More than Mobile Banking – A Taxonomy-based Analysis of Mobile Personal Finance Applications

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Abstract

Mobile personal finance applications cannot only assist users in daily personal finance activities, e.g., mobile banking, but can also guide users to optimize long-term financial decisions. Still, research lacks a rigorous classification of this critical mobile commerce domain. We provide insights by developing a taxonomy and conducting a cluster analysis of mobile personal finance applications. We classify 170 mobile personal finance applications into twelve dimensions, combining a technical artifact perspective with a financial services perspective. Additionally, we empirically identify ten distinct clusters of archetypical application configurations. While we classify the field and give inclinations for future research, financial service providers and application developers can understand their competitors and use our insights to improve their applications. Potential users of these applications can use our findings to select mobile applications to optimize their personal finance endeavors.

Keywords: Personal Finance, Mobile Applications, Mobile Finance, Mobile Commerce, Taxonomy Development, Cluster Analysis, Archetypes

Introduction

"Finance is not merely about making money. It's about achieving our deep goals and protecting the fruits of our labor. It's about stewardship and, therefore, about achieving the good society."
– Robert J. Shiller (Nobel Prize Winner for Economics in 2013)

While it is always important for individuals and households to make "good" financial decisions, it is especially crucial in the current turmoil times, where the future consequences of the Covid-19-pandemic

on the economy cannot be calculated (e.g., Garman and Forgue 2018; Lusardi and Mitchell 2014; Zhang et al. 2020). To make reasonable financial decisions, individuals and households need to have a decent amount of knowledge in finance, often referred to as *financial literacy*, as well as their own financial goals planned and financial information tracked (Lusardi and Mitchell 2014; van Rooij et al. 2011). Therefore, budgeting and financial transaction tracking should be part of the daily life of individuals and households. Having one´s own personal finance under control is relevant for everyone and can be life-changing, e.g., when highly in debt. Still, surveys and literature about personal finance, e.g., concerning budgeting, transaction tracking, credit behavior, and stock market participation, suggest a lack of coherent and sophisticated financial literacy in many societies (Huston 2010; Lusardi 2019; van Rooij et al. 2011).

Digital tools and services, especially in the form of and delivered through mobile applications ("apps"), help to plan financial goals, track financial information, and in general, nudge users into more robust and long-term thinking financial-related behaviors (Bunnell et al. 2020; Ky et al. 2021). With personal mobile finance apps, users interact with their chosen financial service providers, capture their spending, save for bigger purchases, invest for retirement, or transfer money fast and easily between each other. Since these mobile apps can be used without time- and place restrictions, they are often the preferred way for users to manage their money and finances and interact with financial institutions (Han et al. 2016; Sharma and Sharma 2019). Therefore, mobile apps are receiving an ongoing interest in the context of "m-commerce" (Sarkar et al. 2020) and especially within the financial services sector from both consumers and financial services providers (Malaquias and Hwang 2019).

While there is a wide range of research concerning the acceptance and adoption of specific mobile finance apps, e.g., to deliver mobile banking services (Arcand et al. 2017; Kim et al. 2009; Shaikh and Karjaluoto 2015) or mobile payment services (e.g., Dahlberg et al. 2008; Schierz et al. 2010), only Huebner et al. (2018) describes, as an aside, how differing financial services delivered through mobile apps can be distinguished from each other. Still, rigorous research to structure the domain integrating technical mobile app elements and underlying personal finance service elements currently does not exist. Also, empirically validated archetypes of mobile personal finance apps are missing. To address these research gaps, this paper aims at answering the following research questions (RQs):

RQ1: How can mobile personal finance applications be classified within a taxonomy?

RQ2: Which archetypes of mobile personal finance applications can be deduced empirically with this classification?

Our RQs' objectives are to provide a rigorous structure of the field and classify mobile personal finance apps in empirically validated archetypes. Therefore, we develop a taxonomy according to Nickerson et al. (2013) utilizing literature of the domain of interest and a sample of popular real-world mobile personal finance apps as objects to classify (RQ1). Based on our taxonomy, we conduct a cluster analysis aiming to classify objects into groups, minimizing differences within a group and maximizing differences between groups (Kaufman and Rousseeuw 1990). We derive, interpret, and explain these distinct mobile personal finance app groups or clusters to identify archetypical mobile app configurations (RQ2).

Mobile app developers and financial service providers can benefit from our taxonomy and derived archetypes to classify their apps, observe what the competition is doing, and use our insights to support app development, e.g., by combining less frequent combinations of characteristics. Finally, regular users of mobile personal finance apps can use the taxonomy and archetypes as decision support for selecting mobile apps enhancing their personal finance endeavors. Also, people who have no experience with financial services on their mobile phones can grasp what is possible on a mobile platform.

First, we explain the term "personal finance" and summarize existing research concerning mobile personal finance applications. Afterwards, we introduce our methodological approach for the taxonomy development, present our iterative development and final taxonomy. Subsequently, we perform our cluster analysis and deduce specifics for each identified mobile personal finance app archetype. We discuss our results and findings, implications, and recommendations, as well as limitations and future research directions. Conclusions summarize our most important insights answering our RQs.

Mobile Personal Finance Applications

Personal finance is characterized as the management of money of individuals and households and includes activities like budgeting money, transfer of money, lending, investing, or retirement planning (Garman and Forgue 2018). However, people first need to acknowledge the importance of such matters, need to be educated about financial instruments and backgrounds, and, in the end, need to be able to manage their personal finance problems. This knowledge and application dimension, known as financial literacy, is important, since people with a lower financial literacy are less likely to invest and make positive long-term financial decisions (Huston 2010; Lusardi and Mitchell 2014; van Rooij et al. 2011). This leads to less financial freedom of the individual associated with more dependence on state benefits and reduced retirement wealth (Lusardi and Mitchell 2014).

Mobile personal finance apps assist and support users concerning their financial needs. They can educate and assist users with user-centric information, making the user more financially literate (Angel 2018; French et al. 2020). In general, mobile apps are defined as "an [information technology] (IT) software artifact that is specifically developed for mobile operating systems installed on handheld devices, such as smartphones or tablet computers." (Hoehle and Venkatesh 2015: 437). Both big app markets, Apple's App Store and Google's Play Store ("app stores") categorize mobile apps within different categories. The App Store, for example, defines apps in the "finance" category as "apps that perform financial transactions or assist the user with business or personal financial matters"(Apple 2021). We combine both these explanations and define mobile personal finance apps as *IT software artifacts developed for mobile operating systems and installed on smartphones that assist the user with personal financial matters.* Later, we use this working definition as a theoretical background for the inclusion and exclusion of mobile personal finance apps in our sample.

