Towards Design Excellence for Context-Aware Services - The Case of Mobile Navigation Apps

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Abstract. To satisfy service customers and create unique value in a digitized world, companies must strive for exceeding customers' expectations of e-service experience by establishing high e-service quality. However, an increasing amount of e-services is performed by context-aware mobile technology, which is able to sense and react to changes in the user's environment. Although these context-aware services are able to address our personal needs and already determine our everyday live, knowledge on how to develop such services is sparse. In our study, we qualitatively compare three mobile navigation apps based on their user reviews in order to elicit first requirements and design approaches for e-service quality oriented design. Results show that well known e-service quality models are not fully applicable to the case of mobile navigation services.

Keywords: context-aware services, design requirements, e-service quality, user reviews

1 Introduction

In today's fast-paced digitized world, companies increasingly strive for creating unique value to customers in order to distinguish their own service offerings from those of competitors. Attracting, keeping and satisfying customers and making profit are becoming more difficult in times of low to zero marginal costs as one effect of product and service digitization. In the past, value was considered as ratio between service quality and cost [1]. However, Vargo and Lusch offer a new perspective on customer value by introducing the concept of value in use [2]. According to them, service users are both co-creators and judges of service value [1], which implies that how value is perceived is predominantly determined by customer's individual service experience [3]. In this regard, service quality, i.e., the discrepancy between expected and realized service experience [4], is the focal enabler of customer satisfaction [5, 6]. Whereas in a traditional human-to-human service encounter service employees are able to adapt interactively on customer reactions to improve service quality, an increasing amount of services are nowadays based on technology, which rely on electronic interfaces and predefined interaction procedures. In this context, service quality is usually conceptualized as e-service quality (ESQ), suggesting that interaction with e-services,

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such as mobile applications or websites, is different to traditional human-to-human service encounters [7, 8].

With the rise of smartphones and the vision of ubiquitous computing, in which computers surround and adapt to the lives of humans without being obtrusive [9], the deterministic behavior of technology-based services, however, becomes increasingly turned upside down. Every modern mobile phone nowadays contains sensors to detect and adapt to changes of the user's physical or logical context, bringing context-aware mobile services a huge step towards non-determinism and ubiquity. Reflecting the new possibilities involved in the autonomous adaption to context information, such as time, location, speed, temperature, calendar entries, relevant news and (especially due to the success of smart watches) even health data like blood pressure and heart rate, adaptability of systems to users' real current needs is finally becoming possible. Context-awareness holds the potential to yield high-quality (i.e., perfect fit to individual users and their contexts) services that anticipate and hence satisfy customer needs in an entirely new manner. Against this backdrop, context-awareness can be considered a new and yet mainly unexplored paradigm that allows service and application designers to meet or even exceed customers' expected service experience in order to achieve high ESQ by design.

However, the question of how to design context-aware applications to meet requirements of high ESQ remains unanswered in scholarly and practical literature. In fact, even requirements that depict ESQ as design goal are sparse. This research gap may have manifold reasons. First, the definition and demarcation of service experience, service satisfaction, ESQ and related terms can be considered a conceptual chaos, since many schools of thought work towards many different directions. This leads to confusion in theory and practice when it comes to identifying the correct concept for a certain problem and its relation to adjacent ones. Second, ESQ as such has not be sensed as explicitly important for the design of (context-aware) services by practitioners, yet. Third, although many empirical data and a huge amount of measurement models exist on ESQ, no requirements or design principles for service and system development have been established based on this foundation. With this contribution, we aim to stress the importance of an ESQ-oriented system design approach. Our work is guided by the research question: *What are requirements and design approaches for high ESQ when developing mobile navigation services, as a subclass context-aware services?* We therefore identify, screen, cluster and analyze user reviews of three successful mobile navigation apps, as an important subclass of context-aware services, with regard to ESQ dimensions. In doing so, we aim at inductively identifying ESQ requirements and design approaches that help developers and requirements engineers to identify what makes the design of the mobile navigation services superior and what to consider when developing context-aware applications with ESQ as an overarching design goal.

The paper is structured as follows: In section 2, we give an overview on the peculiarities of context-aware services and introduce the concept of ESQ. Afterwards, our research approach is described in detail in section 3. Section 4 depicts the results of our study, which are then discussed in section 5. We conclude with a short summary, propose theoretical and practical contributions as well as limitations and next steps in section 6.

