essence, more is better. Thus, consumers are encouraged by the existence of many others who have already purchased the same product. The large number of reviews would add credibility to the product's value. These reviews also positively contribute to the value of the rating, and more importantly, a favorable perception of said product.

Palomba et al. (2015) investigated how user reviews of mobile apps can help app developers improve their products, and further, how the improvements reflect on follow-up user reviews. The study relied on three research questions one of which (RQ) investigated the effect of crowd reviews. The found that *"…apps implementing a higher number of ratings always exhibit a statistically significantly higher increment of their average score than apps having a lower percentage of reviews implemented…"* (p. 298). They believed that the more informative the user reviews the better the new version of the app. higher the percentage of useful user reviews. Thus, we posit that:

H3: The number of existing ratings of a mobile banking app will be related to better ratings.

4.4 Mobile App File Size

In software engineering research, it is well known that functionality is correlated with software filesize [46]. While users typically want more features, a software package or application's file size can become problematic when transmitting it – whether over the Internet or through the airwaves, as in the case of mobile apps. User satisfaction is known to decline when system response time becomes even a few seconds slower [52]. Thus, understanding the pros and cons of having larger app file sizes may be an important driver of mobile user satisfaction. For example, Boiano, Bowen, and Gaia [5] discussed file size in their research on the processes involved in creating and distributing iPhone apps. They shed light on the importance of concise file size to help speed the download process for an app. As they described, app file size become large with the use of graphics, animations, and audio components. This matter pushed Apple to enact a policy that an app whose size was larger than 20 megabytes would need a wireless connect not to inflict on network resources. Ghose and Han [15] attributed that several app characteristics form the basis for users' preferences, and thus, the content of their reviews. For example, they noted that user reviewers mentioned app file size, app version, app age (days since app release), and app version age (days between different version releases).

Kendall, Nino, and Stewart [24] suggested that file size affects performance at two different levels: the speed by which in downloading and installing a software application and they indicate the increase in number of features. Similarly, there exists research [30] that correlates app properties such as file size and detailed description to app sales. In another study, Ghose and Han [15] investigated the drivers for consumer demand in mobile apps. One of their findings suggested that larger file sizes could hinder potential users' demand for apps. Specifically, they observed that a 10% increase in app file size reduced user demand by 1.1%. This underscored the downside of larger app sizes, especially if app success is evaluated based on the number of user downloads of the app. While Ghose and Han analyzed file size and the number of features, in terms of their impact on user demand and development cost, our current study will look at file size and features in with respect to user reviews.

Liu, Au, and Choi [38] discussed mobile app file size in their empirical study of mobile app offerings. They used it as one of the variables in a model that explored the effect of the freemium strategy for mobile apps. The study found that *"…freemium strategy is positively associated with increased sales volume…"* (p. 1). That, in turn, indicated that the reviews of free version on an app can help improve the paid version. Similarly, McIlroy et al. [43] used one of their projects to investigate mobile app update frequency from a software development perspective. They used over 10,000 apps to answer three questions: *"…How frequently and consistently are apps updated...What is the rationale for frequent updates...What is actually changing for frequent updates?"* (p. 1347). The answer for this last question provided some insight in mobile apps file size. First, in general, mobile app updates (code change) resulted in an increase in file size (6%). Second, and more importantly, the study found out that mobile app updates were received positively. The authors observed that frequently updated apps have earned better user ratings. Thus, we posit that:

H4: The file size of a mobile banking app will be related to better ratings.

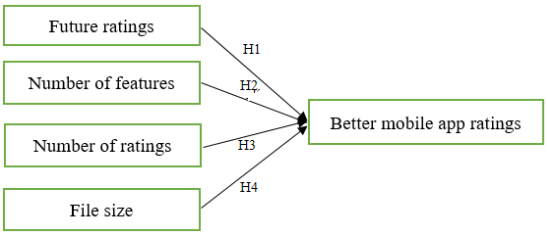

Figure 1. Research model

5. Methodology

We consulted a list of the top 50 largest banks registered with the U.S. Federal Deposit Insurance Corp. (FDIC), a U.S. federal agency whose mission is

to ensure stability and earn public confidence in the U.S. banking system. We then searched the Apple iTunes website to identify the existence of a corresponding app for each bank. Thus, the sample *n* for the three years included 2012 (n=39), 2016 (n=41) and 2018 (n=46). The data was collected in years with variation durations: four years between 2012 and 2016 and two years between 2016 and 2018. We thought the number of banks with mobile apps would increase continuously, and therefore, a bigger number of ratings. The sample (*n*) difference in the data meant that ratings did not exist for some of these banks in these years. For example, Bank of America's app had ratings for all three years, but Goldman Sachs' app only had data for two of the three periods (2016 and 2018); there was no mobile app for Sachs in 2012. The assuring thing for this sample was that this study was consistent with using the top 50 richest banks regardless.