Financial services providers face ongoing challenges forced by the digital transformation, e.g., changing customer demands or new competitors, for example, BigTechs or FinTechs (Puschmann 2017). Given tighter regulations of the financial services market, low interest rates, and high cost pressure, many banks face critical challenges (Gomber et al. 2017). While smaller businesses develop and publish mobile apps often more quickly due to, for example, agile working environments, incumbents need to react to this new threat in an appropriate manner (Vasiljeva and Lukanova 2016). As a result, the market must develop or advance mobile apps according to customer demands and must consider mobile apps domain-specific aspects, e.g., data usage or privacy concerns of the users (Malaquias and Hwang 2019). Han et al. (2016) reveal that personal finance apps have the lowest usability and one of the shortest time usages per week compared to other app categories. This is crucial since the app provider must deliver an appropriate service through well-designed mobile apps to fulfill customers' needs in a short usage time. Plus, the services delivered through these apps are a success factor for the long-term persistence of customer relationships, since users can easily switch from one app to another (Arcand et al. 2017). Furthermore, mobile personal finance apps can handle financial matters quickly from wherever and whenever (Malaquias and Hwang 2019; Sharma and Sharma 2019).

Past research on mobile apps in the financial services sector is mainly concerned with acceptance and adoption factors (e.g., Schierz et al. 2010; Shaikh and Karjaluoto 2015), especially with regards to trust (e.g., Kim et al. 2009; Sharma and Sharma 2019) or security aspects of these apps (e.g., Khalilzadeh et al. 2017). Other researchers examined mobile apps focusing on financial inclusion, specifically for developing countries (e.g., Ky et al. 2021) or financial literacy, but did not examine the overall functions of the market of financial apps in detail (French et al. 2020). Another study investigates the impact of user ratings for mobile finance apps with a quantitative approach across different sub-categories (Huebner et al. 2018). While this study uses a rudimentary taxonomic approach to find the service-based sub-categories of "finance" apps, it does not focus on the more specific "personal" trait of finance apps and does not provide insights by combining a technical and financial service perspective on apps. Thus, a well-structured and comprehensive classification of personal finance apps in the form of a taxonomy and an empirically validated clustering, with the integration of technical and underlying financial services perspectives, is missing.

Methodological Approach of the Taxonomy Development

Taxonomies play an important role in research, e.g., to structure and organize a domain of interest. A taxonomy is suitable for analyzing complex domains and building more in-depth knowledge about the objects in a domain (Glass and Vessey 1995; Nickerson et al. 2013). As Nickerson et al. (2013: 1) mentioned, "a fundamental problem in many disciplines is the classification of objects of interest into taxonomies." A taxonomy as a structure-giving artifact is used to understand, grasp and analyze complex issues (Hevner et al. 2004; Szopinski et al. 2019). Therefore, by proposing a taxonomy to understand the dimensions and characteristics of mobile personal finance apps and their interrelated connections in the form of archetypes, we analyze the domain. By using the methodology for taxonomy development by Nickerson et al. (2013), we follow the "most prominent and widely used approach in the field" (Schöbel et al. 2020: 647): After the determination of one *meta-characteristic* and objective and subjective *ending conditions*, iteratively either a *Conceptual-to-Empirical (C2E)* or an *Empirical-to-Conceptual (E2C)* is undergone to develop the taxonomy further. At the end of each approach, the taxonomy is *checked*, thus continuing the development with a C2E- or E2C-approach, when the ending conditions are not met or terminating the development when the ending conditions are met. In the following, we describe our adapted research design for each step of the taxonomy development.

Meta-Characteristic. The meta-characteristic is defined as the most comprehensive characteristic that serves as the basis for all dimensions and characteristics that follow (Nickerson et al. 2013). To be useful, the meta-characteristic must reflect the expected users and purpose of the taxonomy (Nickerson et al. 2013). We decided that the perspective of the activity with the mobile personal finance app by the user will lead to the most insights. It becomes apparent that for mobile personal finance apps, there is a distinction between what is being delivered (*financial service*) and how it is delivered through the mobile app (*technical artifact*). Thus, we perceive the usage of an app in the domain of interest from two viewpoints: The *technical artifact perspective*, including all mobile app related elements and the *financial services perspective*, including all elements of the underlying personal finance service the app provides. The taxonomy aims to determine and present the interplay between these perspectives on mobile personal financial app usage. Therefore, we define the meta-characteristic for this taxonomy as *technical functionalities of and financial services delivered through mobile applications in the area of personal finance from the perspective of its users*.

Ending Conditions. Nickerson et al. (2013) describe, besides the two defining factors of a taxonomy, namely its *mutual exclusivity* and *collective exhaustiveness*, seven objective and five subjective ending conditions, that must be met to terminate the taxonomy development procedure. We aim at meeting all ending conditions in our final taxonomy. Table 1 shows which defining factors and ending conditions were met at the end of each iteration of our taxonomy development.

Conceptual-to-Empirical (C2E) approach. In C2E-approaches, existing knowledge within the domain of interest gets reviewed, including identifying main concepts from literature (Eickhoff et al. 2017). Based on that knowledge and the taxonomy's key intention in the form of the meta-characteristic, the researchers deduce relevant dimensions and characteristics (Nickerson et al. 2013).

Empirical-to-Conceptual (E2C) approach. In E2C-approaches, real-world objects within the domain of interest are categorized, thereby modifying, merging, adding, and deleting dimensions and characteristics of the taxonomy (Nickerson et al. 2013). The objects we classify are native mobile apps found in the corresponding "finance" sections in both Apple App Store and Google Play Store offered in Germany. The selected app stores are the only respectively biggest channels for delivering mobile apps to the most popular mobile operating systems, iOS and Android (e.g., Lee and Raghu 2014). Germany has one of the largest smartphone userbases worldwide. The domestic app stores provide a wide range of different apps in the finance category due to its competitive and highly digitally advanced financial services market (e.g., Jünger and Mietzner 2020). Also, it was the most pragmatic app region for us to use, since we could download and use the apps, to its full potential. However, to obtain a relevant and workable sample of apps, we needed to restrict the objects to the most relevant. For that, we choose to use the apps that are highest ranked in each app store. The app stores sort apps into three classes: free, paid, and grossing, e.g., by in-app purchases. We captured the top-ranked apps for each app store and class by using the databases Similarweb and Appbrain, which accumulate this data. We

found that both platforms' apps have sufficiently similar technical functionalities and support of the underlying services. Therefore, we just included one app in our sample, if both iOS and Android apps were within the top-ranked apps. All apps were selected based on the ranking of January 10th, 2021.

To ensure a decent quality of our app sample, we only included apps whose download count was at least 5000+ and that were updated within the last two years. We also needed to exclude apps that, even though listed in the finance category, do not meet our personal finance definition. Therefore, we excluded apps for small businesses, e.g., to write invoices, apps for earning money by playing games with ads, and apps, which only purpose is to support the identification as a person. In contrast, apps that legitimize financial transactions, e.g., "Pushtan" or "PhotoTan," are included in our sample. We excluded password and pin managers, mobile data usage trackers, national debt trackers, and calculators without a clear focus on personal finance matters. In contrast we included, e.g., currency, car tax and pension calculators. Lastly, we excluded apps that are exclusively distributed for tablets.

To analyze the final pool of 170 apps, we first read the description given in both app stores, if applicable. Of our final pool, 19 apps are exclusively on iOS, 24 apps are exclusively on Android, and 127 apps are available on both mobile platforms. For more complex apps or less expressive descriptions in the app stores, we also considered the app provider's website. If characteristics could not be determined by store description or internet search, we downloaded the app and tried the functionalities in detail. All decisions concerning modifying, merging, adding, and deleting dimensions and characteristics were conducted based on discussions within the author team.