2 Background

2.1 Context-Aware Services

Following the vision of ubiquitous computing, one of the first ideas of applications that adapt to changes of their environment was introduced by Schilit and Theimer in 1993, who define the location, people and objects in proximity as well as their history as context of an application [10]. The question "Where you are, who you are with and what resources are nearby" thus characterize the context of an application [11, 12]. Ryan et al. define context as any collection of information about a system's environment, such as location, time, temperature and user identity [13]. Pascoe et al. state, however, that to define context is a complex task which cannot be done by simply listing possible context information [14]. Furthermore, Dey et al. conceptualize context as "any information about the user and the environment that can be used to enhance the user's experiences" [15]. In our work, we build up on abovementioned definitions and regard context as an attribute comprising all information about an entity's physical (e.g., location, temperature, humidity, etc.) and logical (e.g., calendar events, relevant news feeds, etc.) environment which can be captured by sensors. Furthermore, we focus on applications that are able to detect context (context detection) and react to this information by changing their behavior or functionality (context adaption). From a service science perspective, which focuses on the interaction and co-creation between entities within a service system to achieve a certain value, context-aware services play an increasingly important role [16, 17]. Glushko conceptualizes context-aware services as one field for future service design [18]. Nowadays, an increasing amount of technology-based services are aware of and adaptive to context, such as personal fitness, healthcare, disaster warning and navigation apps.

2.2 E-Service Quality

As a key driver leading to satisfied customers and economic growth, quality has its roots in marketing and consumer research, management science, engineering and operations. Golder et al. show that different understandings of quality have emerged in these academic fields [19]. The most pivotal perspective for our approach is obtained in marketing and consumer research which focuses customers' perception of quality. However, due to the heterogeneity of quality perspectives, "no universal, parsimonious, or all-encompassing definition or model of quality exists" [20]. One reason for the complexity of quality is that "objective quality may not exist because all quality is perceived by someone" [21]. In academic literature, the concept of perceived quality was proposed for services in manifold forms [8, 21–25]. Most existing approaches for analyzing and measuring service quality are based on the GAP model introduced by Parasuraman et al. [24] and SERVQUAL, a measurement instrument adopted from marketing [21]. Although they have massively shaped the research on service quality, these approaches have been established for services that encompass human actors only. However, due to digitization, many services are nowadays delivered and consumed through technology, which turns them into e-services. In the context of our study, we

follow Riedl et al. who define e-service as "a business activity of value exchange that is accessible through an electronic interface" [26]. Parasuraman et al. correctly find, that service quality literature is dominated by people-delivered services whereas only a limited number of articles deal with customers' assessment of ESQ, its antecedents and consequences [7]. However, there is a need for separately investigating ESQ, since customer evaluation of technology is different due to technology-based customer beliefs (e.g., technology-readiness) and technological peculiarities (e.g., server problems or connectivity issues) that may influence the quality perception process [7, 27]. Thus, Parasuraman et al. present a multiple-item scale for measuring ESQ called E-S-QUAL [7]. It is constructed and tested for measuring ESQ delivered by websites for online shopping. Despite the basic E-S-QUAL scale, which consists of 22 items in four dimensions (efficiency, fulfillment, system availability and privacy), they developed a scale for customers who have non-routine service encounters with the websites, which consists of 11 items in three dimensions (responsiveness, compensation and contact) called E-RecS-QUAL. Further models include zone-of-tolerance-based IS-SERVQUAL [28], SERVQUAL for E-commerce [29], eTailQ [30], WebQual [31, 32] and SaaS-Qual [33]. To consolidate all previous findings about ESQ and establish a common conceptual model, Blut et al. meta-analyze the most important empirical data [5]. In our work, we use their conceptual model as a starting point for developing coding categories. The meta-analysis conducted by Blut et al. reviews and summarizes a wide range of prior ESQ research and results in a conceptual model of four dimensions: website design, fulfilment, customer service and security. However, previous ESQ research also covered by Blut et al. has mainly focused on the interaction of customers with e-commerce websites [27]. For example, Parasuraman et al. define ESQ as "the extent to which a web site facilitates efficient and effective shopping, purchasing, and delivery" [7]. Thus, there is a huge research gap for investigating ESQ in a non-E-commerce context, such as context-adaptive services.

