Society-Oriented Applications Development: Investigating Users' Values from Bangladeshi Agriculture Mobile Applications

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ABSTRACT

With the increasing use of smartphone, mobile applications (apps) are ubiquitous in all aspects of human life, therefore, it is required that human values should be reflected in apps. Instead of the importance of considering human values in apps, existing apps pay limited attention to consider human values that are reflected in frequently occurring value breaches incidents with apps. This results in users' dissatisfaction and several negative socio-economic consequences. To ensure sustainable use of apps, this research aims to provide a direction to the developers on which users' values they need to focus while developing apps. Towards achieving this goal, we conducted a case study with the existing Bangladeshi agriculture mobile apps to investigate what values users expect from these apps. For this purpose, we manually classified 1522 reviews of 29 existing apps based on a widely used human values theory to explore users' desired values from these apps as well as to identify the proportion of the presence of these values in the selected apps. Our results show that users expect 21 individual values from these apps where 11 values are already reflected in the apps and 10 values are not. Therefore, we encourage the developers of Bangladeshi agriculture apps to consider these values while developing apps. We believe, this research will be a reference point to conduct similar research with the apps built for other societies to explore the expected values of the users of those apps that will help to develop society-oriented apps.

KEYWORDS

Mobile Apps, Human Values, Review Analysis, Society-Oriented Applications Development

1 INTRODUCTION

Nowadays, software has influences in all aspects of daily life, yet human values may not be taken into account in the development of software. Even, Software Engineering (SE) research and practices also pay limited attention to the majority of human values [33]. The consequences of ignoring values in software can be seen only when breaches of values occur. For example, The Volkswagen CEO had to resign for the recent issue of installing a deceptively designed software to fool fuel emission tests in Volkswagen emissions fiasco. It was a contradiction of the company's corporate value of "responsible thinking" and resulted in 30% drop in the company's stock price and 25% drop in sales within a year [28].

Value breaches in mobile applications (apps) can even be more dreadful as the use of apps is increasing day by day in daily life. Nowadays, people use smartphone as an entry point in the virtual world [7]. To date, more than 2 million apps are available both in the Google Play Store and the Apple App Store [3]. As smartphones become more personal to its users, a breach of human values, such as safety or privacy, in these mobile apps can lead to serious consequences. For example, Instagram has been accused as partly responsible to a suicide of a British teenager [6]. This incident enforced Instagram to remove self-harm or suicide images in their platform [27]. Another example, Facebook has been blamed for letting over 50 million of their users' personal information to be collected and harvested without consent by Cambridge Analytica [5]. As consequences, Facebook's CEO was scrutinized in front of the U.S. Congress [24], Facebook lost over 119 billions U.S. dollars on market values [30] and fined more than 5 billions U.S. dollar by the Federal Trade Commission (FTC) and the Information Commissioner's Office (ICO) [2].

The above mentioned incidents show the urgency of the consideration of human values in mobile apps development . With this aim, we conducted a case study with the Bangladeshi agriculture mobile apps to explore the users' desired values from those apps as well as to identify the reflected and missing desired values of the selected apps for the purpose of sustainable use of mobile apps. The motivation of doing this case study came from a project named PROTIC (Participatory Research and Ownership with Technology, Information and Change) of Oxfam in Bangladesh in collaboration with Monash University [35]. This project works for the poor, marginalized and vulnerable people in Bangladesh to accelerate their economic development and empowerment through smart phones [43].

In this study, we analyzed users' reviews because feedback in the form of reviews is the most helpful for the developers as it provides information on feature requests, experiences with the new features, suggestions for improvements and details about user requirements which can guide the developers to develop apps that meet users' preferences [15]. We did not take star ratings into account because it hardly reflect users' values which we are looking for. Moreover, star ratings are given for the whole app, not for a

particular feature, therefore, it is difficult to understand how users feel about a particular feature [15].

In this research, 1522 reviews from 29 Bangladeshi agriculture apps were collected from a web crawler named 'WebHarvy' [16]. The reviews were manually classified based on a human values theory which is explained in detail in section 2. After the classification, each review was coded and analyzed manually to relate the reviews with values by not only matching the words with values but also thinking the semantics of the reviews. The classification and analysis based on values were challenging because of the abstract and ill-defined nature of values [33]. This issue is mitigated by the expertise of the researchers on human values and human values in SE .

As an outcome, the study found 21 desired individual values of users from the Bangladeshi agriculture apps. Among them, 11 individual values are already present and 10 are missing in the apps. The contribution of this study is to provide guidelines to the developers on which users' values should be taken care of while developing apps.

2 BACKGROUND

Human values are *"important as guiding principles in life"* [37]. Values are something that reflect people's personal and social preferences [4, 37]. Social scientists have conducted research to conceptualize human values since 1950 [40]. For example, in 1973, Rokeach categorized values into goals in life and mode of conduct which he named as terminal values and instrumental values respectively [36, 37]. He found 18 terminal values and 18 instrumental values [37]. Similarly, Hofstede (1979, 1980, 1982, 1983) conducted several studies to work with values among employees of different subsidiaries of the same multinational business organization [17–20]. Parashar et al. (2004) introduced the micro and macro concept of values which are individual behaviour and cultural practices respectively [32]. Three by two framework with six basic value categories and 3 specific values under each category have been found by Gouveia et al. (2013) [14].