Towards a Taxonomy of Mobile Personal Finance Applications

To address RQ1, we describe the taxonomy development of mobile personal finance apps by detailing each of the six iterations and visualizing the dimensions' progression in Figure 1. Table 1 shows which defining factors and ending conditions were met at the end of each iteration. Lastly, we present the final taxonomy in Table 2. We defined all final dimensions and characteristics online in Table A.
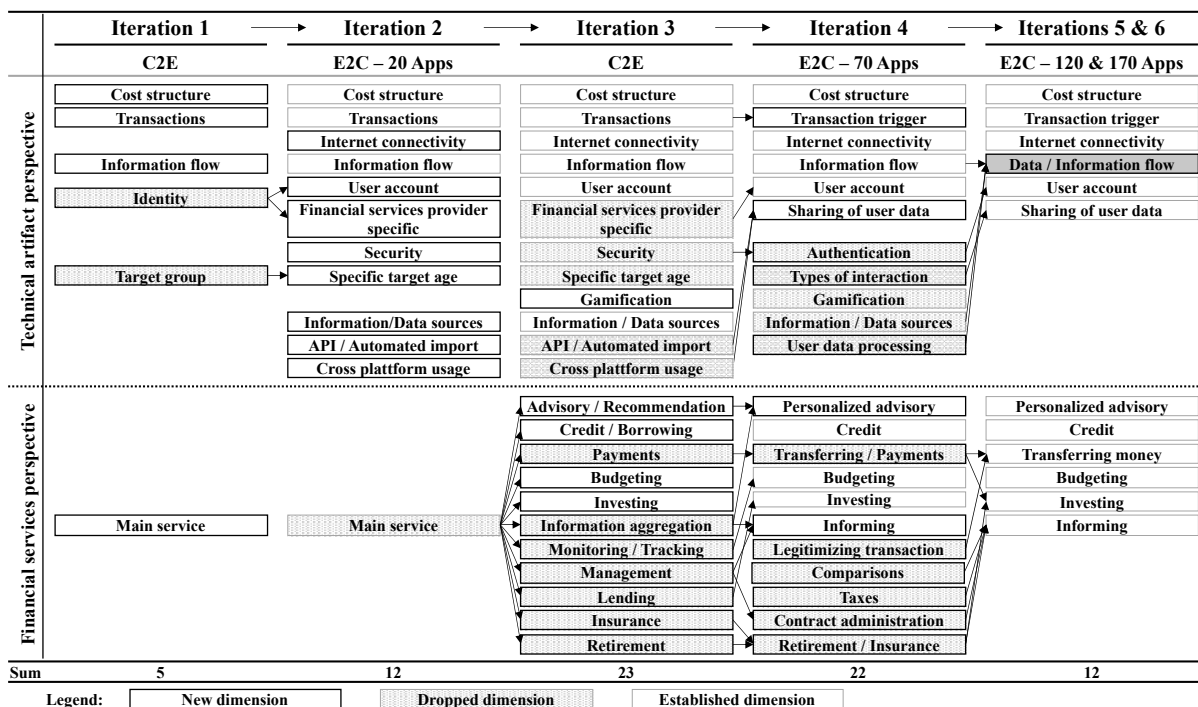
Figure 1. Dimensions in each Iteration of the Taxonomy Development Process

Iteration 1 - C2E. In the first iteration, utilizing the C2E-approach, we used the theoretical background regarding personal finance and related aspects of mobile apps in this domain to construct a preliminary taxonomy with first dimensions and characteristics. Following our definition of personal finance, we constructed the dimension *Main service* with characteristics of more traditional financial services, e.g., "Money management," "Budgeting," "Investing" or "Credit" (e.g., Garman and Forgue 2018), and

more recent Digital Finance services, e.g., "Peer-to-Peer (P2P)-lending", "Crowd funding" or "Digital payments" (e.g., Gomber et al. 2017). Concerning the *technical artifact perspective,* we established a *Cost structure* dimension. Cost structures of apps delivered through App Stores are denominated as app-level attributes, that are a necessary technical condition, i.e., app-specific properties, to use the app and the underlying services (Lee and Raghu 2014). The characteristics "Free," "One-time payment," "Subscription," and "Transaction dependent" are derived from the app classification in the app stores. The other dimensions *Transactions* ("No tracking"; "Manual tracking"; "Automated tracking"; "Scan"), *Information flow* ("Unidirectional to user"; "Unidirectional from user"; "Bidirectional"), *Identity* ("Identity-based"; "Non-identity-based") and *Target group* ("Individual"; "Group") originated from the mobile apps taxonomy of Nickerson et al. (2013). This first preliminary taxonomy did not meet the defining factors of a taxonomy, thus necessitating the continuation of our development.

Table 1. Defining Factors and Ending Conditions met in each Iteration of the Taxonomy Development

	Ending Conditions	Iterations I1	I2	I3	I4	I5	I6
Def.	*Mutually exclusive:* No object has two different characteristics in a dimension			●	●	●	●
	Collectively exhaustive: Objects have at least one characteristic in each dimension		●			●	●
Objective	All objects (or a representative sample) were analyzed					●	●
	No objects were merged or split		●	●	●	●	●
	At least one object assigned to each characteristic		●			●	●
	No new dimensions or characteristics were added in the last iteration						●
	No dimensions or characteristics were merged or split in the last iteration						●
	Every dimension and every characteristic within their dimension are unique			●	●	●	●
	Every combination of characteristics is unique			●	●	●	●
Subjective	*Concise*: Dimensions and characteristics are limited	●	●			●	●
	Robust: Sufficient number of dimensions and characteristics			●	●	●	●
	Comprehensive: Identification of all (relevant) dimensions of an object				●	●	●
	Extendable: Possibility to easily add dimensions and characteristics in the future	●		●	●	●	●
	Explanatory: Dimensions and characteristics sufficiently explain the object				●	●	●

Iteration 2 - E2C. Within the second iteration, we classified a randomly selected first set of 20 apps, picked from our pool, into our preliminary taxonomy. Many new functionalities surfaced, and we needed to derive new dimensions or modify existing ones. We refined the *Cost structure* dimension with new characteristics, namely "For free," "Freemium [in-app purchase]," "Freemium [subscription]," "Freemium [transaction dependent]," and "Premium." Within the *Transaction* dimension, we merged the "Automated" and "Scan" characteristics to "Assisted manual + automated." *Target group* was further refined to *Specific target age* with the characteristics "None," "Child," "Young adult," and "Elderly." We split the dimension *Identity* into more specific dimensions, *User account* ("Mandatory"; "Not mandatory") and *Financial service provider specific* ("Customer account required"; "No customer account required"). Also, new dimensions and characteristics emerged within the *technical artifact perspective,* namely: *Internet connectivity* ("Yes"; "Partially"; "No"), *Security* ("No password"; "Password / Biometric"; "Password / Biometric + 2-Factor"), *Information / Data sources* ("Internal"; "Bank"; "External partners"; "Hybrid"), *API / Automated import* ("Yes"; "No") and *Cross platform usage* ("Not possible"; "Automated"; "Web service"). Having classified a small set of apps and not fulfilling all defining factors, we continued the taxonomy development.