3 Research approach

In order to identify requirements and good design approaches for excellent mobile navigation apps, our approach is based on the method of Pegano and Maalej, who analyze user feedback from app stores and its impact on the user community [34]. For *data extraction*, we focus on the two biggest app stores: Apple's AppStore and Google Play. We registered to an online service[1] for crawling app reviews from these platforms (by using e.g., Apple's RSS feed generator) and converting them to comma-separated values (CSV) files for better analyzability. With this service, we extracted user reviews on top navigation apps on the US market: Google Maps, Waze and Navigon. According to download rate and overall user rating, these apps can be considered best-of-breed mobile navigation services. Our data sample covers the latest 1,500 user reviews (August 21, 2016; 500 reviews per app due to technical restrictions of the web service). The CSV data set contains the date, title and content of the review, nickname of

[1] https://heedzy.com/

reviewer, rating, reviewed app version and device of the reviewer. After extracting the reviews, *data analysis* was started by sorting out reviews with low to no informational value regarding requirements or design approaches for app development (e.g., ”Don’t download!!!” or “I love google maps”). Based on the ESQ dimensions and their definitions meta-analyzed by Blut et al. [5], we started building a category system for our endeavor, following the logic of qualitative content analysis [35]. However, since the meta-analysis mainly comprises studies that investigate ESQ with regard to e-commerce websites, not all dimensions conceptualized by Blut et al. are appropriate for our case of navigation services. This is mainly because (1) e-commerce providers use websites for information and facilitation of order processing whereas (context-aware) applications such as navigation apps are stand-alone e-services with backstage processes far behind the customer’s line of visibility, and (2) in e-commerce value is created through effective and efficient order processing and not by just using an electronic interface which, however, is the case for mobile applications. Hence, initial categorization was critically contrasted with other analyzed literature concerning ESQ. Categories must further fit to our research context and, following our understanding of context-adaptive services as mentioned above, reflect users’ perceptions of the app’s (a) context detection (i.e., gathering context data) or (b) context adaption (i.e., changing behavior based on context interpretation) abilities.

Thus, rearranging categories (i.e., ESQ attributes) from the initial framework was the first step: design was kept since we suggest it is important for app ESQ, especially when context changes (e.g., driving through a tunnel may cause the app to darken the screen to prevent dazzling). Following this logic, also information quality, ease of use, personalization and system availability have been kept from the design dimension, whereas e-commerce specifics (e.g., purchase process) were dropped. Furthermore, all categories regarding fulfilment and customer service were dropped from the initial framework, since they are by definition too e-commerce specific. Security and Privacy were kept since these appear crucial to context data detection. Reviewing prior research reveals that Benlian et al. is closer to our research context than other work in the field, since they provide not only ESQ items for user-to-provider but also for direct user-to-software encounters [33]. Some of these items are transferable to categories that are valuable for our approach. We hence added functional reliability and functional features (i.e., offline usability, search, etc.) as new categories. Search terms were defined, which we used to deductively classify the reviews into our categories. Since we conducted deductive content analysis, categories formed for coding qualitative data ought to be challenged by the actual data during analysis to evolutionarily emerge [35]. We hence inductively found one more category, network data usage. Final coding categories and definitions are presented in table 1. 583 helpful (i.e., related to one or more ESQ dimension and reflecting requirements and/or information about design approaches) user reviews were analyzed.

Table 1. Coding categories and definitions based on applicable ESQ dimensions

Source	Coding Category	Definition
Adapted from [5]	Design	Adaption of the user interface…
	Information quality	Actuality and accuracy of information…
	Ease of use	Intuitiveness of usability…
	Personalization	Fit to user's preferences…
	System availability	Stability during runtime…
	Privacy/Security	Perceived data protection…
Adapted from [33]	Functional reliability	Accessibility of desired functions…
	Functional features	Range of functionalities…
New	Network data usage	Data usage…

… when detecting or adapting to context.

4 Results

4.1 Design and information

In the following, we compare the results for the categories mentioned above by using quotes from user reviews as examples to highlight our interpretation. In this section, we focus on *Design, Information quality, Ease of use* and *Personalization.*

Design. In terms of general application design, Google Maps users clearly stress the superiority of how the app appeals. They found the app very well organized, accurate and convenient. Users tend to connote Google's design with quality, since it is clean and simple. For Navigon, however, the majority of the users accredit the app to have an "awkward" user interface design. Users do not perceive the user interface as contemporary and wish easier access to important menu points and settings to have better control over the service's functionality. *"[…] it seems that the company is relying on their exceptional map data to compensate for an exceptionally bad UI"*. Waze, which is a navigation app based on crowdsourcing (i.e., users are able to mark traffic jams, red light cameras or police spots right in time), has been judged by users with both positive and negative evaluations almost equally. The comic style interface is rated as good and innovative by some reviewers, weird and confusing by others.

