A Study on Visualization of User Reviews

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Abstract—**User reviews is a research method with increasing application in the application ('app') industry in recent years because it allows development teams to better understand users' needs and ideas through user review analysis. However, deciding how to interpret the massive daily incoming user review data and how to sort them into useful information is a challenge that development teams must address. This study combined the architecture of an app with the excellent information communication capability of information visualisation and compiled a priority list of version releases based on function areas mentioned in user reviews, allowing development teams to create strategies for updates and emergency resolution, as well as designing apps to meet users' expectations, and to therefore achieve better user experience. Subsequent to a heuristic evaluation, the three most important suggestions were made: 1. Improve the enrichment of the visualisation chart; 2. Increase follow-up evaluation; and 3. Understand the reasons and context that lead users to like apps. Experts that participated in the evaluation believed that the visualisation chart generated in this study allows developers to better understand users' real needs, to be able to focus on the more serious issues related to system structure, and assign them with higher priority for repair such that product evaluation will be enhanced resulting in more download volume and profits. The experts also believed that if visualisation charts can be enhanced with more flexibility and user reviews will be followed up with ongoing evaluation, the approach suggested in the present study will surely prove to be very useful in the app market application.**

Keywords-user review analysis; structured system; information visualization; negative feedback.

I. INTRODUCTION

As the mobile app market continues gaining momentum, more developers are now paying attention to user reviews. Consumers usually consult others for opinions to better understand their products or services of interest and to support their purchase decisions [17]. To allow consumers the opportunity to preview an app before downloading it, the user reviews and Feedback section is located on the app product download page in each app store download platform to provide reference to consumers before downloading. The section also serves as a channel for developers to make corrections to the app based on the user feedback and to meet the needs of consumers in the market.

Vu et al. [15] pointed out that conducting manual analyses of user reviews is a huge challenge because for a popular app, there are as many as thousands or tens of thousands of reviews daily, and therefore, it would be very time-consuming to read through all the reviews. In addition, user reviews are generally messy due to misspelling, the use of acronyms, abbreviations, emojis, and others. C. Iacob et al. [8] also agreed that users often use unconventional expressions when writing reviews, which can be very brief and unstructured and do not usually follow syntax and punctuation rules. This implies that merely relying on computer programming to sort out and analyse user reviews is not feasible. Rather, a certain level of artificial judgment is needed in the preliminary sorting of messy raw reviews before further computer processing should be performed to ensure the accuracy of the results that are generated. Thus, the question of how to filter out invalid reviews to pinpoint authentic errors for correction and set the stage for generating accurate results in subsequent computer processing is an issue that development teams must address.

[7], [9] argued that product characteristics or product functions identified in user reviews are conducive to manufacturers in making adjustments to respective characteristics or functions. In [11], semantics used in user reviews were analysed for classification based on directional product characteristics in reviews. Subsequent evaluation was then conducted to sort out the good reviews from the bad based on product characteristics. The respective experimental results showed that this methodology is effective to developers, as keywords extracted from product characteristics help developers quickly locate problem areas and understand the situation. Linking user reviews with the system functionality and characteristics of an app will certainly help developers expedite the sorting of messy user reviews to a certain extent, resulting in the ability to make up for negative user reviews.

In addition, [10] revealed that among the review ratings that included the keyword 'shortcoming' in the feedback, the percentages of ratings from 5-star to 1-star were: 0%, 10.84%, 31.03%, 55.36%, and 50.00%, respectively; and that among the review ratings that included the keyword 'bug report' in the feedback, the percentages of ratings from 5-star to 1-star were: 0%, 0%, 22.41%, 33.93%, and 46.38%, respectively. We can see that for the keyword 'shortcoming', there was a huge increase from 31% 3-star

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ratings to 50.00% 1-star ratings and similarly, for the keyword 'bug report', there was a big jump from 22.41% 3-star ratings to 46.38% 1-star ratings. As the data showed, 3-star was basically the cut-off in users' app ratings, as the majority of user reviews related to 'shortcoming' and 'bug report' was accounted for in 3-star and below reviews. Therefore, from the perspective of development teams, user review analysis that focuses on 3-star and below reviews is relatively cost-effective in app optimisation.

Appbot is a website exclusively designed to help development teams further understand user reviews. Appbot calculates the average star rating, provides rankings of reviews based on the most frequently appearing words, and combines star ratings with text to inform development teams whether there is any need for imminent correction while serving as correction support to development teams for the next version release of the app. However, from the perspective of development teams, information that only presents flaws in the app is not sufficient for developers to quickly identify the source of and reasons for the problem, since development teams still need to spend a lot of time identifying the exact problem area in the complex programming before they can further resolve the problem.