Iteration 3 - C2E. Approaching the third iteration, we faced difficulties, especially with the dimension *Main service*: We were hindering a more *comprehensive* and *explanatory* taxonomy with too many characteristics in one dimension. Also, our taxonomy did not fulfill the defining *mutual exclusiveness*. Therefore, we choose to step back and conduct a second C2E-approach. To showcase more diverse app characteristic combinations and thus to comply with the *extendibility* of the taxonomy, we broke up the *Main service* dimension into an array of distinct service-related dimensions within the *financial services perspective*. These often had binary characteristics "Yes" or "No" when the mentioned service or value is supported respectively not supported by the app. Of these dimensions, four comprised of *Advisory / Recommendation*, *Information aggregation, Monitoring / Tracking,* and *Management*, determining the more abstract received value for the user (Eickhoff et al. 2017). The other five consisted of *Credit / Borrowing* and *Lending* (with each "Traditional" and "P2P" characteristics replacing "Yes"), *Payments* (with "Traditional," "Digital" and "Crypto" characteristics replacing "Yes") and *Budgeting, Investing, Retirement* and *Insurance* summarizing the underlying personal finance services of the apps (Garman

and Forgue 2018; Gomber et al. 2017). Within the functional perspective, we introduced *Gamification* ("Yes"; "No"), based on its nudging power, especially in the mobile apps domain (Schöbel et al. 2020). While finally meeting the *mutually exclusivity*, we did not meet the *collective exclusiveness* factor that necessitated further taxonomy development.

Iteration 4 - E2C. Intending to broaden the now conceptually more rigid taxonomy, we classified 50 more apps of our app pool. To strengthen the distinctiveness between both perspectives and since the monitoring of transactions is described within the dimension *Budgeting*, we changed *Transaction* to *Transaction trigger* ("Manual + Assisted manual"; "Manual"; "None"). *Financial services provider specific* merged into *User account*, since the corresponding characteristics correlated frequently and therefore did not provide more explanatory power to the taxonomy. Both just established dimensions, *API / Automated import* and *Cross platform usage* from the third iteration, are merged into the new dimension *Sharing of user data* ("App provider only"; "[Other] banks"; "Third parties"; "Banks + Third parties"). We changed *Security* to *Authentication* ("No factor [know/have/are]"; "One factor"; "Two factor"), approaching a more explicit categorization of security factors. Additionally, we introduced the dimensions *Types of interaction* ("No interaction with others"; "Business-to-Customer/Business-to-Government"; "Peer-to-Peer"; "Business-to-Customer/Business-to-Government + Peer-to-Peer") and *User data / information processing* ("No processing"; "Aggregation for presentation"; "Aggregation + Further processing"), thus broadening the functional perspective even more. Since we could not find enough variations in the sample of apps concerning *Specific target age*, we dropped the dimension.

Within the financial services perspective, we merged all received value dimensions established in the third iteration into the financial services dimension, thus merging *Advisory / Recommendation* and *Information aggregation* in the new formed *Personalized advisory* ("Hybrid"; "Automated"; "Human advice through app"; "None"). While *Monitoring / Tracking* merged into *Budgeting* ("Manual"; "Automated"; "Manual + Automated + Prediction"; "None"), *Management* merged into the new dimension *Contract administration* ("Yes"; "No") and the new dimension *Informing* ("News and pricing"; "Educational content"; "Multiple information offerings"; "None"), which also incorporates parts of the *Information aggregation* dimension. We merged the dimensions *Retirement* and *Insurance*, because of its common services provided to users, to *Retirement / Insurance* ("Offering"; "Mediating"; "Monitoring"; "None"). Since *Lending* merged into *Investing*, which now incorporated the new characteristic "P2P-Lending", we could also rename *Credit / Borrowing* into the more concise *Credit* dimension. To account for the transfer of financial assets, we modified the *Payments* dimension to *Transferring / Payments* ("Money [bank transfer]"; "Money [retail]"; "Crypto currency"; "Hybrid"; "None"). Finally, we introduced the following new dimensions: *Legitimating transactions* ("Yes"; "No") and *Taxes* ("Yes"; "No"). We continued the taxonomy development, since we found that the defining factor *collective exhaustiveness* and the *conciseness* ending condition were still violated.

Iteration 5 - E2C. Due to the taxonomy's high complexity, with 22 dimensions and 87 characteristics, we mitigated the *explanatory* nature of the taxonomy, discovering interrelated connections between dimensions and characteristics especially hard. We approached the goal to reduce the taxonomy complexity by discussing the following questions within the researchers' team: "*Which dimensions are the most important?" - "Which dimensions add the most to the taxonomy?" - "Which dimensions will users find most useful?"*. First, the dimension *Information flow* was modified to *Data / Information flow* and incorporated much of the explanatory power of both dimensions *Information / Data sources* and *User data processing*. *Types of interaction* merged into *Sharing of user data*, which was established within the last iteration. While *Authentication* correlated often with the *User account* dimension, the reason for deleting *Gamification* was that only five apps in our sample provided any gamification elements. Therefore, the dimension did not provide enough data to explain the interrelated connections between the apps of interest. Lastly, we added a characteristic "Hybrid" to the *Cost structure*.

Within the financial services perspective, we changed the characteristics in the *Credit* dimension to accompany, what the app supports concerning credit, instead of where the borrowed money comes from ("Offering / Mediating"; "Monitoring"; "None"). Within *Transferring / Payments,* we moved the characteristic "Crypto currency" to the *Investing* dimension. Thus, the new dimension *Transferring money* ("Money [bank transfer]"; "Money [retail]"; "Hybrid"; "Legitimating transactions only"; "None") emerged, which also integrated the *Legitimizing transaction* dimension. *Investing* was, like the

dimension *Credit*, changed to account for the service provided through the app, but simultaneously distinguishes between traditional and non-traditional financial assets to invest in. Because of its frequently low usage, we also merged *Retirement / Insurance* into *Investing* ("Traditional financial assets"; "Non-traditional financial assets"; "Hybrid"; "Monitoring"; "None"). Finally, we changed the *Informing* dimension to incorporate the previously established dimensions *Comparisons*, *Taxes,* and *Contract administration.* For that, we developed the more abstract distinction between "non-individualized" information offerings, e.g., news or pricing, and "individualized" information, e.g., on personal contract administration or taxation. Finally, we almost halved the number of dimensions, thus meeting the *conciseness* and *robustness* ending conditions. By classifying 50 more apps of our pool, we also verified that we preserved most of the descriptive and *comprehensive* power of the taxonomy by meeting both defining factors of a taxonomy *collective exhaustiveness* and *mutual exclusivity* simultaneously. Still, we did not meet both objective ending conditions concerning adding, splitting, and merging dimensions and characteristics, and therefore continued the taxonomy development.