"Good design. Best navigation app ever!"

"The UI is so bad that I find it easier to just quit the app and restart whenever I need to change something than to try to decipher the UI elements."

Whereas Waze users do not explicitly judge design, Google users mainly appreciate the quality of the maps and the satellite imagers. However, when it comes to navigation (i.e., functionality for context adaption), some users find roads hard to identify since they are painted in shades of light and dark grey that are close to each other. Navigation

design is considered easy and intuitive instead. Requirements are raised concerning unwanted rescaling of the map when using the 'find my location' button and icon sizes. For Navigon, also neither great concerns nor compliments are posted by the users. One minor requirement is to enlarge road signs (showing speed limit and other information on screen based on the user's location), making them easier to read. Also the Navigon app is perceived as superior in navigation mode. It is considered easy and reactive to users' driving behavior, as it displays the current speed, ETA and speed limit warnings.

> *"In general it works really well, gives accurate instructions and easy to follow graphical instructions that warn of upcoming changes. So I recommend it!!!"*

A minor requirement is raised regarding the text size of current speed, road name, ETA and speed limit in navigation mode. Waze users are also satisfied with the navigation design.

Information quality. Reviews on information quality are mostly related to the up-to-dateness of map material and the correctness of driving recommendations. User reviews on Google Maps reveal that location and road information as well as in-time traffic updates are very useful. Users perceive that the app adapts to their situation when suggesting alternative routes that are faster. Since map data is usually loaded via internet when needed and is updated regularly based on user feedback, traffic news and GPS patterns (e.g., for detecting traffic jam), map data is considered up-to-date.

> *"Real time traffic updates, route updates, and very clear, easy to follow travel instructions makes this app excellent."*

Although some users praise the actuality of its maps, the majority of Navigon users claim that map data is out of date. Furthermore, some users note that the navigation functionality is *"saddled with Microsoft's 'Here' map search which can never seem to find anything".* Waze users do not focus their reviews on road/map data up-to-dateness. However, some users posit that the quality and actuality of map and road data heavily relies on how active and efficient the crowd provides information. Thus, the crowd provides further information about the actual context and determines information quality.

> *"What Waze accomplishes is providing true real-time traffic and routing updates that are as good as the user community deserves. See, many use Waze for its superior alerts and routing capability over other GPS apps. However, it's really only as good as the user community is willing to make it"*

Ease of use. All three apps are described as very easy to use and intuitive by the majority of reviewers. As mentioned above, Navigon is perceived to have a complex menu organization which needs initial settling-in.

> *"Interface is straightforward although the depth of features sometimes requires digging around in settings and experimenting to get the app to do exactly what you want."*

However, all apps provide real-time adaption to context changes by displaying useful options. For example, Google Maps and Waze detect whether other drivers using the app are stuck in a traffic jam. If this is the case, it informs the driver and calculates

alternative routes to bypass the overloaded road. Drivers can select a faster route by just clicking on the alternative route as it appears on screen.

Personalization. All apps provide the opportunity to store and recall personal waypoints for route calculation as well as individual points of interest. When the user is close to one of these points and selects the 'discover neighborhood' (or similar) option, the user is located and the distance to her personal point of interest is calculated. However, although it is possible, user reviews reveal that it is still difficult in Google Maps to set multi waypoint routes.

4.2 Functional features and reliability

As done above, in this section, we elaborate more on the findings for the categories *Functional features* and *Functional reliability*.

Functional features. Although the apps work on different mechanisms, all three services provide navigation and location functionalities. Google Maps and Navigon further provide the opportunity to use offline map data for navigation. However, both use different approaches for doing so: In Google Maps it is possible to zoom out of a map to a certain degree and save this section to the phone. Navigon works with downloadable region maps (e.g., for Europe, North America, etc.). In contrast, Waze needs a permanent internet connection in navigation mode to load map material. Although the majority of users appreciate the novel offline functionalities of Google Maps, users negatively rate the inconvenient way how offline maps are saved and used for navigation.