Among those, this paper uses Schwartz theory, which is the most cited and widely applied not only in the social sciences but also in other disciplines [10, 42]. This theory has been also used in Computer Science [1, 29] and SE research [10].

In 1992, Schwartz introduced his theory of basic human values which recognized 10 main human value categories measured using 58 individual value items [38, 39]. This theory has been assessed with the data from 82 countries around the world irrespective of diverse geographic, cultural, linguistic, religious, age and gender [41]. Furthermore, it clarifies not only the components of human values but also how people's value priorities might differ [36]. The 10 main value categories in this model are categorized based on their motivational goals (see Table 1) and measured from 58 individual value items [41]. Schwartz created a circular structure with these 10 main value categories along with the 58 individual value items as shown in Figure 1. In Schwartz's theory, values located close to each other are congruent and those further apart are opposite in nature [38, 41].

The contribution from SE research to operationalize human values in SE is limited [33]. To mention a few studies, Values-First SE, attempted to give more visibility to the interplay between SE choices and underlying human values [9]. In another study, Ferrario et al. introduced *Value Q-sort* method that contributes to measuring developers' values in SE [46]. Moreover, software engineering practice has paid little attention to human values except for well-known quality attributes such as security, privacy or accessibility [45]. Similarly, there are very few research on human values in mobile apps. For example, Value-Sensitive Design (VSD) framework has

Table 1: Value categories and descriptions [41]

Value Category	Description (motivational goals)
Self-direction	Independent thought and action–choosing, creating, exploring
Stimulation	Excitement, novelty, and challenge in life
Hedonism	Pleasure or sensuous gratification for oneself
Achievement	Personal success through demonstrating competence according to social standards
Power	Social status and prestige, control or dominance over people and resources
Security	Safety, harmony, and stability of society, of relationships, and of self
Conformity	Restraint of actions, inclinations, and impulses likely to upset or harm others and violate social expectations or norms
Tradition	Respect, commitment, and acceptance of the customs and ideas that one's culture or religion provides
Benevolence	Preserving and enhancing the welfare of those with whom one is in frequent personal contact
Universalism	Understanding, appreciation, tolerance, and protection for the welfare of all people and for nature
Holistic View	Human values considered holistically without focusing on predetermined values

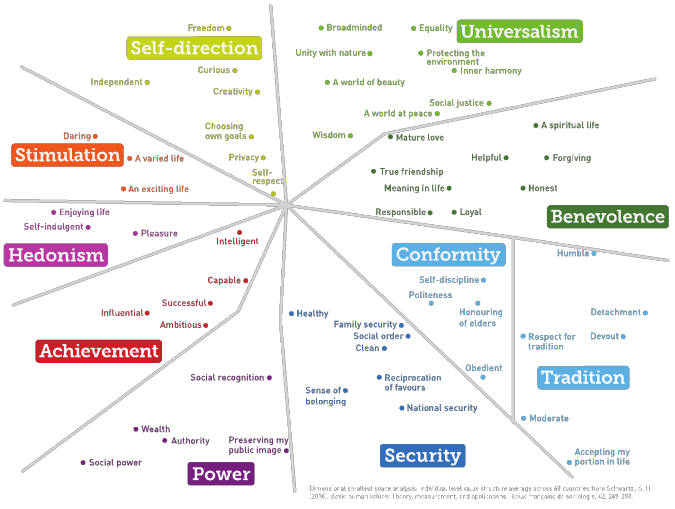

Figure 1: Theoretical model of basic human values by Schwartz [34]

been adopted to analyze reviews of mobile apps regarding Diabetes self-management [7] and adolescent mobile safety [13].

3 METHODOLOGY

This research investigated the user reviews of the Bangladeshi agriculture mobile apps with the aim to provide directions to the developers about what values should be considered while developing Bangladeshi agriculture mobile apps. We expect that the similar research can be conducted to explore the values of the users of the apps developed for other societies as well which will help to develop society-oriented apps by considering those values.

We conducted this study with android apps as Android dominates the market share of the smartphone which is almost 83% [13, 23]. This research intends to address the three following research questions:

(RQ1) From the Bangladeshi agriculture mobile apps, what values are desired by the users of those apps?

(RQ2) Which of those desired values are missing in the existing Bangladeshi agriculture apps?

(RQ3) To what extent are the desired values present in the existing Bangladeshi agriculture apps?