Iteration 6 - E2C. Finally, we evaluated the stability of our taxonomy by classifying the last 50 apps of our pool. Since we did not need to further modify the taxonomy dimensions and characteristics to capture the technical functionalities and underlying financial services, we found that the taxonomy is stable. Thus, we terminated the taxonomy development after the sixth iteration. In Table 2, we present our final taxonomy with twelve dimensions and 46 characteristics, including the number of occurrences for each characteristic. We also present all 170 apps classified in the final taxonomy online in Table B.

Table 2. Final Taxonomy (with number of occurrences for each characteristic), n=170 Apps

	Dimension	*Characteristics*					
Technical artifact	***Cost structure***	For free (57)	Freemium [in-app purchases] (30)	Freemium [sub-scription] (17)	Freemium [transaction dependent] (31)	Premium (27)	Hybrid (8)
	Transaction trigger	None (98)		Manual (41)		Manual + Assisted manual (31)	
	Internet connectivity	Mandatory (122)		Periodically online (32)		Offline (16)	
	Data / Information flow	Unidirectional to user (34)		Unidirectional from user (44)		Bidirectional (92)	
	User account	Mandatory (115)			Not mandatory (55)		
	Sharing of user data	App provider only (112)		[Other] banks (18)	Third parties (25)	Banks + Third parties (15)	
Financial services perspective	***Personalized advisory***	Hybrid (6)		Automated (18)	Human advice through app (8)	None (138)	
	Credit	Offering or mediating (18)		Monitoring (26)		None (126)	
	Transferring money	Money [bank transfer] (21)	Money [retail] (5)	Hybrid (14)		Legitimating transactions only (12)	None (118)
	Budgeting	Manual (31)		Automated (19)	Manual + Automated + Prediction (17)	None (103)	
	Investing	Traditional financial assets (14)	Non-traditional financial assets (20)	Hybrid (7)		Monitoring (30)	None (99)
	Informing	Non-individualized (65)		Individualized (18)	Hybrid + Education (23)	None (64)	

Cluster Analysis and Archetypes of Mobile Personal Finance Applications

To address RQ2, we conducted a cluster analysis, based on our taxonomy, to empirically identify typical patterns (archetypes) of personal finance apps. A cluster analysis aims to find groups of classified objects (personal finance apps) that minimize differences within a group and maximize differences between groups (Kaufman and Rousseeuw 1990). For this study, we choose the k-means clustering technique, one of the most commonly used unsupervised machine learning algorithms to partition a data set to *k* groups or clusters. The k-means clustering thereby minimizes the variance within each cluster [total within-cluster sum of square (WSS)] by moving the objects iteratively to the nearest clusters centroid (Punj and Stewart 1983).

Before performing a k-means clustering, one must first decide on the number of clusters the data set should be classified into. Many approaches exist to find the optimal number of clusters based on the data set, e.g., by calculating the average silhouette width in the "silhouette" method or by minimizing the WSS for different k clusters in the "Elbow method." In our case, while the *silhouette* method suggested that the data should be categorized into eight clusters, the *Elbow-method* implied eight or ten clusters. Therefore, we conducted the cluster analysis with eight and ten groups using R-Studio with the *kmeans* function and the argument *nstart* set to 25, setting all other arguments to their defaults. We found that the ten-cluster results provided more distinction between the clusters and more potential for interpretation. The resulting cluster analysis in Table 3 shows percentages for each characteristic within a cluster and shading between 100% (dark) and 0% (light). For example, 26% of all apps in cluster 1 require a user account, whereas 74% do not require a user account.

In the following, we elaborate on these ten clusters and describe the archetypical technical functionalities and financial services provided, including exemplary apps of each cluster. Additionally, a list of all apps categorized in the clusters can be found online in Table C.

Table 3. Results of the Cluster Analysis

Dimension	Characteristic	Cluster 1 23 Apps	Cluster 2 7 Apps	Cluster 3 31 Apps	Cluster 4 26 Apps	Cluster 5 13 Apps	Cluster 6 18 Apps	Cluster 7 17 Apps	Cluster 8 14 Apps	Cluster 9 8 Apps	Cluster 10 13 Apps
Cost structure	For free	17%	0%	3%	4%	100%	72%	41%	29%	25%	92%
	Freemium [in-app purchases]	26%	14%	13%	46%	0%	6%	35%	0%	0%	0%
	Freemium [subscription]	35%	29%	3%	4%	0%	0%	12%	0%	38%	0%
	Freemium [investment / transaction dependent]	0%	0%	81%	0%	0%	6%	6%	0%	38%	8%
	Premium	22%	14%	0%	38%	0%	17%	6%	50%	0%	0%
	Hybrid	0%	43%	0%	8%	0%	0%	0%	21%	0%	0%
Transaction trigger	Manual + Assisted manual	0%	14%	6%	0%	8%	44%	0%	0%	75%	0%
	Manual	0%	0%	90%	0%	0%	50%	12%	0%	25%	0%
	None	100%	86%	3%	100%	92%	6%	88%	100%	0%	0%
Internet connectivity	Mandatory	100%	0%	100%	31%	100%	72%	47%	36%	100%	100%
	Periodically online	0%	100%	0%	31%	0%	28%	53%	21%	0%	0%
	Offline	0%	0%	0%	38%	0%	0%	0%	43%	0%	0%
Data / Information flow	Unidirectional to user	74%	0%	0%	0%	92%	17%	6%	36%	13%	0%
	Unidirectional from user	9%	43%	0%	100%	0%	6%	18%	57%	0%	8%
	Bidirectional	17%	57%	100%	0%	8%	78%	76%	7%	88%	92%
User account	Mandatory	26%	29%	97%	35%	100%	100%	94%	0%	100%	100%
	Not mandatory	74%	71%	3%	65%	0%	0%	6%	100%	0%	0%
Sharing of user data	App provider only	83%	0%	55%	100%	92%	50%	65%	100%	13%	23%
	[Other] banks	0%	71%	10%	0%	0%	6%	0%	0%	38%	46%
	Third parties	17%	0%	32%	0%	0%	17%	24%	0%	25%	15%
	Banks + Third parties	0%	29%	3%	0%	8%	28%	12%	0%	25%	15%
Personalized advisory	Hybrid	0%	0%	0%	0%	0%	6%	18%	0%	25%	0%
	Automated	0%	43%	10%	0%	0%	0%	35%	0%	63%	8%
	Human advice through app	22%	0%	0%	0%	0%	0%	0%	0%	13%	15%
	None	78%	57%	90%	100%	100%	94%	47%	100%	0%	77%
Credit	Offering / Mediating	0%	14%	6%	0%	0%	50%	6%	0%	25%	23%
	Monitoring	0%	86%	0%	23%	0%	22%	12%	14%	0%	46%
	None	100%	0%	94%	77%	100%	28%	82%	86%	75%	31%
Transferring money	Money (bank transfer)	0%	14%	16%	0%	0%	50%	6%	0%	25%	23%
	Money (retail)	0%	0%	0%	0%	8%	22%	0%	0%	0%	0%
	Hybrid	0%	0%	6%	0%	0%	11%	0%	0%	0%	77%
	Legitimating transactions only	0%	0%	0%	0%	77%	11%	0%	0%	0%	0%
	None	100%	86%	77%	100%	15%	6%	94%	100%	75%	0%
Budgeting	Manual	0%	0%	3%	92%	0%	11%	18%	7%	0%	0%
	Automated	0%	0%	10%	0%	0%	44%	6%	0%	0%	54%
	Manual + Automated + Prediction	0%	100%	0%	8%	0%	17%	6%	0%	25%	15%
	None	100%	0%	87%	0%	100%	28%	71%	93%	75%	31%
Investing	Traditional financial assets	0%	0%	10%	0%	0%	0%	0%	0%	63%	46%
	Non-traditional financial assets	0%	0%	61%	0%	0%	0%	0%	0%	13%	0%
	Hybrid	0%	0%	16%	0%	0%	0%	0%	0%	25%	0%
	Monitoring	100%	14%	0%	4%	0%	0%	18%	0%	0%	15%
	None	0%	86%	13%	96%	100%	100%	82%	100%	0%	38%
Informing	Non-individualized	52%	14%	90%	8%	0%	0%	0%	86%	25%	62%
	Individualized	9%	0%	0%	4%	0%	0%	82%	7%	0%	0%
	Hybrid + Education	39%	29%	10%	0%	0%	0%	12%	7%	75%	0%
	None	0%	57%	0%	88%	100%	100%	6%	0%	0%	38%