We copied details of the ratings and features of each bank's app to an Excel spreadsheet. We recorded following data for each app for the three years: (a) app version number; (b) app size (in megabytes); (c) number of customer ratings for the latest version; (d) number of ratings per each star rating (number of ratings providing one star, two stars, etc.); and (f) the number of features documented by iTunes). With regards to the number of features, we identified this value based on reading the short descriptions provided on the iTunes site for the current app version as well as for previous versions (see Figure 2). We counted the number of features by treating each description of a new capability as a separate feature. We did not count anything related to bug fixes as new feature (see, for example, versions 7.4.12 and 7.4.8 in the Figure, below). We summed the number of features based on the current and prior app versions displayed on the iTunes site.

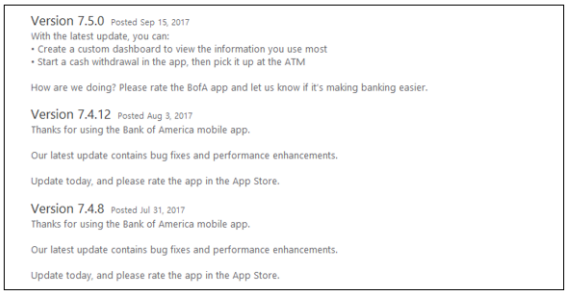

Figure 2. Banking app version update sample

Apple iTunes uses a five-star rating scale with customers choosing "1 star" to designate *"I hate it"* up to "5 stars" to designate "*it's great."* A three-star rating is considered a moderate view – also known as the "middle-ground attitude" [48]. While the star ratings for mobile banking apps vary from one to five, the mean is typically high and the extreme ratings of "1" and "5" typically account for a majority of the scores [21]. We used the 5:1 ratio as support for our data analysis.

6. Analysis and Results

We first processed and cleaned the data using Excel to compute descriptive statistics for all constructs. We started by weighing number of customer ratings and star ratings, the mean rating was 3.36 in 2012, 4.52 in 2016 and 4.82 in 2018. In contrast, unweighted means (averaging the means for all banks, despite the number of ratings) was 3.23 in 2012, 3.12 in 2016 and 3.9 in 2018. These differences suggested that the most frequently reviewed bank apps had much higher customer ratings. Additionally, we conducted an overall comparison for the ratings of 2012, 2016 and 2018. They showed the similar behavior and observed J-shape plot where there was higher percentage of people rating 1 and 5 as compared to 2, 3 and 4. The rating 5 being the highest and 1 being the lowest. In addition, a simple analysis of the extremes provided in Table 1.

Table 1. Comparison of 1-star and 5-star ratings for three years

Yr	**Total no. of ratings**	**No. of 1-star ratings**	**% of 1-star %**	**No. of 5-star ratings**	**% of 5-star %**
2012	7,273	2009	28%	3,106	42.71%
2016	30,365	1744	6%	23,142	76.21%
2018	4,710,106	46,187	1%	4,120,931	87.49%

The J-shaped ratings plot in Figure 3 was asymmetrical i.e. the frequencies are higher on the extremes as compared to the frequencies of other ratings. The ratings is J-shaped distribution where the frequencies are higher on the extremes as compared to the frequencies of other ratings. The rating 5 being the highest number and 1 being the second highest number. Hu et al. [20] mentioned that the people who either moan or brag are more likely to express their views. Khalid et al. [26] echoed the same sentiment. Hence, resulting in the more people rating at the extremes (5-star or 1-star) than those with moderate views leading to J-distribution.

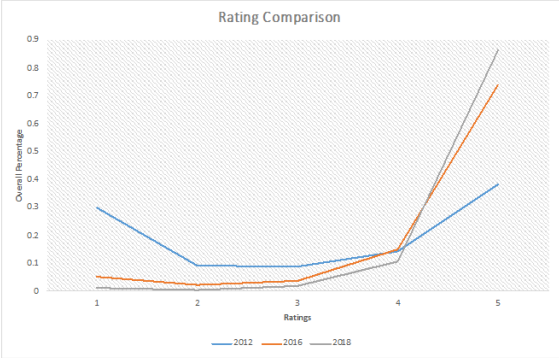

Figure 3. Ratings comparison for 2012, 2016, and 2018

The non-parametric distribution that called for an approach that did not rely on any of the parameters but the ranking or the ordered data (Kerby, 2014). These are often called as distribution free approach and is based on fewer assumptions. Wilcoxon (1945) suggested when the data is collected at different time points and within pair differences are ordinal that needs non-parametric approach.