The discussion in the introduction section shows that user favorability can be promoted through the creation of a good review ecosystem, achieving a high download rate and an increase in profits. However, most of the current analytic tools used in user reviews focus on user emotions, frequently used words and sentences, or custom searches for specific words or meanings as a basis for analysis; a tool that can help development teams clearly identify the specific problem area and the version with ongoing problems is still missing. Therefore, development teams need to spend a lot of time analysing the huge volume of reviews in order to pinpoint the function pain point before they can report to engineers for repair.

Therefore, the goal of this study is to identify user pain points from a huge volume of messy consumer reviews. Combined with the system architecture of the app, the system function areas identified as pain points were analysed and presented in a visualization chart format. A preliminary model was then created to provide development teams with queries for fast judgment, serving as support for decision-making in upgrade proposals.

This paper is organized as follows. In Section II, we present the literature review. Section III introduces the method and the content analysis study. Section IV reports on the results and summarizes the related work.

II. LITERATURE REVIEW

As a new genre of word-of-moth information, online consumer product feedback is an emerging market phenomenon that is playing a more significant role in consumers' purchase decisions. Online user feedback is information left by users based on their personal experiences and can therefore be regarded as a novel type of communication tool that helps consumers identify the most appropriate products [3]. According to [4], [13], user feedback is like electronic word-of-mouth (eWOM) marketing, and WOM marketing is widely recognised as a very influential communication method. Prior to making a purchase, consumers tend to refer to online feedback systems. Therefore, from the perspective of providers of goods and services, online feedback and feedback volume directly impacts the sales volume of products and services. Furthermore, user reviews and evaluations will form an ecosystem; that is, bad ecosystems will slowly affect the sales volume of products or sales and gradually deteriorate into an even worse ecosystem, creating a huge roadblock during product promotion and sale. Therefore, developers must pay attention to the trend in user reviews at all times. When reviews are found to be forming a bad cycle, timely changes must be made to products and services to prevent a bad ecosystem from forming. On the contrary, a good ecosystem will continue increasing the sales volume intangibly, resulting in a positive multiplying effect in sales; good mass effect will create widespread benefits to development teams.

Platform service providers are the medium between developers and users. Nowadays, all major software and publishing platforms such as the Apple App Store and the Google Play Store have provided a user reviews section on the bottom of each product page that also shows the average rating of the product, providing consumers with easy access to other users' tips and comments on their personal experiences. Before downloading an app (especially for apps that are not free), app users can easily check the ratings of the respective app, hence cutting down the cost of time spent searching. In addition, since reviews are made by users who are also consumers of the same product, their reviews are considered more credible than the information provided by developers due to conflicts of interests. Ante [1] pointed out that majority of consumers look up user reviews and ratings before making a purchase. Because of this, the consumer's first impressions become the basis for consumption. For developers, platform service providers not only can bring in high subscription volume and browsing volume but can also save development teams time on product promotion. Online user reviews also facilitate development teams to release faster updates on products and services.

Vasa et al. [13] argued that although the user review is a new concept in the app industry, user reviews have been regarded as a business strategy in other industries for many years. Negative reviews allow developers to focus on specific areas that need to be corrected. Therefore, development teams can prioritise updates based on the urgency expressed in the feedback, which will result in better subsequent user reviews. According to [14], [16], in the hotel industry, making appropriate analysis of reviews will generate business opportunities. These two studies found that prioritising updates on design or service process that most consumers felt inappropriate makes consumers feel valued by the business, thereby increasing the probability that consumers will make repurchases or leave better reviews in the future, both of which are beneficial to the service provider.

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According to [12], user reviews are a form of value co-creation. [2] additionally found that product evaluation provided by consumers are perceived by fellow consumers as more trustworthy than information provided by sales personnel. One of the reasons why most consumers trust consumer reviews was put forward in [3]: that consumer reviews are based on personal usage experiences, leading to the creation of a unique type of product information that can help consumers identify products that they really need. Therefore, online user review systems provide a venue for consumers to share their opinions and experiences about products. On the other hand, such venues also provide valuable information resources to potential buyers, facilitating effective and rational purchase decisions. Users' word-of-mouth is more convincing than traditional media [4].