(Technical artifact perspective: Cost structure, Transaction trigger, Internet connectivity, Data / Information flow, User account, Sharing of user data. Financial services perspective: Personalized advisory, Credit, Transferring money, Budgeting, Investing, Informing.)

Cluster 1 – App Provider Specific Financial News and Analysis. Apps in this relatively big cluster provide non-individualized information about financial assets and monitor portfolios of traditional and non-traditional assets e.g., cryptocurrencies without the possibility to trigger transactions. The majority of apps do not provide other services, except apps like "Seeking Alpha," that provide financial analysis from human experts, e.g., in the form of forum posts or educational content. Because being informed means having up-to-date information, the apps require a constant internet connection to deliver their service. Although most apps are usable without an account, a user account and additional in-app

purchases or subscriptions can provide features, e.g., more sophisticated financial analysis tools, more profound expert advice, or an ad-free experience.

Cluster 2 – Advanced Budgeting. Within this cluster, seven apps provide advanced budgeting services, including future predictions based on personal transactions. These personal transactions can be synced automatically and periodically from the user's bank accounts, credit cards, and depots through bank APIs or web crawling (e.g., Banking4). Most apps do not require a user account but provide more services with an account and in-app-purchases, subscriptions, or both, e.g., more in-depth budget analyses and advice on cheaper insurances, automatically analyzing financial transactions.

Cluster 3 – Transaction Remunerated Trading and International Money Transfer. Apps within this biggest cluster of our sample provide international transfer of money (e.g., MoneyGram International) and assets (trading), in general, without advising the user. While a minority of apps provide traditional asset trading (e.g., Trade Republic), most apps are specialized in cryptocurrency and other non-traditional asset trading (e.g., Coinbase). To perform trading and money transfers, thus triggering financial transactions, the apps need to be online. Being online is required to process the orders and to update non-individualized information on the pricing of assets or conversion rates in international money transfers. Users also need to have an account, often personally legitimated. User data is often shared with brokers, in the case of traditional assets, with banks, in the case of money transfers, and with third parties in case of cryptocurrency orders. Users are paying for the service by fees on the transaction or investment amounts.

Cluster 4 – Manual Budgeting without Data Sharing. The second biggest cluster in our sample incorporates less advanced, manual budgeting apps. Apps like "1Money" do not sync data with banks. Therefore, users need to manually track financial transactions in the app to control their budgets. Except for credit monitoring, these apps do not provide any additional services. Because of its rudimentary service provision, manual budgeting apps do not often require user accounts or internet connections, except when backing up user data. Therefore, user data is not shared with other entities, and the apps can be used offline. The apps often deliver rudimentary functions in a free version and provide more customization or in-depth analysis when users pay in advance (premium) or through in-app-purchases.

Cluster 5 – Transaction Authorization. This cluster consists of apps that can authorize financial transactions, e.g., transferring money or buying assets. The apps are often supplementary to their financial service provider, e.g., the "Commerzbank photoTAN" app for the Commerzbank, and therefore free to the user. Because of their limited functionality, only legitimizing transactions, the information flow is just unidirectional to the user. Also, because of their security purpose, apps do not share their user data with other entities.

Cluster 6 – Credit Card and Retail Payment. Apps within this cluster provide monitoring of credit cards (e.g., Amazon.de VISA Card) and function as retail payment methods (e.g., Google Pay). Because the apps can trigger manual transactions in retail or provide sensible personal credit information, users need to have an account. These apps are often supplementary to bank accounts or credit cards, therefore free for users. Apps in this cluster do not offer advisory or investing services but money transfer, credit services, and automated budgeting through the record of transactions.

Cluster 7 – User-Account-based Individualized Informing. In this cluster, apps provide individualized information services to users. On the one hand, the cluster consists of tax advisor apps (e.g., Taxfix) or insurance / energy contract comparison platforms (e.g., Check24) that take the individual preferences and life circumstances of the user into account and provide contract monitoring services (e.g., Clark). On the other hand, apps in this cluster let groups of users collaborate on budgets, e.g., by splitting transactions or sharing money pools (e.g., Splitwise). Consequently, a user account and at least a periodical internet connection are often necessary. These apps also have in common that no actual transactions are triggered, except when buying specialized insurance manually through the app (e.g., Getsafe). Furthermore, information flows bidirectionally to and from users, and data is shared frequently with other entities to provide the underlying service. Most of the apps are free to use or provide further services, e.g., tax declaration submissions through the app, by in-app-purchases.

Cluster 8 – Non-Individualized Informing. In contrast to cluster 7, apps in this cluster provide mainly non-individualized information. For example, apps in this cluster convert currencies (e.g., Exchange rate converter) or calculate net salaries. Information within these apps flows unidirectional to or from the user, never bidirectional. User accounts are not necessary, and an internet connection is not always required to provide the service to users. Therefore, the user data remains at the app provider only. Since the apps are not connected to other entities or services, they often need to be paid for in advance.

Cluster 9 – Investing with Advice. Apps in this relatively small cluster offer investing services in conjunction with personalized advice. Compared to the apps in cluster 3, these apps provide not only information about the pricing of the assets of interest but educate the user about investing or provide automated or even hybrid personalized advice on portfolio decisions. Traditional financial assets as well as investing in cryptocurrencies is possible (e.g., eToro). Triggers to invest are mainly manual but can also be assisted through the app, depending on the user's investment behavior and the degree of decision-making delegation to the service, for example, full automation in the case of Robo-Advisors (e.g., Scalable Capital). Despite its freemium nature, users have to pay for the service depending on the transaction value or investment amount. Consequently, apps in this cluster require a legitimized user account, an internet connection, and information flows bidirectionally to and from the user.