A manual analysis was performed instead of taking help from automated tools because automated tools cannot detect sarcasm [31] whereas sarcasm is very common in user reviews. For example, we got a review, "The app is not working on my new phone. Wow great!!". Though the words 'Wow' and 'Great' are related to praise and can be related to the Schwartz value *Pleasure*, this review is nothing but a sarcasm where *Pleasure* is actually missing. Moreover, we got many reviews with spelling and grammatical mistakes for which we cannot expect accurate results from automated tools. For example, "This is geret af" actually means "This is a great app". Similarly, many reviews with different local Bengali accents were found. As the annotator is Bangladeshi and aware of the different local accents, the chance of misinterpreting the reviews is very low.

Among the two available methods for qualitative data analysis (coding and qualitative content analysis [7]), we adopted coding as it is the best way to analyze app reviews [7]. Details are explained in subsection 3.2. At first each review was read and interpreted. Then, relevant information was tried to be found in each review to categorize it (see phase 1 in subsection 3.2) and relevant reviews were tried to be related with values according to the process mentioned in phase 2 in subsection 3.2. Figure 2 shows the overall app analysis architecture for this research. The details are described in the following subsections.

3.1 Data Collection

Data collection was conducted with the following two phases.

Phase 1: Data Extraction

We started our study by searching for relevant mobile apps in Google Play. While searching, the item *'apps'* was selected and the keywords *'agriculture'*, *'Bangladesh'* were given with conjunction *'and'*. The inclusion and exclusion criteria for selecting the applications are shown in Table 2. We collected all the relevant apps manually through this searching scheme. Another iteration of searching was done by giving the same keywords but without the conjunction. Finally, a list of 35 Bangladeshi agriculture mobile apps with their names, descriptions, play store ratings, number of downloads, number of raters and Google play link was created in an online spreadsheet. The data regarding descriptions, play store ratings, number of downloads and number of raters were saved for future use. The file was last updated in September 2018.

Table 2: Inclusion and Exclusion Criteria for Choosing Mobile Applications from Google Play

Inclusion criteria	Apps of farming
	Apps of livestock
	Apps of farming equipments
	Apps of agriculture online shopping
	Apps of agriculture news
Exclusion criteria	Language other than English and Bengali
	Farming game
	Agriculture examination questions guide for students

For each app, all the user reviews were crawled through a web crawler named 'WebHarvy' [16] on 6 September, 2019. A total of 3991 user reviews along with user ratings on a 1-5 scale and date were crawled and kept in an online spreadsheet. We did not crawl the identity of the reviewers due to privacy reason and this information is not necessary at all for our research. From the 35 Bangladeshi agriculture apps, 6 apps have no reviews. Therefore, we crawled the data from 29 relevant apps. The first 654 reviews were manually checked to ensure if 'WebHarvy' crawled the reviews and corresponding data precisely.

Phase 2: Data Pre-processing

Before proceeding to the data analysis, the database of 3991 reviews and corresponding information was checked manually if there are any irrelevant and meaningless reviews. We found 119 irrelevant and meaningless reviews and removed those reviews manually. As we are looking for some constructive reviews other than compliments only which can direct us towards new values, we removed the common and obvious reviews that mention one word only such

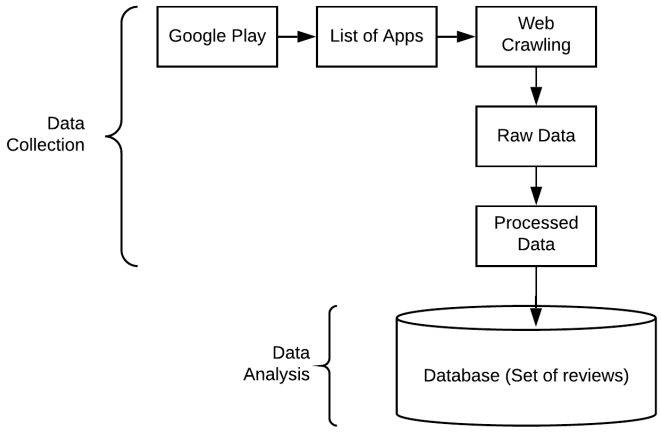

Figure 2: Overall design of app analysis

as ‘good’, ‘excellent’, ‘amazing’, ‘nice’, ‘wow’, ‘great’, ‘awesome’, ‘helpful’ and ‘important’. Let’s imagine these words are ‘X’. We also removed the reviews which mention “It is X”, “The app is X”, “X app”, “Really X”, “Very X” as well as a combination of the given words such as “Good, awesome, helpful”. The reviews related to the words ‘Love’ and ‘Like’ such as “Loving it so much” or “I like it” were also removed. After removing all of these kind of reviews, we created a new database of 1522 reviews with the corresponding ratings and date with which we moved forward to the next step. The ratings and date are saved for future use.

3.2 Data Analysis

Data analysis was conducted with the following two phases.