From the perspective of sellers, [6] indicated that subsequent to service failure, the majority of service providers will take remedial measures to improve consumer experience, hoping to change consumers' negative word-of-mouth into positive word-of-mouth. In terms of development, user's negative feedback related to system errors are often valuable information that can be collected for analysis and upgrades, as well as the promotion of satisfaction intensity in related products and services. [5] also pointed out from research results that user reviews are similar to users' needs, ideas, or ways of improvement that provide positive inputs to development personnel.

From the perspective of users, the majority of designs in product promotion are focused on the strengths of products, with shortcomings left off. However, user reviews are the opposite: consumers will take a neutral stance when making comments, pointing out both the strengths and shortcomings of the product. This is in essence a type of promotion that is co-created by a group of consumers, and is therefore of more reference value and is important information for decision-making by new consumers.

From the perspective of developers, launching new versions and functionalities to maintain user freshness is important, but user reviews will directly impact customer retention rate such that excessive negative reviews will be a threat to product promotion and sales, and therefore should not be neglected. Thus, how to strike a balance between retention rate and freshness intensity is a serious challenge to development teams.

III. METHODS

Based on the literature review, this study put forward two areas of improvement that should be addressed in user review analysis: 1. The volume of user reviews was too huge making efficient classification impossible; 2. It was impossible to pinpoint problem areas from user reviews. In light of these two areas, this study adopted a system structure and information visualization to simultaneously resolve the above two problems. Taking advantage of information visualization characteristics, complex data would be converted into images that development team members could understand, and related problems could then be quickly clarified.

Thus, this study was divided into four stages: 1. User review data collection; 2. Data arrangement and analysis; 3. Visualization of analysed results; and 4. Heuristic evaluation, as explained in Figure 1.

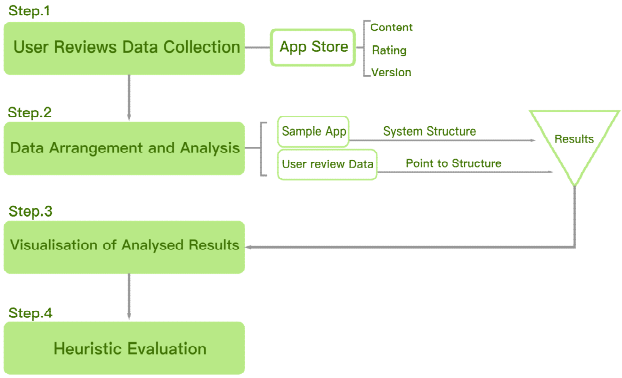

Figure 1. Study Flowchart

Sample App Selection

The two appropriate sample apps selected for examination (due to the fact that the maximum number of user reviews iTunes allows for scraping is 500, app selection criteria in this study was having more than 500 reviews) in this study were Walkr (Figure 2) and OPUS: Rocket of Whispers (Figure 3) after obtaining agreements from the two related development teams to provide assistance. The following is a brief introduction of the two development teams and the respective apps they have developed.

Walkr

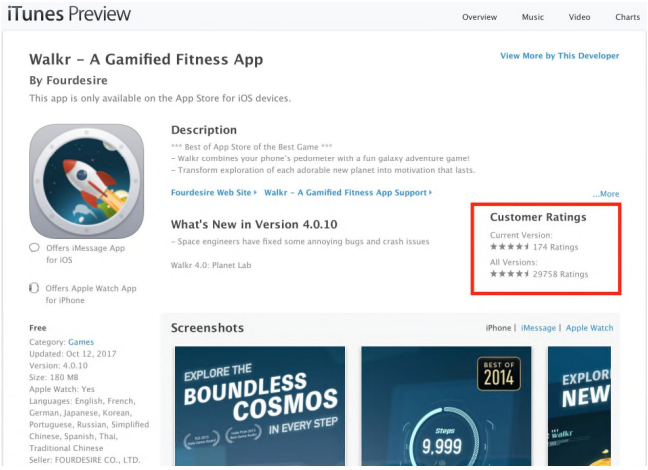

Figure 2. Walkr (captured on 13th October 2017), data source:iTunes

Walkr (Figure 2) is a game app developed by Fourdesire in Taiwan that was released in August 2014 with nearly 30,000 user reviews on versions released in the United States.