The nature of the sample called for the use of Generalized Estimating Equations (GEE) for analysis. Liang and Zeger [33] introduced GEE to treat cluster-type data. Because the group designation (top 50 riches banks) was more important than the individual banks, GEE was a worthy choice. We noted at the beginning of this section that some data was present for all three periods for most banks, but was missing for some, GEE was recommended to overcome the discrepancies [17].

McGrath et al. [42] found that in their study of physicians' online ratings that most of the ratings are at the extremes, with most rated at 1 or 5 and recommended. They relied on using the 5 to 1 ratio based on previous work in psychology. Also, Huber et al. [22] analyzed the online content of urogynecologists' ratings to transform ratings to improve care. They compared 5:1 ratio with various characteristics and practice qualities to assess physicians' performance. This current study has similar 5 to 1 ratio undertones as Table 2 shows. Thus, we used the same principle of 5:1 ratio as basis for testing our hypotheses.

The simple Linear Regression Model with GEE was performed – the 5:1 ratio is regressed against the categorical variable year. From the Results 1, the year 2016 is found significant when considering the p-value of the Wald Statistic of 0.0402 (less than 0.05) and 2018 years are found most significant when considering the p-value of the Wald Statistic of 0.000087 (less than 0.05). The year 2016 and year 2018 being significant supports that the ratings improved from 2012 to 2016, and ratings further improved from 2016 to 2018. This supports *H1: Mobile banking apps will have better user ratings in as they progress in the future.*

Table 2. H1 result summary

DV	IV	Result	Test Used	Stat Used	p-value
5:1 Ratio	Year 2016	Sig.	Linear Regression Model with Generalized Estimating Equations	Wald Statistic	0.040
	Year 2018	Most Sig.			<0.001

To address the relationship within the sample of each year or among the data for the three years, we used the Wald test. It is a parametric statistical test to express relationship within a sample or among data items as a linear model. A main feature for this test is that it is more effective at joint group comparison test than many other ratio tests [34]. It can help find out whether input variables in the model can explain the model or not, or if they are significant or not. If the probability of Wald Statistic was less than or equal to (1- α) where α was equal to 95% confidence interval, then the variable was significant. The data was first categorized based on the banks and year as the sub-category. We then tested the data for the various hypotheses.

Two tests were performed with GEE. Initially, the 5:1 ratio was regressed against the mobile app size variable. Secondly, the 5:1 ratio was regressed against the mobile app size and year. Then, the F-test from ANOVA was used to compare the two above models in order to find if the file size played a significant role in improving predicting the ratings over the years.

The simple regression model with 5:1 ratio as dependent variable and size as the independent variable. As shown in the Results 2, the slope was non-zero with value of 0.1673 and was significant when considering the p-value of the Wald Statistic of 0.006. That indicated that size was significantly associated with the ratio. The hypothesis could not be rejected that the file size of the mobile app was related to better ratings.

The second regression result for the model as shown in Result 3 - 5:1 ratio as output variable and Size and Year as the input variables. The slope of Size with the value of 0.1278 was marginally significant considering the p-value of the Wald Statistic of 0.067 (greater than 0.05). The impact of Year 2016 and 2018 was captured by the slope values -3.5655 and 15.8622. Considering the p-values of the Wald Statistic into account - it seemed that there was no significant impact for the Year 2016 (p-value: 0.513>0.05) but there was significant impact for Year2018 (p-value: 0.044<0.05).

Table 3. H2 result summary

DV	IV	Result	Test Used	Stat Used	p-value
5:1 Ratio	*Size*	Sig.	Linear Regression Model with Generalized Estimating Equations	p-value of Wald Statistic	0.006
5:1 Ratio	*Size*	Marg. Sig.	Linear Regression Model with Generalized Estimating Equations	p-value of Wald Stat	0.067
	Year 2016	Insig.			0.513
	Year 2018	Sig.			0.044

However, size was significant in the first model but was not in the second model. The Year2018 was making significant impact whereas Year2016 was not. That implied that Year itself was not significant. Two more tests were performed with GEE. Initially, the 5:1 ratio was regressed against the number of features in the mobile applications. Secondly, the 5:1 ratio was regressed against the number of features and the year. Finally, the F-test from ANOVA test was used to compare the two above models.

The first regression result for the model - 5:1 ratio as output variable and number of features as the input variable. As shown in the Results 4, the slope was non-zero with value of 1.669 and was marginally significant when considering the p-value of the Wald Statistic of 0.056 (less than 0.05) indicates that size was significantly associated with the ratio. The null hypothesis can be rejected indicating that there was significant relationship between the file size of the mobile app and the 5:1 ratio. The hypothesis confirms that the number of features of the mobile app was related to better ratings.

