster	/	/	/
Positive reviews	(1) I am very nice to have a vibrate alarm clock and it seems to be good (2) ……	(1) You don't have to worry about being awakened by a huge alarm sound every day in your sleep, and it's awesome (2) ……	(1) I had set no alarms, battery lasted for nearly a month (2) ……
Neutral reviews	(1) You can set your alarm after touching mi band 3 at the top of the profile (2) ……	(1) I haven't tested the alarm clock yet, I hope the vibration can be strong enough to wake me up (2) ……	(1) I'm getting over 12-13 days of battery life with wake option on, vibrate alarms and idle alarms (2) ……
Negative reviews	(1) It is for alarm but the vibration is weak (2) ……	(1) The band can't set the alarm clock independently (2) ……	(1) Vibration is not enough in case of alarm (2) ……

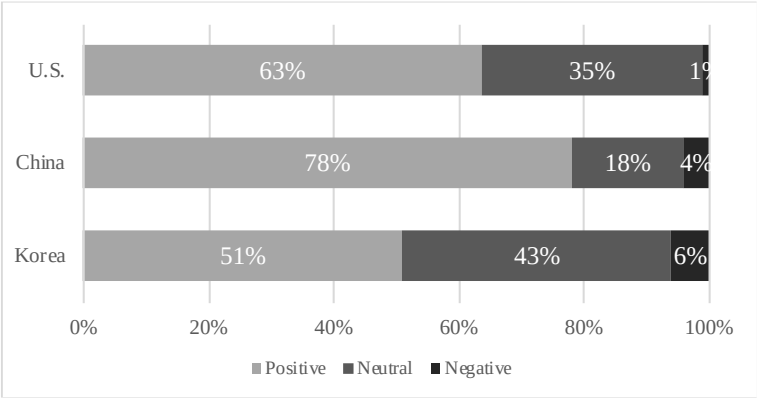

Figure 27. Sentiment analysis result of the aspect 'alarm'

Korean think the function of alarm is 'good', 'convenient', and 'easy' to use. Chinese also think the function of alarm is 'good' and 'easy' to use. They often use the vibration of the alarm clock to wake themselves up and they do not worry about the big alarm sound that can bother people.

American (28th) pay less attention on alarm than Korean (16th) and Chinese (15th). Nevertheless, they care about how long is the battery life whether the function of alarm, notification, and silencing the phone are set on or off. Some users from all the three countries complain that the vibration is a little weak and should be stronger.

4.4.19 Gift

Table 26. The result of aspect 'gift'

	Korea	China	U.S.
Rank	7	42	/
Normalized frequency	0.25	0.02	/
Positive	45%	78%	/
Neutral	52%	18%	/
Negative	3%	4%	/
Associated words	give, like, children, father, good, satisfy, love, happy, receive, husband, son	good, like, father, give, company, girlfriend, practical, family, daughter	/
Cluster	/	○	/
Positive reviews	(1) I bought one more for the gift because I think the value for money is good (2) ……	(1) Very good, good gift for my girlfriend, very light and smart, good (2) ……	/
Neutral reviews	(1) I buy it as a birthday gift (2) ……	(1) Very good, help the company to buy, fast (2) ……	/
Negative reviews	(1) However, it may be inappropriate as a senior gift because it is small (2) ……	(1) I want to buy a gift for a foreigner, but unfortunately only Chinese, simply wear them (2) ……	/

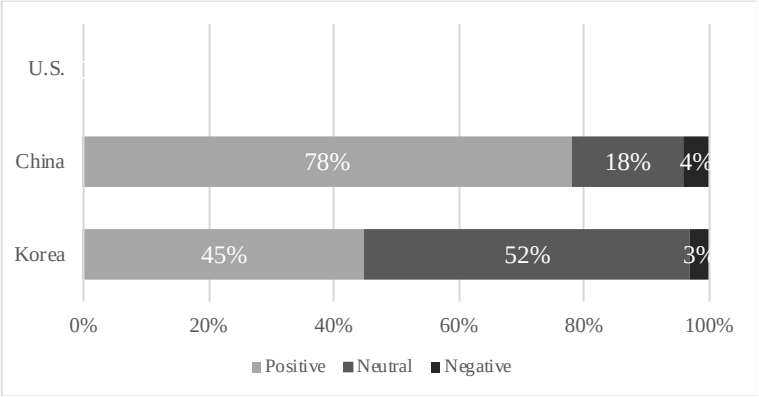

Figure 28. Sentiment analysis result of the aspect 'gift'

Only some Korean and Chinese tend to buy Mi Band 3 for friend or family as gift, especially Korean. Besides, companies in China buy the smart band as gifts, with the word 'company' associated with 'gift'. However, American seldom say that it is taken as a gift.

In the word frequency ranking of Korea, gift ranked 7th, and birthday ranked 49th. They prefer to buy Mi band 3 as a gift to 'children', 'father', 'husband' and 'son'. In the ranking of China, gift ranks 42nd. They prefer to give it to 'father', 'girlfriend', 'family', 'daughter', and 'company'. Chinese think Mi band is 'good' and 'practical' as a present.

In Chinese reviews, the cluster with topic 'gift' contains words related with appearance, such as 'black', 'packaging', and 'nice'. It means that when Chinese choose a gift, appearance is an important aspect to consider.