OPUS: Rocket of Whispers

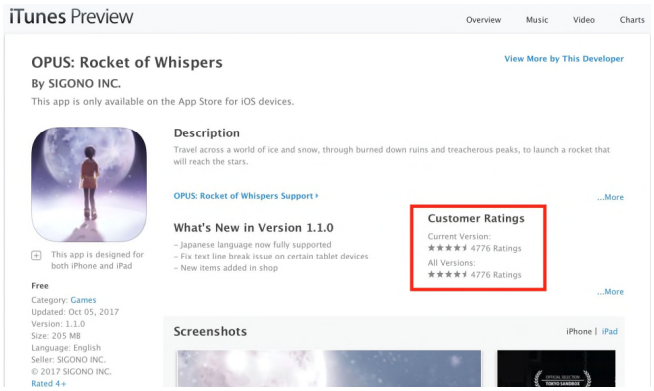

Figure 3. OPUS: Rocket of Whispers (captured on 13th October 2017), data source:iTunes

OPUS: Rocket of Whispers was a game app developed by Sigono in Taiwan that was released on 14th September 2017. Its user reviews in Taiwan reached 4,000 immediately after release.

The following steps and pictures are presented using Walkr as an example.

Step 1. User Review data collection

Since it was time-consuming and error-prone to manually enter reviews, Python programming was employed because of its simple logic, fast download speed, and ability to handle massive data. The development team only needed to enter the review download addresses that Apple iTunes allowed to open and define the data needed, and they could then be quickly extracted. The reviews were from the Apple iTunes stores in United States and Taiwan to ensure languages used in post-hoc comparison were English and Chinese only. The following five types of data were also scraped: review date (Date), review title (Title), review content (Content), Rating (Rate), and version (Version). However, due to the fact that the maximum number of user reviews Apple iTunes allowed for scraping in each app was 500, this study ranked the data based on the feature 'Most Helpful'. Users mark that they agree or disagree with other users' reviews, and the system would rank the reviews based on number of users that agreed to determine the 'Most Helpful' feature. That is, the more users who agreed with a review, the higher the review would be ranked. This ranking mechanism could eliminate invalid reviews to a certain extent, alleviating the burden in subsequent data arrangement. For each app, 500 user reviews would be scraped as raw data, which were then directly exported to Excel, as shown in Figure 4.

date	title	content	rate	version
2015-03-05	Not Happy with	You really should allow us to j	1	1.3.6
2017-07-13	Need to update w	Can't play as after the July upd	1	4.0.0
2016-08-30	Crashes all the ti	This app used to be great, cute	1	2.2.3
2017-07-13	Update: New ver	Updated review: I was really lo	1	4.0.0
2017-07-13	Great walking ap	Another Update: Unfortunately	1	4.0.1
2017-07-14	Support Needed	I have to edit my original 5star	1	4.0.1
2016-02-29	Really like it, but	This game encourages you to w	2	2.1.7
2016-03-10	I hate the ads	The game is fun, save a few litt	2	2.1.7
2016-01-07	A fun, yet tediou	It would be nice if there was m	2	2.1.5

Figure 4. Partial map of Walkr's raw review data

Step 2. Data Arrangement and Analysis

This stage involved raw data arrangement and mapping of the app framework. Raw data were sorted based on Rate and reviews that were 3-stars and below with emojis or garbled reviews were eliminated; only raw data refreshed with text arrangement were retained.

Secondly, the app structure was drawn using mind mapping, and all clickable buttons in the app were drawn from left to right according to the page flowchart (Figure 5). Lastly, Python programming was employed using the text search function to search for the function areas mentioned in the reviews, that is, all the reviews that mentioned a certain function were included in the mind map (Figure 6 is a magnified version of the area enclosed in red in Figure 5). Orange text represents 3-star reviews and red text represents 1-star and 2-star reviews.

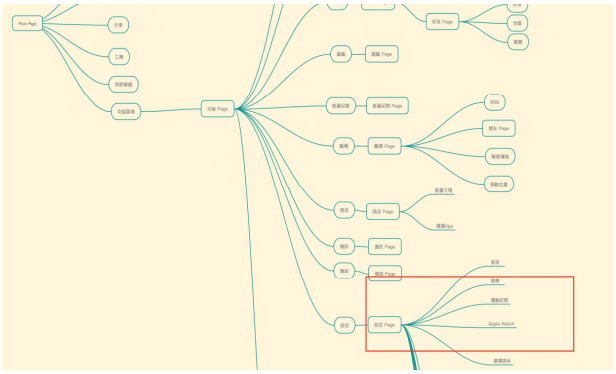

Figure 5. Partial system structure of Walkr(1)

Figure 6. Partial system structure of Walkr(2)

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Step 3. Visualization of analysed results

App structure is often large, and although problems are mostly concentrated in certain areas, with reviews included, too much data and too big a page will not only make it difficult to spot the problematic function area, but also make the review text section impossible to read. Therefore, in the visualization design stage, the functions mentioned in user reviews were first sorted out in the structure using a version timeline to sort on the timeline axis that could on the one hand enhance readability, and on the other hand allow the development team to gain a clear understanding of whether the functional problem in the version was ongoing or coincidental, and facilitate decisions on update priorities. Figure 8 is a visualization chart.