Phase 1: Preparation of Value Analysis

The reviews were manually divided into ‘Praise’, ‘Criticism’, ‘Problem faced’, ‘Suggestions’, ‘Expectations’ and ‘Queries’ for the convenience of relating each review with values. For example, the review “It’s a hacking app. It collects personal data” can be placed under ‘criticism’ (“Hacking app”) and ‘problem faced’ (“Collects personal information”). It can also be placed under ‘expectations’ (“App which ensures privacy and security” and “the developers should be loyal and honest”) though it does not directly mention *security*, *privacy*, *loyalty* and *honesty*. As we worked with an abstract topic like values, we tried to think openly and understand the semantics of the reviews. On the other hand, this review has no ‘praise’, ‘suggestions’ and ‘queries’. Another example is “Really it is a great app for all farmers or stakeholders who are related to agricultural practice, especially very helpful for students of plant pathology or agriculture! But more pesticides of different companies may be included in it!”. This review reflects ‘praise’ as it is great and helpful, gives ‘suggestions’ to add more information on pesticides of different companies and has ‘expectations’ to get this app being more informative. Similarly the review “Where can I get hydroponic solution for plants?” can be placed under ‘queries’. All of the 1522 reviews were gone through this process and prepared for value analysis.

Phase 2: Value Analysis

Each review was also manually classified with “Present individual value items”, “Present main value categories”, “Desired individual value items” and “Desired main value categories”. The term ‘Present’ and ‘Desired’ have been used when a value is already reflected in the apps and when users expect a value from the apps respectively. The individual value items and the main value categories are classified according to Schwartz circular value structure. The annotator has reasonable knowledge on Schwartz value structure and conducted similar research on human values in Software Engineering.

According to Figure 3, we relate values with the categories mentioned in phase 1.

As an example of the analysis of reviews and relation with values, the above-mentioned review in phase 1, “It’s a hacking app. It collects personal data” does not have any present individual and main values. Rather, it can be related to a few desired individual value items such as *Security*, *Privacy*, *Loyal* and *Honest*. According to Schwartz value structure, these individual values are categorized under the main values *Security*, *Self-direction* and *Benevolence* (*Loyal* and *Honest* both are under *Benevolence*) respectively. Similarly the review “Really it is a great app for all farmers or stakeholders who are related to agricultural practice, especially very helpful for students of plant pathology or agriculture! But more pesticides of different companies may be included in it!” has two present individual value items, *Pleasure* and *Helpful* as according to the reviewer, it is great and helpful. These are under the main value categories of *Hedonism* and *Benevolence* respectively. It has also two desired individual value items, *Curious* and *Wisdom* as this review is expecting more information on a particular topic. These values are under the main value categories of *Self-direction* and *Universalism* respectively. Likewise, the review “Where can I get hydroponic solution for plants?” can be related to a desired individual value item, *Curious* and the desired main value category *Self-direction*. For better understanding, more examples corresponding to each value are given in Table 3. This table contains the values that we got as outcome of this research, details are described in section 4.

While doing the analysis, it is found that almost all the reviews can be related to the values, *Pleasure* and *Helpful*, either in "present individual value items" or "desired individual value items". For example, a positive review means the app provides *Pleasure* and it is *Helpful* to the reviewer whereas a negative review means the app lacks *Pleasure* and *Helpfulness*. To solve this issue, only the reviews that contain words like ‘good’, ‘best’, ‘nice’, ‘love’, ‘like’, ‘happy’ were related to *Pleasure* and the reviews that contain the word ‘helpful’ are related to the value *Helpful*. As some of the reviews that contain only these words were removed as explained in the phase 2 of subsection 3.1, the problem regarding *Pleasure* and *Helpful* was already solved to a certain extent. Still, there are many reviews that contain these words such as “I like the weather and climate information of this app” and “From this app, I can be aware of the market price. This is really helpful for me”. Other than these kinds of reviews, no review was related to the values *Pleasure* and *Helpful*. There was another challenge to relate the reviews