Cluster 10 – Full-Featured Mobile Banking. Mobile apps in this cluster provide many traditional mobile banking services (e.g., Deutsche Bank Mobile). Generally, they are free to download, but users must have an account from the financial service provider to get access to the services. Internet connectivity is mandatory, and transactions can be triggered manually or assisted by mobile device functions, e.g., photographing bills. Based on the included services provided, e.g., transferring money, credit offerings, and monitoring, as well as investing in mainly traditional assets, the transfer of user data is manifold. App providers also offer non-individualized information to broaden their services, but without providing educational content. Still, these apps only rarely offer advisory services to their users.

Discussion, Implications, and Recommendations

The final taxonomy provides relevant dimensions and characteristics to structure the field of mobile personal finance apps with the widely used approach by Nickerson et al. (2013). Therefore, our study can serve as a systematic discussion platform among academics and practitioners about the status quo of the personal finance app domain. Moreover, the expandable nature of our taxonomy allows researchers and practitioners to modify, merge, add and delete characteristics and dimensions.

Our cluster analysis derived ten distinct clusters, which indicates mobile personal finance apps' versatility, and that the domain delivers more than just mobile banking. This study is thereby the first to our knowledge that combines and discusses technical functionalities as well as the underlying delivered personal finance services. In that regard, financial service providers and developers can compare their apps with the competition on an objective scale and gain insights into common archetypical configurations of characteristics. Based on these insights, they could add new technical features and services, focus marketing activities on their unique feature set or find innovative combinations of characteristics not yet present on the market. While we found that our target age group dimension did not provide enough explanatory power to be part of our final taxonomy, developers could build apps specifically for less often addressed but relevant, segmented customer groups. For example, apps could target children, teenagers, or elderly since these demographics have distinctly different needs for technical app features and financial services compared to adults (e.g., Xue et al. 2020). Also, policy makers can use our taxonomy and cluster analysis to identify service providers of relevance and thereby focus their regulation activities and monitoring especially regarding new market entrants. Lastly, researchers could use our taxonomy for theory development, e.g., for explaining app success.

Interpreting the app sample from the *technical artifact perspective*, we can state that the majority of personal finance apps need a mandatory internet connection and a user's account to deliver their services. Only two archetypes, *manual budgeting without data sharing* and *non-individualized informing* provide any offline functionality. This can be explained by mobile internet connections becoming less expensive, and user accounts becoming more ubiquitous due to social media and other personalized internet offerings. While the information and data flows are more frequently bidirectional

in comparison to unidirectional, the user data sharing with other entities is not that common. This could be interpreted as a data security measurement or as a less feature-rich app configuration pattern.

Concerning the *cost structure*, we found a shift from less featured apps that are mostly premium, or freemium-based, to more innovative or feature-rich apps with either subscription- or transaction-based revenue models or are free to the user. In the first case, to be up to date on functionality and security, developers need to work on their apps iteratively and therefore need to finance their constant advancement (e.g., Lee and Raghu 2014). In the second case, developers have a smaller demand to produce revenue since new apps rely more on backing through venture capitalists, and the goal is often to build a big userbase first (e.g., Gomber et al. 2018).

Within the *financial services perspective,* it is noticeable that personal finance apps frequently do not provide more than one service to the user. Except for apps within *cluster 10 – full featured mobile banking*, the majority of apps specialize in one service and mostly differ in their technical functionalities. That said, personal advisory seems not very common in mobile banking despite its large-scale service provision. Furthermore, we only found two clusters that deliver educational content of personal finance at all, almost always concerning investment decisions. This seems like a missed chance for financial services providers since financial education can play a significant role for users, not only in their investment behavior. Delivering more educational content to the user can raise the trust in the financial services provider and cause higher engagement with the app. This can lead to higher investment amounts, thus increase the revenue of the app provider (e.g., van Rooij et al. 2011).

Limitations and Future Research Directions

Our following limitations can guide future research on mobile personal finance apps. Firstly, we classified a sample of 170 apps from the German app stores to develop our taxonomy. While the German app market is big and diverse, it can be criticized that the results are not generalizable to other app market regions. In that regard, we examined a sample of the top mobile personal finance apps from the US app stores and found that the sample could be sufficiently described and categorized using our taxonomy and archetypes. Still, future research should evaluate the applicability of our taxonomy and archetypes to app markets in other regions and with a larger sample size.

While we performed a sixth iteration within the taxonomy development to show our taxonomy's stability, we did not evaluate our results by third parties. Evaluation is an important step for taxonomy development to support its usefulness and correctness (Szopinski et al. 2019). Therefore, future research could evaluate our taxonomy, e.g., by conducting interviews with financial services providers or other app developers. Also, our cluster analysis could be evaluated e.g., by using other clustering methods or discriminant analysis.

Based on the taxonomy and clustering, a higher-order predictive theory that allows researchers to better design and evaluate mobile personal finance apps could be valuable (Gregor 2006). In that regard, a possible research direction could be the measurement of mobile finance apps' success, e.g., with the information systems success model of DeLone and McLean (2004). We found that download numbers, review counts, and ratings differ between the apps within the archetypes. These possible information systems success measurements could be further analyzed, e.g., regarding the archetypes, to find principles for successful mobile personal finance app designs.

Lastly, it seems promising to develop innovative IT-artifacts using a design science research approach. For example, based on one or a combination of multiple of our archetypes, researchers could integrate emerging concepts, for example, gamification elements. These, we only found rarely and rudimentary, e.g., in the form of awards for saving money within the app "Finanzguru." When used more robustly, gamification elements can enhance user engagement with the app and could thereby positively influence personal finance activities of the user (e.g., Schöbel et al. 2020).

Conclusions

Mobile personal finance applications can not only assist users in daily personal finance activities, for example, mobile banking but can guide users, e.g., to optimize long-term financial decisions. To shed

light on this important and diverse mobile commerce domain, we developed a taxonomy and classified 170 mobile personal finance apps (RQ1). We identified twelve dimensions and 46 characteristics, combining a technical perspective and a financial services perspective. In addition, we examined archetypes of these mobile apps based on a cluster analysis, which we derived from the taxonomy (RQ2). We empirically identified ten application archetypes, namely, financial news and analysis, advanced or manual budgeting, transaction authorizing, credit card and retail payments, mobile banking, individualized or non-individualized information, and investments with or without advice.

Besides providing a rigorous classification that can be a starting point for further research, financial service providers and mobile app developers can benefit from our insights when comparing with competitors. Furthermore, we support them to advance their applications with new technical functions or services. Potential users of mobile personal finance applications can use our taxonomy and archetypes to support the selection of mobile apps that optimize their personal finance endeavors.

References

Angel, S. 2018. "Smart Tools? A Randomized Controlled Trial on the Impact of Three Different Media Tools on Personal Finance," *Journal of Behavioral and Experimental Economics* (74), pp. 104–111.

Apple. 2021. *App Store Categories*, https://developer.apple.com/app-store/categories/.

Arcand, M., PromTep, S., Brun, I., and Rajaobelina, L. 2017. "Mobile Banking Service Quality and Customer Relationships," *Service Quality* (35:7), pp. 1068–1089.

Bunnell, L., Osei-Bryson, K.-M., and Yoon, V. Y. 2020. "FinPathlight: Framework for an Multiagent Recommender System Designed to Increase Consumer Financial Capability," *Decision Support Systems* (134), Article 113306.