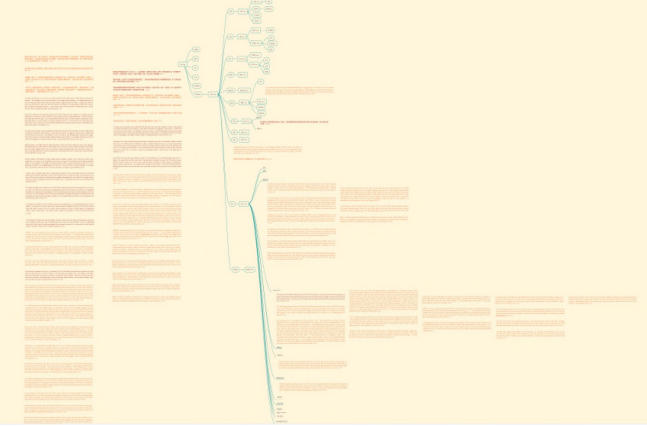

Figure 7. Partial system structure of Walkr(3)

Figure 8 is a visualization chart showing the user reviews analyzed by Walkr and it is composed of six block areas that allowed the development team members to easily understand and analyze the results. The meanings represented by the six block areas are presented in the following accordingly.

1) App name

2) Icon: orange circle represents 3-star user reviews and red circle represents 1- and 2-star reviews.

3) Problematic functional structure (viewed together with block area 4): the functional structure mentioned in user reviews in the system structure in Figure 7. For example, activity tracking was mentioned by users in Figure 6 and, therefore, activity tracking was included in this block area to be viewed in conjunction with the version timeline.

4) Version Timeline (viewed in conjunction with block area 3): version that users reported problematic in the related function. For example, under activity tracking in Figure 6, there were 9 users reporting a problem in the following 8 versions: 1.3.3, 1.3.5, 1.3.6, 2.0.1, 2.0.2, 2.1.8, 2.1.10, and 2.1.13, all of which were 3-star ratings and were therefore denoted by orange circles. According to the activity tracking in Figure 8, the order was sorted according to versions. Among them, version 2.02 appeared twice and was therefore denoted with "x2" on top.

5) Sentiment Analysis: the higher the number, the more negative the user sentiment is. Red represents 1- and 2-star user ratings; orange represents 3-star user ratings.

6) Raw Data: the number of user reviews searched are noted here; the number of 3-star, 2-star, and 1-star reviews are also given; grey represents the number of 4- and 5-star user reviews.