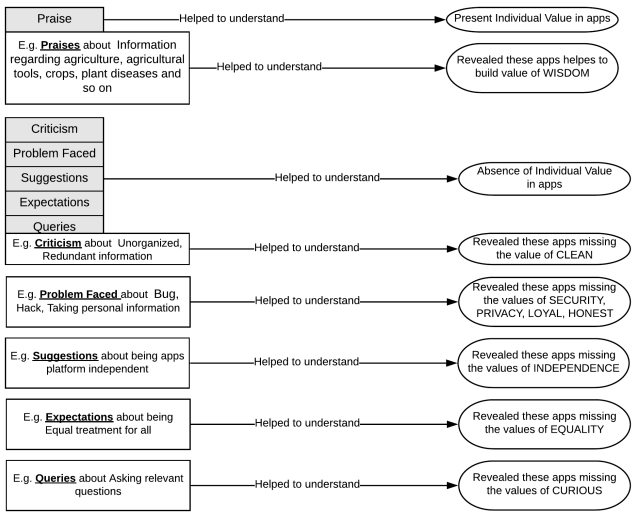

Figure 3: Relations between Values and the preparation phase

Table 3: Individual value items with corresponding status and example of reviews

Status of Values (Present/Missing)	Values	Examples of Reviews
Present desired individual value items	Pleasure	For the first time I got an app what exactly I wanted. Really happy to get this.
	Capable	This app can find the location.
	Respect for tradition	Nice to see an app where all the features including date are written in Bengali. Feeling like I am in a local environment.
	Ambitious	Bangladesh is moving forward, becoming up-to-date. This app is the reflection of it.
	Wisdom	Now I know all the information related to agriculture.
	Wealth	It saves my money as I came to know about pest control by parching with minimum cost.
	Curious	Through this app, I came to know which seeds are good.
	Helpful	It is helpful for the farmers as it makes their job easy.
	Responsible	After adding my crops information in the app, it notifies me fortnightly what I should do to take care of the crops.
	Creativity	It contains Leaf Color Chart (LCC), now I can match the color of the leaves of my plants.
	Intelligent	An intelligent, innovative and game changing platform for farming community.
Present individual value items that are not desired	Unity with nature	The app gives weather prediction and climate information.
	Protecting the environment	Thanks for giving green economy.
	Healthy	It provides information on crops disease control.
	Social recognition	The app is laudable. For this app, farmers got their identities.
	True friendship	This app is the true friend of farmers.
	Influential	A potential and promising app.
Missing desired individual value items	Freedom	Why Internet connection is needed?
	Independent	It is not working on Android9. As it is an agriculture app, it should be platform independent.
	Clean	It is not well-organized, lots of redundant information.
	Successful	Regular monitoring and updated information are needed to make this app successful.
	Equality	This is not for all, only for the smart farmers.
	Security	It's a hacking app.
	Privacy	It collects personal data.
	Loyal	Rather giving useful information, it is actually marketing its own product.
	Honest	Only gives information of medicines of ACI company (owner of the app).
	Self-discipline	I didn't find any index of the app.

that mention "Security of the app" to the individual value items. According to Schwartz value structure, there are two individual value items, *National Security* and *Family Security* under the main value, *Security* but security of the app is neither *National Security* nor *Family Security*. For this case, The individual value item was also kept *Security* only to avoid the confusion.

For the whole dataset, the analysis was conducted thrice to ensure the intra-rater reliability [8].

4 RESULTS

This section presents the results of the review analysis of Bangladeshi agriculture mobile apps. As a reminder, we are exploring the answers of the following three research questions:

(RQ1) From the Bangladeshi agriculture mobile apps, what values are desired by the users of those apps?

(RQ2) Which of those desired values are missing in the existing Bangladeshi agriculture apps?

(RQ3) To what extent are the desired values present in the existing Bangladeshi agriculture apps?

4.1 Answering RQ1: Desired Values

Figure 4 shows the desired individual value items of the users of Bangladeshi agriculture mobile apps. Among the 58 individual values from Schwartz circular value structure, users expect 21 values to be reflected in the existing Bangladeshi agriculture apps. According to the figure, the value *Curious* is the most desired value of the users from these apps that are reflected in 26.6% reviews. The second most desired value is *Wisdom* that constitutes 22.0%. The least desired values (0.3%) are *Clean*, *Self-discipline* and *Responsible*.

Similarly, Figure 5 shows the desired main value categories of the users of Bangladeshi agriculture mobile apps. According to Schwartz, the 21 desired individual value items can be categorized under the 9 main value categories. As there are 10 main value categories in Schwartz value structure, users expect all of the value categories except for *Stimulation*. It is obvious that *Self-direction* is the most desired main value category (36.5%) as it contains the most desired individual value item *Curious*. Similarly, *Universalism* is the second most desired main value category (24.2%) as *Wisdom* is constituted in this category.