Dahlberg, T., Mallat, N., Ondrus, J., and Zmijewska, A. 2008. "Past, Present and Future of Mobile Payments Research: A Literature Review," *Electronic Commerce Research and Applications* (7:2), pp. 165–181.

DeLone, W. H., and McLean, E. R. 2004. "Measuring E-Commerce Success: Applying the DeLone & McLean Information Systems Success Model," *International Journal of Electronic Commerce* (9:1), pp. 31–47.

Eickhoff, M., Muntermann, J., and Weinrich, T. 2017. "What Do FinTechs Actually Do? - A Taxonomy of FinTech Business Models," *38th International Conference on Information Systems (ICIS), Seoul, South Korea*.

French, D., McKillop, D., and Stewart, E. 2020. "The Effectiveness of Smartphone Apps in Improving Financial Capability," *The European Journal of Finance* (26:4–5), pp. 302–318.

Garman, E. T., and Forgue, R. E. 2018. *Personal Finance*, (13th ed.), Boston, USA: Cengage Learning.

Glass, R. L., and Vessey, I. 1995. "Contemporary Application-Domain Taxonomies," *IEEE Software* (12:4), pp. 63–76.

Gomber, P., Kauffman, R. J., Parker, C., and Weber, B. W. 2018. "On the Fintech Revolution: Interpreting the Forces of Innovation, Disruption, and Transformation in Financial Services," *Journal of Management Information Systems* (35:1), pp. 220–265.

Gomber, P., Koch, J.-A., and Siering, M. 2017. "Digital Finance and Fintech: Current Research and Future Research Directions," *Journal of Business Economics* (87:5), pp. 537–580.

Gregor, S. 2006. "The Nature of Theory in Information Systems," *MIS Quarterly* (30:3), pp. 611–642.

Han, S. P., Park, S., and Oh, W. 2016. "Mobile App Analytics: A Multiple Discrete-Continuous Choice Framework," *MIS Quarterly* (40:4), pp. 983–1008.

Hevner, A. R., March, S. T., Park, J., and Ram, S. 2004. "Design Science in Information Systems Research," *MIS Quarterly* (28:1), pp. 75–105.

Hoehle, H., and Venkatesh, V. 2015. "Mobile Application Usability: Conceptualization and Instrument Development," *MIS Quarterly* (39:2), pp. 435–472.

Huebner, J., Frey, R. M., Ammendola, C., Fleisch, E., and Ilic, A. 2018. "What People Like in Mobile Finance Apps: An Analysis of User Reviews," *17th International Conference on Mobile and Ubiquitous Multimedia (MUM), New York, USA*.

Huston, S. J. 2010. "Measuring Financial Literacy," *Journal of Consumer Affairs* (44:2), pp. 296–316.

Jünger, M., and Mietzner, M. 2020. "Banking Goes Digital: The Adoption of FinTech Services by German Households," *Finance Research Letters* (34), Article 101260.

Kaufman, L., and Rousseeuw, P. J. 1990. *Finding Groups in Data*, Hoboken, NJ, USA: Wiley & Sons.

Khalilzadeh, J., Ozturk, A. B., and Bilgihan, A. 2017. "Security-Related Factors in Extended UTAUT Model for NFC Based Mobile Payment in the Restaurant Industry," *Computers in Human Behavior* (70), pp. 460–474.

Kim, G., Shin, B., and Lee, H. G. 2009. "Understanding Dynamics between Initial Trust and Usage Intentions of Mobile Banking," *Information Systems Journal* (19:3), pp. 283–311.

Ky, S. S., Rugemintwari, C., and Sauviat, A. 2021. "Friends or Foes? Mobile Money Interaction with Formal and Informal Finance," *Telecommunications Policy* (45:1), Article 102057.

Lee, G., and Raghu, T. S. 2014. "Determinants of Mobile Apps' Success: Evidence from the App Store Market," *Journal of Management Information Systems* (31:2), pp. 133–170.

Lusardi, A. 2019. "Financial Literacy and the Need for Financial Education: Evidence and Implications," *Swiss Journal of Economics and Statistics* (155:1).

Lusardi, A., and Mitchell, O. S. 2014. "The Economic Importance of Financial Literacy: Theory and Evidence," *Journal of Economic Literature* (52:1), pp. 5–44.

Malaquias, R. F., and Hwang, Y. 2019. "Mobile Banking Use: A Comparative Study with Brazilian and U.S. Participants," *International Journal of Information Management* (44), pp. 132–140.

Nickerson, R. C., Varshney, U., and Muntermann, J. 2013. "A Method for Taxonomy Development and Its Application in Information Systems," *European Journal of Information Systems* (22:3), pp. 336–359.

Punj, G., and Stewart, D. W. 1983. "Cluster Analysis in Marketing Research: Review and Suggestions for Application," *Journal of Marketing Research* (20:2), pp. 134–148.

Puschmann, T. 2017. "Fintech," *Business & Information Systems Engineering* (59:1), pp. 69–76.

van Rooij, M., Lusardi, A., and Alessie, R. 2011. "Financial Literacy and Stock Market Participation," *Journal of Financial Economics* (101:2), pp. 449–472.

Sarkar, S., Chauhan, S., and Khare, A. 2020. "A Meta-Analysis of Antecedents and Consequences of Trust in Mobile Commerce," *International Journal of Information Management* (50), pp. 286–301.

Schierz, P. G., Schilke, O., and Wirtz, B. W. 2010. "Understanding Consumer Acceptance of Mobile Payment Services: An Empirical Analysis," *Electronic Commerce Research and Applications* (9:3), pp. 209–216.

Schöbel, S. M., Janson, A., and Söllner, M. 2020. "Capturing the Complexity of Gamification Elements: A Holistic Approach for Analysing Existing and Deriving Novel Gamification Designs," *European Journal of Information Systems* (29:6), pp. 641–668.

Shaikh, A. A., and Karjaluoto, H. 2015. "Mobile Banking Adoption: A Literature Review," *Telematics and Informatics* (32:1), pp. 129–142.

Sharma, S. K., and Sharma, M. 2019. "Examining the Role of Trust and Quality Dimensions in the Actual Usage of Mobile Banking Services: An Empirical Investigation.," *International Journal of Information Management* (44), pp. 65–75.

Szopinski, D., Schoormann, T., and Kundisch, D. 2019. "Because Your Taxonomy Is Worth It: Towards a Framework for Taxonomy Evaluation," *27th European Conference on Information Systems (ECIS), Stockholm, Sweden*.

Vasiljeva, T., and Lukanova, K. 2016. "Commercial Banks and Fintech Companies in the Digital Transformation: Challenges for the Future," *Journal of Business Management* (11:1), pp. 25–33.

Xue, R., Gepp, A., O'Neill, T. J., Stern, S., and Vanstone, B. J. 2020. "Financial Literacy and Financial Strategies: The Mediating Role of Financial Concerns," *Australian Journal of Management*.

Zhang, D., Hu, M., and Ji, Q. 2020. "Financial Markets under the Global Pandemic of COVID-19," *Finance Research Letters* (36), Article 101528.