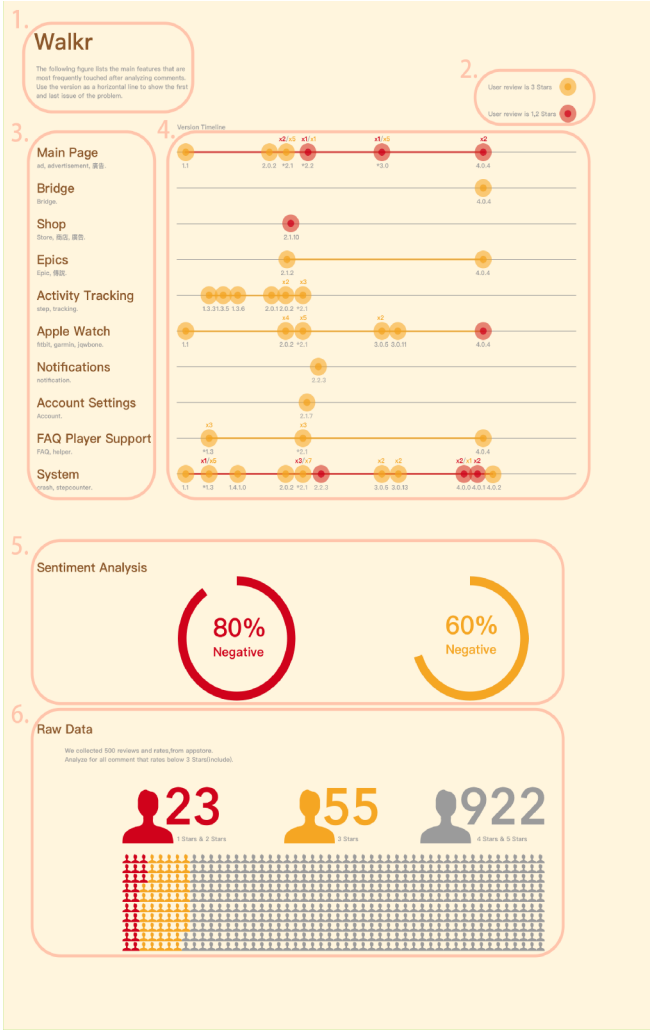

Figure 8. Partial system structure of Walkr(3)

Method

Taking the epic function in Figure 8 as an example: when users reported problems in version 2.1.2, which were also reported in version 4.04, it could be deduced that such functional problems might likely be coincidental and perhaps had to do with hardware problems in users' mobile phones. In that case, developers could choose to repair functions that were mentioned more frequently in reviews. For example, for the function of Apple Watch (The sixth item in block 3 of Figure 8) that users have repeatedly mentioned about system failure from version 1.1 to version 4.0.4, development teams could intercept the programming

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codes directly to test and repair the related area shown on the picture.

As for system function (The last item in block 3 of Figure 8), there were significantly more orange circles (3-star) than red circles (1- and 2-star), indicating on the one hand that there was not an urgent need for system improvement. However, repairs targeted at maintenance purposes such as system logistics, interface design, and logo design would make the system more better and could closely follow users' needs. On the other hand, it can be seen (In block 4 of Figure 8) that the development team has actually made gradual system-related revisions as shown in the increase in spacing between version 3 and version 4, indicating that system stability and overall logistics design were gradually recognised by users resulting in lower probability of getting reviews of 3 stars (inclusive) and below. This could be viewed as a sign of the gradual maturity of the system.

Step 4. Heuristic Evaluation

This study adopted a heuristic evaluation for validation by sending the development team the system architecture and a design of the visualisation chart for review together with two questionnaires that they were asked to fill out as feedback. There were 7 true-false questions in Questionnaire I aiming at understanding whether the results of the present study were useful to development teams. There were four short-answer questions in Questionnaire II, the topics of which were focused on the following: methodology adopted by the development team in previous user review analysis, possible dilemmas development teams have encountered, and the development team's thoughts on the recommendations made in the present study. Below is a brief introduction of the background of the three experts invited to participate in the evaluation (as shown in Table 1) and the two questionnaires (Table 2 and Table 3) of questions listed with respective reasons for question design.

The questions were designed not only to help the researcher of this study obtain the development team's thoughts and recommendations on the results, but also (and equally importantly) to share the development team's practical experience in handling issues and bottlenecks in the past, the essential elements and application approaches needed for user review behaviour analysis, and the identification of context from feedback while helping the development team further understand the advantages and shortcomings of apps so that the development team can draw on the advantages for better performance in the future while making corrections to deficiencies for further improvement.

The three experts invited to take part in the heuristic evaluation were team members in charge of user behaviour studies. In Questionnaire I, all three experts raised the issue that the system architecture or functions seemed irrelevant to the overall system architecture. To address this issue, the following explanation was presented to the development team: the user review analysis approach provided in the present study was designed exclusively for internal use within the development team. Therefore, during architectural mapping, the development team could refer to the files of the original system architecture design and edit the design accordingly until reaching full integration without leaving any deviation. Regarding mapping function keywords, the way the present study named and understood the keywords might be different than that of the development team. However, if the system functions chart was created by the development team, not only could the team focus on new functions for independent analysis, but common function issues could also be identified for further investigation, resulting in a higher level of accuracy. The experts also mentioned that they hoped to have more detailed user reviews.

TABLE I. LIST OF EXPERTS

Expert	Position	Years of Experience	Affiliation
A	Sales	3.5 years	Fourdesire
B	Sales	4 years	Fourdesire
C	Product Manager	8 years	Sigono

TABLE II. QUESTIONNAIRE I.