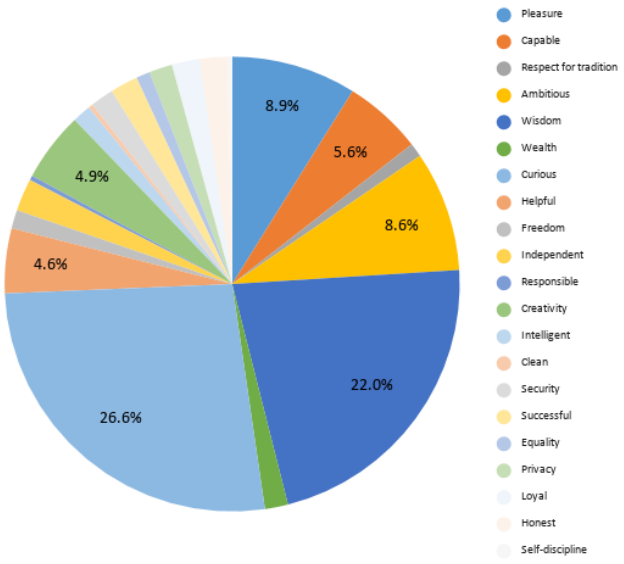

Figure 4: Desired individual Value items

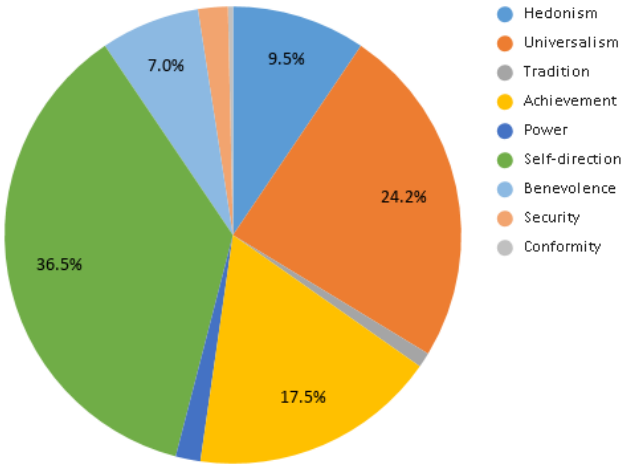

Figure 5: Desired Main Value Categories

4.2 Answering RQ2: Missing Desired Values

Among the 21 desired individual value items got from the result of RQ1, 10 individual values are completely missing in the reviews (1522 reviews) of all the 29 apps as shown in Figure 6. Among them, 15.9% users expect the value *Independent* which is the maximum. The noticeable finding is that for all the 8 individual values other than *Clean* and *Self-discipline*, there are not much fluctuations in the percentages of expectations from the reviews.

There are only two desired main value categories that are missing in the existing reviews of all of the 29 apps. These two are *Security* (85.7%) and *Conformity* (14.3%) for the individual value items *Security* and *Self-discipline*. The main value categories that contain the other missing 8 individual values are already reflected due to other present individual value items. For example, *Freedom*, *Independent* and *Privacy* are under the main value category, *Self-direction* which is already reflected because of other individual value items, *Curious* and *Creativity*.

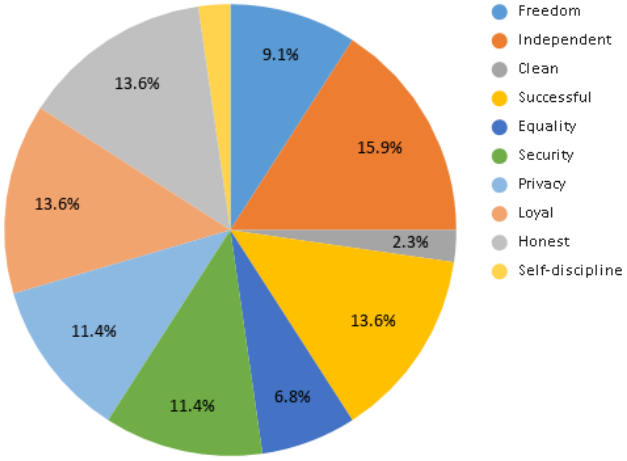

Figure 6: Desired individual Value items that are missing in the existing apps

4.3 Answering RQ3: Reflecting Desired Values

There are 11 desired individual value items that are present in the existing Bangladeshi agriculture apps among the 21 desired individual values got from the result of RQ1. The proportion of the presence of each of these 11 values is shown in Figure 7. According to the figure, the desired value *Wisdom* has the maximum presence which is 53.1% (1051 out of 1522 reviews). That means, 1051 reviewers think that the existing apps are informative, enhancing their knowledge and thus meeting their value, *Wisdom*. *Curious* and *Pleasure* are also two values among these 11 which occurred the most after *Wisdom*, 17.9% and 13.6% respectively. The value *Intelligent* has the minimum occurrence (0.1%) among all.

Figure 8 shows the desired main value categories that are present in the existing apps. As *Wisdom* is under the main value category *Universalism*, the occurrence of *Universalism* is the maximum

(54.5%). Similarly, for the individual value items *Curious* and *Pleasure*, the main value categories, *Self-direction* and *Hedonism* have the second and third highest occurrences, 18.2% and 13.6% respectively.

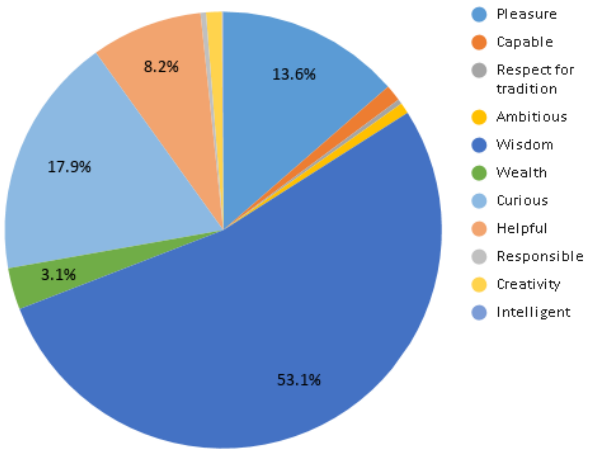

Figure 7: Desired individual Value items that are being present in the existing apps