The second regression result for the model- 5:1 ratio as output variable and number of features and Year as the input variables. As shown in the Results 5, the slope of *Features* with the value of 1.276 was not significant considering the p-value of the Wald Statistic of 0.1865 (greater than 0.05). The impact of Year 2016 and 2018 was captured by the slope values -4.615 and 23.81. Considering the p-values of the Wald Statistic into account - it seems that there was no significant impact for the Year 2016 (p-value: 0.5182>0.05) but there was significant impact for Year2018 (p-value: 0.0024<0.05). The statistical results showed that number of features was not significant, and Year was not significant either.

Table 4. H3 result summary

DV	IV	Result	Test Used	Stat Used	p-value
5:1 Ratio	*Features*	Marg. Sig	Linear Regression Model with Generalized Estimating Equations	p-value of Wald Statistic	0.056
5:1 Ratio	*Features*	Insig.	Linear Regression Model with Generalized Estimating Equations	p-value of Wald Statistic	0.186

Finally, the features variable was marginally significant in the first model but was not in the second model. The Year2018 was making significant impact whereas Year2016 was not implied that Year itself did not play any significant role. As a result, the test failed to support the relation between the number of features and ratings.

The same approach was used for *H4*. The 5:1 ratio was regressed against the number of ratings (ratings count). The ratings count was found significant when considering the p-value of the Wald Statistic of 0.00014 (less than 0.05). The ratings count being significant supports the ratings improved with the increase in the count of ratings. Thus, we could not reject *H4: The increase in number of ratings showed improvements in app ratings.*

Table 5. H4 result summary

DV	IV	Result	Test Used	Stat Used	p-value
5:1 Ratio	*No. of Ratings*	Sig.	Linear Reg. Model with GEE	p-value of Wald Stat	<0.001

The mobile banking ratings not only improved over time (*H1)* but the number of reviewers also – this was evident from the increase in the number of ratings count (*H4*). The increase in either number of features (*H2*) and file size (*H3*) or are not playing significant role in improving the 5:1 ratings ratio. This study calls for further investigation into the rationale of adding more features, which usually causes the increase in the file size.

Table 6. All hypotheses result summary

Hypothesis	Result
H1: Mobile banking apps will have better user ratings in as they progress in the future	Supported
H2: The number of features in a mobile app will be positively related to better ratings.	Not Supported
H3: The number of existing ratings of a mobile app will be related to better ratings.	Supported
H4: The file size of a mobile app will be related to better ratings.	Not Supported

7. Limitations and Delimitations

This had some limitations and a delimitation. First, while we collected data for three time points (the years 2012, 2016 and 2018), iTunes does not store historical data, we were unable to capture the customer ratings data during the intermediate years (2013, 2014, 2015 or 2017). A second limitation was that iTunes provided customer ratings only for the current app version during the current year. This meant that if a given bank produced multiple app versions during a given year, only the customer ratings for the most current version were available and not earlier versions.

As a delimitation, the study was confined to data from the iPhone platform (iOS) apps and App Store for experiment controls purposes. It is acceptable to focus on single-platform apps in empirical research on mobile apps (Fu et al., 2013).

8. Conclusion, Implications, and Future Research

This research project is an empirical study on banking mobile apps. It aimed to add to the limited research of the business' perspective of mobile app development. The data for the analysis were collected for three years. The analysis was based on quantitative metrics (app star ratings) that were available on the App Store website for three periods (2012, 2016 and 2018). The study included information on the nature of sample and its unbalanced nature.

Also, the use of the 5:1 ratio measure is a noteworthy contribution of this study. Hu et al. [20] explained that the 5:1 ratio could be interpreted as how many people disliked as compared to number of people liked something. Using 5:1 ratio metric minimizes the data skewness without losing the context of the useful information for the analysis. Levy, Duan, and Boo [32] emphasized the importance of one-star reviews. Their study favored that businesses should use these specific ratings as a gauge for performance.

Second, this study looked at a small sample from the banking industry. The study found that there were significant improvements in banking mobile apps star ratings between 2012 and 2018. Mobile apps are daily bread for many industries [11]. The study did not consider other factors but the ratings, investigation of the literature did not produce any information on the relationship between mobile development and strategic planning.

One research possibility is to do a similar study for consecutive years instead of having that time gap. It is also possible for future studies to analyze customers' qualitative comments as well [48]. Another research possibility is to compare the ratings of mobile apps in different industries. One major control to consider is the number of revisions of each version of the respective apps. As noted previously, there is expansive literature that analyzes customers' qualitative comments (*reviews*), in contrast to customers' numeric ratings of products and services *(ratings)*. Given that qualitative ratings contain different information, and at times, the same customer's review contradicts their own ratings, there are many lines of future research possibilities in customer ratings. More research is needed on the use of reviews and ratings into development decision-making in the banking industry. This research could investigate into the weight of mobile app development with respect to strategic planning in banking.

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