No	Reason for question design	Question
1	To understand the background and experience of the team member.	What is your position in the development team? How many years of related experience do you have?
2	To understand whether the developer agrees with the importance of user reviews.	As a study of user behaviour, do you think that User Review analysis will help improve development projects?
3	To understand whether negative reviews have a higher priority for consideration of handling and if duration is an important basis.	Did the ratings of 1-, 2-, and 3-star help the development team quickly adjust the priority list of issues to be handled?
4		Was information related to the problematic version and the duration of problem an important indicator to the development team?
5	To understand whether the present study can effectively help alleviate the developer's burden in analysing user reviews.	The present study combined user reviews with system function architecture. Did this approach enhance the development team's precision in identifying and handling the problem areas?
6		To continue with the above, did the problems located in the function area that was identified in user reviews (such as the area enclosed in red shown in the figure below) help shorten the time needed for the development team in system optimisation?
7	To understand whether the results of the present study are accurate.	According to the development team's past experiences, were the problematic functions listed in the visualisation chart of the present study accurate? (Here accuracy is defined as: 1. whether the system functions pointed

No	Reason for question design	Question
1	To understand the background and experience of the team member.	What is your position in the development team? How many years of related experience do you have?
		out in user reviews were accurate, and 2. whether the function actually existed in user feedback.

This was due to the fact that iTunes' limit on the number of user review downloads allowed for each app was 500, so the present study could not provide more to the team. The general public is not allowed to obtain all user reviews for any single app. However, the app's developer is allowed to download every single review. Therefore, if developers are to take charge of data scraping from different versions, especially scraping 1-star reviews, a certain degree of improved operationality is guaranteed, meaning that results will be more accurate.

TABLE III. QUESTIONNAIRE II.

No	Reason for question design	Question
1	To understand the benefits the development team has gained from the results of the present study.	What do you think is the most helpful feature in the areas of updating and optimisation provided in the case study of the present study?
2	To understand the past issues encountered by the development team and to try to resolve them using the results of the present study.	What are the most common issues or bottlenecks the development team has encountered in previous versions?
3	To understand the important features that the development team will pay attention to when studying user reviews.	How did your development team handle user reviews in the past?
4	To understand the expert's suggestions to the results of the present study.	Is there anything else or any particular item the development team would like to further understand that has not been discussed in the results?
5	Q&A	Lastly, if there are still any questions or interest in the topic of this study, you are welcome to leave message here with your contact information. We will reply as soon as possible.

Feedback from the three experts on analysis made in the present study is arranged and presented as follows:

1) After the new version release of a function, the follow-up evaluation should be conducted on user reviews related to this function.

2) Add more enrichment to the visualisation chart.

3) In terms of user reviews of higher ratings, in the case of Walkr, which had relatively fewer 1- to 3-star reviews, analysing 4- and 5-star reviews may help find out what functions users like and why.

4) The suggested approach was able to expedite the identification of problem areas and versions.

5) Visualisation design facilitated understanding of the severity of issues and the frequency of occurrence.

6) To understand whether issues were resolved by version iteration.

7) System architecture and function names did not fit the overall system.

8) The number of reviews was not enough, and the flexibility of the visualisation chart was limited.

Lastly, the questionnaires that were returned showed that after eliminating the programming bugs that needed repair, the development team did not know how to focus on the issues raised in user reviews, nor did they know how to set up a priority list of issues to be corrected. In other words, team members did not have a dedicated set of analytical tools that allowed them to handle the large volume of user reviews from various sources, and they had not set a priority list of issues to be corrected.

IV. CONCLUSIONS

As seen from the analysis in the present study, user reviews are a key factor in judging whether there is gradual growth in an app. If there are enough user reviews, taking a comprehensive view on user reviews helps developers understand whether an app is on the right track for growth. Visualisation charts also provide development teams easy understanding in user review distribution and direction, reducing the search time for identifying issues while quickly understanding the real needs of users.

It is found from the two case studies that if an app only has a few negative reviews, if user reviews are classified into directional (clearly pointing out the area in system function or architecture) system architecture review and non-directional (mostly focusing on narrative of user experience) user review, few directional user reviews mean that the app currently does not have any issues in structural functions. The majority of users are satisfied with the system functions and have therefore switched focus to expressing ideas and suggestions to the system, hoping that the development team can follow the direction of the reviews in updating. At this time, the development team can follow the original plan to announce the new release of functions to increase user freshness. On the contrary, having more directional than non-directional user reviews means that users think that there is problem in the system function. Ignoring users' requests at this time will result in user churn. Thus, the development team must fix the problem as soon as possible, rather than releasing new functions, to calm down angry users and alleviate user churn.