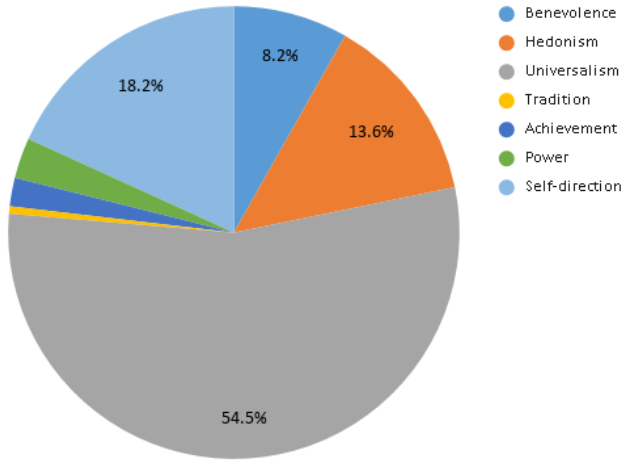

Figure 8: Desired main value categories that are being present in the existing apps

5 DISCUSSION

From section 4, it is clear that users expect 21 individual value items to be reflected in the Bangladeshi agriculture apps (subsection 4.1). As 11 of them are already present in the existing apps (subsection 4.3), the missing 10 values (subsection 4.2) should be considered by the developers while developing agriculture apps for Bangladesh. For this purpose, Table 1 might be helpful for the developers to understand the values and their corresponding meanings. Furthermore, we have a couple of interesting observations from this study which are described below.

Observation 1:

There are 6 individual value items as shown in Figure 9 that are present in the existing apps but not desired by the reviewers. Among them, *Unity with nature* and *Healthy* have a substantial amount of occurrences, 48.8% (296 out of 1522 reviews) and 42.5% (258 out of 1522 reviews) respectively. As reviewers praised the apps for providing these values, an argument can be made that why they do not expect these values? In our opinion, this is because, users might already get a few features from the apps which gave them the feeling of *Unity with nature*, *Healthy* and other 4 values, therefore they did not mention these values as expectations. For this reason, developers should be careful about these values as well for developing future apps.

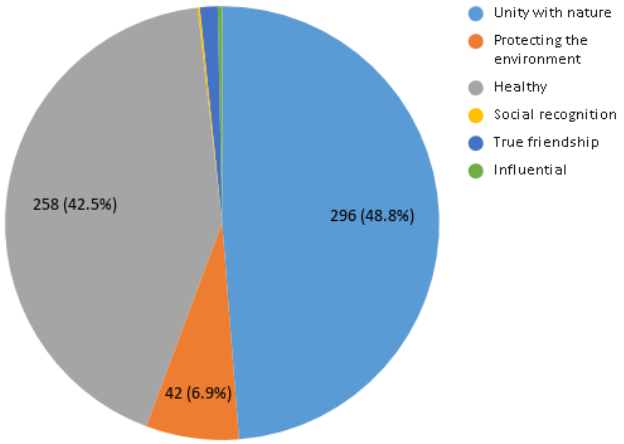

Figure 9: Present individual value items that are not desired by the reviewers

Observation 2:

There are 11 desired individual value items that are present in the existing apps as shown in Figure 7. One question can be raised that if these values are already present, why do the users expect these values again? In our opinion, these 11 values are related to several features of the apps. For a single value, if the users get one of the corresponding features, it can be reflected through their reviews in the present value category but if the other corresponding features of that value are missing, it can also be reflected from their reviews as desired value.

Observation 3:

After completing the analysis, we observe an interesting trend regarding the no. of occurrences of more than 1 values per review and 1 value per review irrespective of the status of the values (present/ desired). In both cases, the no. of occurrences of more than 1 values per review is greater than the no. of occurrences of 1 value per review as shown in Table 4. This trend reflects that the reviews are constructive enough to be analyzed and to have ideas regarding values.

Table 4: Occurrences of present and desired more than 1 values, 1 value and no value per review

Status of Values (Present/Desired)	No. of Values Per Review	No. of Occurrences
Present Values	More than 1 values per review	804
	1 value per review	591
Desired Values	More than 1 values per review	100
	1 value per review	58

6 THREATS TO VALIDITY

The limitations of this research towards validity are described in this section.

6.1 Internal Validity

There is a threat working with an abstract topic such as values. Because of the ill-defined nature of values [33], researchers can interpret values differently. Therefore, it can be argued that there is a chance that the review classification scheme are influenced based on the understanding of values of the annotator. Nevertheless, we believe that the chance is very low as the annotator has expertise on human values and conducted similar research several times.

6.2 External Validity

One of the limitations of this study is that the outcome cannot be applied to all kinds of apps. As we have the desired values by analyzing the reviews of the existing Bangladeshi agriculture mobile apps, these values are applicable to the development of Bangladeshi agriculture apps only. The values are expected to be different for the apps other than Bangladeshi agriculture apps but we believe the reviews of any app can also be analyzed the way we did in this research (subsection 3.2) to get the values for that app.