4.4.20 Strap

Table 27. The result of aspect 'strap'

	Korea	China	U.S.
Rank	19	22	16
Normalized frequency	0.11	0.10	0.06
Positive	51%	81%	59%
Neutral	43%	10%	21%
Negative	6%	9%	20%
Associated words	original, different, additional, metal, white	good, comfortable, black, original, orange	good, quality, material, charge, lock, screen, problem, remove, cheap, comfortable, durable, skin, soft
Cluster	/	/	/
Positive reviews	(1) The white strap looks cool (2) ……	(1) Now I use the black strap and I feel very handsome (2) ……	(1) Very Good Battery LifeNice Material of strap do not cause itching or sweating (2) ……
Neutral reviews	(1) Purchase an additional white strap and silver metal strap, and use it according to the color of your clothes (2) ……	(1) The strap is made of silicone material (2) ……	(1) I have screen protector and strap for this band (2) ……
Negative reviews	(1) The strap I purchased is not genuine (2) ……	(1) Recently, the strap was broken and I bought it online (2) ……	(1) Hard to remove the dial from strap while charging (2) ……

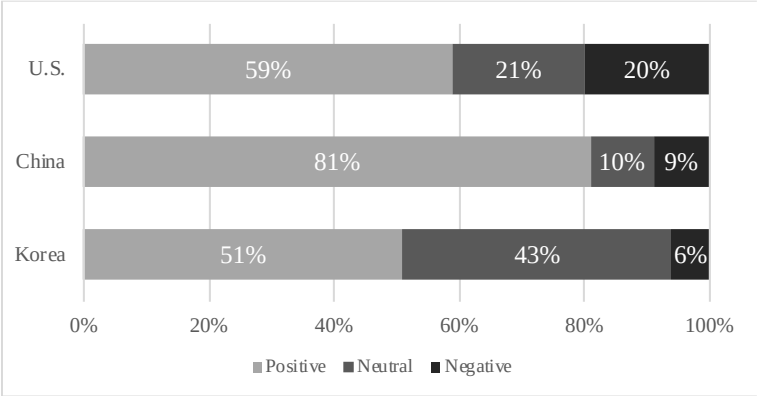

Figure 29. Sentiment analysis result of the aspect 'strap'

Korean tend to buy some additional straps besides the original one. The straps are often different from the original black silicone in color or material, for example, a metal strap or a white strap. There even some users say they will choose the strap with different colors on the basis of the color of the clothes they wear.

An overwhelming majority of Chinese (81%) take a positive attitude to the strap and they think it good and comfortable. They tend to choose the strap with the color black and orange. Besides the original strap with the smart band, consumers also can buy other non-original straps together from the store in China. And they are satisfied with the non-original strap in most cases.

Korean and Chinese are more concerned about the color of the strap, while American do not refer to it. Korean and Chinese have different preference for strap color. In addition to the original black strap, Korean prefer the white color, while Chinese prefer the orange one.

American put an emphasis on the material of the strap. They state that the strap is of good quality. Also, the strap is cheap, comfortable, durable, soft, and skin friendly. However, a lot of American (20%) have negative comments on the strap. There is a problem that it is inconvenient that the main part needs to be removed from the strap to charge, and the screen is easy to get scratches when removing the main part.

Chapter 5. Conclusion

5.1 Summary of Findings

Though there exist similar issues in product preferences of users from South Korea, China, and the United States, numerous cross-cultural differences about Mi band 3 are shown in many product aspects. Users from different cultural regions pay attention to different aspects of products and show different attitudes to the same product aspect.

Korean tend to take Mi band as a fashionable, cool, yet not useful wearable device. They often buy it as a nice gift. They are interested in the appearance of the strap and often buy straps of different colors and materials.

Korean do not enjoy outdoor activities as much as American. And the function of NFC is not prevalent in Korea. Thus, the smart band is not useful to Korean. These can explain why Korean do not care about the quality of the smart band and do not want to buy Mi band at a high price.

Korean think that the language of Korean on the display, application, and manual is the most important feature. The length of Korean texts is longer than Chinese to convey the same information. On the other hand, Korean prefer to check message notification on smart band

rather than call notification. Therefore, Korean need a larger size for screen.

Chinese are more concerned about different kinds of functions including fitness tracker (step counting, heart rate monitoring, and sleep monitoring), notification, and NFC. These different functions are all important and practical to Chinese.

American enjoy outdoor activities and tend to use smart band mostly as activity tracker. They care more about activity tracker function including heart rate monitoring and step counting than Korean and Chinese. They have a higher requirement about the accuracy of measured data and have more negative reviews on activity tracker function than Korean and Chinese. Besides, they need the mode for swimming.

Because American usually use the smart band for outdoor activities, they complain a lot that the screen is prone to scratches and is invisible under the outdoor sunlight. Also, they pay attention to the quality of screen and strap, expecting the material make the screen and strap durable. Besides, battery is the most significant aspect to American. They always try to test each function to find which function makes battery life short.

The outcome can suggest implications for making strategies in product internationalization and product localization for the global marketing of smart band.

The results of the case study prove that the consumer review-based text mining method proposed in the paper can generate cross-cultural difference in product preference effectively, which is helpful to cross-cultural design research. And this method is relatively easy and fast compared to other traditional methods.

5.2 Future Research

In the research, Korean and Chinese were translated into English by Google Translator API. The sentiment shifting and limited vocabulary coverage problems are unavoidable in Machine Translation, which hinders the performance of MT-based approaches. In the future research, we should try to improve the performance of machine translation or take other better approaches instead of machine translation. Moreover, the techniques of NLP (Natural language processing) develop very fast recently. More advanced techniques can be applied into the consumer review–based text mining methods, for example, Latent Aspect Rating Analysis (LARA) (Wang et al. 2010).

Secondly, there may be fake reviews in the review dataset, which may bias our study results. Spam detecting system is better to be built to remove fake reviews.

Then, the research can be expanded by trying reviews from more countries and adding more cases of different products. In this way, the understanding of the methodology can be enhanced.

Lastly, he results of analysis in different methods can be compared, consisting of the method proposed in this paper and other traditional cross-cultural design methods. And the advantages and disadvantages of different cross-cultural design methods should be summarized.

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