The greatest challenge encountered in the course of this study was in heuristic review because this study is still at the model design stage; it needs verification and evaluation from an outstanding and experienced development team in the industry to help perfect the design process of the research results. In addition, business secrets may be involved in the research process, which most developers cannot provide for assistance in evaluation. At the same

time, core members of the development team were not easy to get in touch with; emails sent to development companies were often declined by the support team, resulting in a challenge in seeking experts to participate in the heuristic evaluation.

REFERENCES

[1] S. E. Ante, Amazon: Turning consumer opinions into gold. Business Week, 15, 2009.

[2] B. Bickart and R. M. Schindler, "Internet forums as influential sources of consumer information, " Journal of interactive marketing, vol. 15, no. 3, pp. 31-40, 2001.

[3] Y. Chen, and J. Xie, "Online consumer review: Word- of-mouth as a new element of marketing communication mix," *Management science*, vol. *54*, no. 3, pp. 477-491, 2008.

[4] D. Godes, and D. Mayzlin, "Using online conversations to study word-of-mouth communication," *Marketing science*, vol. *23,* no. 4, pp. 545-560, 2004.

[5] E. Guzman, and W. Maalej, "How do users like this feature? a fine grained sentiment analysis of app reviews," 2014 IEEE 22nd International Requirements Engineering Conference (RE), Karlskrona, 2014, pp. 153-162, doi: 10.1109/RE.2014.6912257.

[6] C. W. Hart, J. L. Heskett, and W. E. Jr. Sasser, "The profitable art of service recovery," *Harvard Business Review, vol. 68*, no. 4, pp. 148–156, 1990.

[7] M. Hu, and B. Liu, "Mining and summarizing customer reviews," Proc. 10th ACM SIGKDD international conference on Knowledge discovery and data mining (KDD '04), ACM, New York, NY, USA, 2004, pp. 168-177, doi: 10.1145/1014052.1014073.

[8] C. Iacob, and R. Harrison, "Retrieving and analyzing mobile apps feature requests from online reviews," 2013 10th Working Conference on Mining Software Repositories (MSR). IEEE Press, 2013, pp. 41-44, doi: 10.1109/MSR.2013.6624001.

[9] X. Meng, and H. Wang, "Mining user reviews: from specification to summarization," In Proceedings of the ACL-IJCNLP 2009 Conference Short Papers, pp. 177-180, 2009.

[10] D. Pagano, and W. Maalej, "User feedback in the appstore: An empirical study," 2013 21st IEEE International Requirements Engineering Conference (RE), Rio de Janeiro, 2013, pp. 125-134, doi: 10.1109/RE.2013.6636712.

[11] G. Somprasertsri, and P. Lalitrojwong, (2010). "Mining Feature-Opinion in Online Customer Reviews for Opinion Summarization," *J.UCS*, vol. *16,* no. 6, pp. 938-955, 2010.

[12] F. T. C. Tan, and R. Vasa, "Toward a social media usage policy," Proc. ACIS 2011, pp. 84-89.

[13] R. Vasa, L. Hoon, K. Mouzakis, and A. Noguchi, "A preliminary analysis of mobile app user reviews," Proc. 24th Australian Computer- Human Interaction Conference (OzCHI '12), ACM, New York, NY, USA, 2012, pp. 241-244, doi: 10.1145/2414536.2414577.

[14] I. E. Vermeulen, and D. Seegers, "Tried and tested: The impact of online hotel reviews on consumer consideration," Tourism management, vol. 30, no. 1, pp. 123-127, 2009.

[15] P. M. Vu, T. T. Nguyen, H. V. Pham, and T. T. Nguyen, "Mining user opinions in mobile app reviews: A keyword-based approach (t), " 2015 30th IEEE/ACM International Conference on Automated Software Engineering (ASE), Lincoln, NE, 2015, pp. 749-759, doi: 10.1109/ASE.2015.85

[16] Q. Ye, R. Law, and B. Gu, "The impact of online user reviews on hotel room sales, " International Journal of Hospitality Management, vol. 28, no. 1, pp. 180-182, 2009.

[17] C. H. Yin, "網路口碑對線上應用程式的購買意圖之影響-以 Apple App Store 為例" [The Influence of eWOM on purchase Intention of Online Applications: An Empirical Study of Apple App Store], 2011, URL: http://hdl.handle.net/11296/t9tju5.

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