6.3 Construct Validity

(1) Threats may arise from the number of annotators for this research. Among 1522 reviews we classified, there are 1194 reviews written in Bengali and 328 reviews in English. As Google translator is not always reliable and does not know the local Bangladeshi accent, the annotator for this research must be a Bangladeshi who knows Bengali and different local accents as well as have expertise in analysing social aspects of Software Engineering. For this reason, All the reviews are analyzed by one Bangladeshi researcher who has expertise in qualitative data analysis specially on human values based Software Engineering and has efficiency in Bengali language (mother tongue). To avoid the possible threats of analyzing the whole dataset by a single researcher and to meet intra-rater reliability [8], all the reviews have been analyzed thrice by the same researcher. While doing second iteration, the outcome of 209 out of 1522 reviews needed to be changed which is 13.7% and during 3rd iteration the outcome of only 11 (less than 1%) reviews needed to be changed which is minimum.

(2) Categorizing reviews in terms of values can be argued as there are no well-defined classification techniques for doing so. Furthermore, as the classification was done by following a specific value structure (Schwartz circular value structure) shown in Figure 1, there is a chance that the annotator might forcefully relate the reviews with any of the Schwartz values even if the reviews can be related to some other values which are not mentioned in Schwartz value structure.

7 RELATED WORK

This section is divided among the related works of three different areas as follows.

7.1 Schwartz Values Theory in SE and Other Domains

Other than social science research, Schwartz theory of basic human values is extensively used in software engineering studies. For example, Mougouei et al. explained the importance of considering human values in software. Schwatz values theory has been used in this research to define what human values are and how to integrate those values into software which they called “operationalizing human values in software” [28]. Schwartz values theory has also been used in another study to understand the prevalence of human values in publications of four top-tier SE conferences and journals from 2015-2018 [33]. Another research used this values theory to investigate the consideration of human values other than functionality, cost, safety, availability and security in SE [45]. To incorporate human values in SE decision-making process, Ferrario et al. also used Schwartz values theory [9]. This theory has also been used in developing a value measurement tool named “Values Q-Sort” for exploring the values of the developers [46].

Schwartz values theory is also used in different areas of computer science. For example, this theory has been used in predicting users’ movie genre preferences from their psycholinguistic characteristics by analyzing the pattern of their uses of social media [29]. Another research use this theory to identify ethical decision-making theories for companion robots [44].

7.2 Mining App Reviews

There are a number of studies for mining feedback of the users of mobile apps. For example, to explore the insights regarding parental control, manual thematic analysis has been conducted with the user reviews of adolescent mobile safety apps [13]. Similarly, over 1 million user reviews of AppStore have been analyzed to determine the pattern of the reviews, when and how users provide reviews and the relation of the reviews with the number of downloads and the ratings [31]. Iacob et al. used an automated tool to analyze user reviews to extract mobile apps feature requests [22]. Similarly, in another research, requirements have been explored by analyzing user reviews through automatic topic extraction [12]. Another study investigated users’ satisfaction by analyzing reviews [25]. Fu et al. proposed a system named "WisCom" that can analyze over 10 million user ratings and reviews of mobile apps to identify inconsistent reviews, to investigate the reason of liking or disliking an app and to provide insights on the overall app market [11].

7.3 Value and Sentiment Analysis

There are a couple of studies of app store data mining that analyze user reviews to explore users' values and sentiments. For example, Dadgar and Joshi schematically coded user reviews of diabetes apps by applying Value-Sensitive Design (VSD) approach to identify users' (patients with diabetes) values and proposed design techniques that consider users' values [7]. Similarly, sentiment analysis on user reviews of apps has been conducted in several studies to inspire designing review analytics tools [26], to explore the influence on product-purchasing decisions [21], to identify users' sentiments about particular features that lead to group fine-grained features into high-level features [15].

8 CONCLUSIONS AND FUTURE WORK

The use of mobile apps in everyday life is dramatically increasing, therefore it gives rise to the need to account for human values in mobile apps. This research intends to work on human values in mobile apps with the vision to make sustainable use of the apps. For this purpose, we conducted a case study with all of the Bangladeshi agriculture mobile apps and analyzed the reviews of those apps based on a widely used human values theory. Primarily, we collected 35 apps and 3991 reviews from these apps and then we moved forward with 29 apps and 1522 reviews based on a set of criteria. The reviews were divided into a few categories such as 'praise', 'criticism', 'problem faced', 'suggestions', 'expectations' and 'queries' to relate the reviews with values. Finally, as outcome of this research, we found that users expect 21 individual value items and 9 main value categories from Bangladeshi agriculture apps. Among them, 11 individual value items and 7 main value categories are already present in the existing apps whereas 10 individual value items and 2 main value categories are completely missing. This research encourages the developers on considering users' values while developing apps. It also particularly mentions which values should be taken care of while developing Bangladeshi agriculture apps. The same process can be applied to the apps built for other societies to explore the expected values of users.

In the future, we hope to increase the sample size by collecting more reviews from apps of other platforms and app stores. Furthermore, we expect to conduct the same study on the agriculture mobile apps of other developing countries to observe the cultural differences regarding values. In addition to that, it will also give an opportunity to provide comparisons between different apps and their corresponding values.

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