> *"It would really be nice, very helpful and much easier if I could save an entire state worth of offline map data instead of fidgeting with a clunky map screen I have to zoom and position so strategically to make sure I get all the roads, railroads and trails I need to have with me at all times."*

Google users especially enjoy that Maps offers up to three route alternatives with ETA which is calculated from length of the road, average personal speed, average speed on the road but also from traffic jams or construction zones detected. The user may choose from these alternatives, which they find simple and convenient. Further requirements are raised concerning a 'reverse option' to toggle start and destination and disturbing voice directions while using the phone for calls. Furthermore, Waze provides 'social' functionality, such as easily sending ETA to phone contacts while driving.

Functional reliability. Most Google Maps users describe the app extremely accurate with regard to the navigation functionality. However, complaints exist about lost GPS receptions in the middle of navigation and wrongly identified fastest routes.

> *"Quite often, it fails to find the fastest route to a destination. Consequently, I have taken to opening Waze and comparing routes. Around 50% of the time, Waze will find a faster way of getting where I need to go. What is keeping me from using that app full-time is their cartoon interface and ghastly color scheme. Google needs to vastly improve their algorithms for this app."*

Also the majority of Navigon users consider its navigation functionality accurate and reliable. Both Waze and Navigon successfully manage to route around traffic problems when internet access is available. User reviews further reveal that offline availability is becoming increasingly important for users.

4.3 Availability, Security and Network Data usage

This section is devoted to findings in the categories *System availability, Privacy/Security* and *Network data usage*.

System availability. As expected, most criticism on the apps is related to system availability. Although according to the users all three apps basically run stable, many users write reviews to complain about crashes and outages. Besides occasional instances in Google Maps and Waze, in which the apps randomly crash or lose network connection, more common concerns have been raised for the Navigon app. Users complain about data losses after updates.

"Navigon has screwed me again. The latest update wiped out all my Favorites. It also removes all the maps and requires individual downloads by state."

Privacy/Security. Navigon users do not raise concerns about data privacy and security. For both Waze and Google Maps, users complain about regularly established GPS connections even when location based services are turned off in phone settings and the apps are not running. A Waze user writes:

"Location Service Always Running even when waze is turned off […] which is a lack of privacy. There is no need to have location service running all the time in background."

However, users tend to hazard consequences of neglected privacy for the sake of functionality, how a Google Maps user describes:

"Yes, Google is probably collecting my usage data. At this point in my life I don't much care. The convenience of finding places and being accurately guided there true my hopes for anonymity."

Network data usage. Waze users do not report on network data usage in online mode. Navigon users tend to rate mobile data usage positive.

"The data usage is very low - so low, it doesn't put a dent in my metered data (probably 200KB or less each 20 min trip)."

Google Maps users, however, recently report about high data usage, which is seen as a severe issue.

"Recently I left this app on in the background while using walking directions and it used over 6 GB of data within hours, with no warning. This app needs a data warning, cut-off, or data usage metering like the Netflix app recently implemented."

5 Discussion

As seen in the reviews, how users experience and evaluate context-aware e-services is highly dependent on individual situations and prior experiences. Many users compare service functionalities with what they know (i.e., formerly used apps) and thus build a state of expectation. This state is challenged when using a new app in order to form an evaluation of ESQ. Thus, it is necessary to consider ESQ as an important design goal for app and service development. Our results indicate that user reviews are a useful source of requirements and first hints for respective 'good practice' design approaches, which confirms conclusions of other scholars in the field of requirements engineering [34, 36]. We were able to extract 20 requirements from user reviews related to context-adaption or context-detection, which thus apply to our understanding of context-aware services. Furthermore, 8 of these requirements can be linked to design approaches that could also be identified in our work. Table 2 provides an overview on the requirements (R) and – if existent – design approaches (D) derived from the user reviews and mapped to context-aware services.

Results regarding the *design* reveal that users of navigation apps prefer a simple and straightforward design which is easy to read and handle. Convenience is especially desired since context-aware applications are mostly used to obtain additional information while concentrating on a real world activity, such as driving. The quality of map data in terms of picture resolution and up-to-dateness is crucial for apps which provide location or navigation functionalities. Basic navigation should be enriched with a choice set of alternative routes. Other requirements in this category relate to map scaling and readability. *Information quality* entails the necessity to continuously update context information by balancing requests and informational value. Further, users value accurate context information which can be established by relying on multiple sources of context data. In case the context-aware application relies on crowdsourcing mechanisms (e.g., Waze for navigation), participation must be enabled and should be rewarded to raise information quality. To increase the *ease of use*, important menu points and settings should be conveniently accessible for the reader (e.g., while driving). In case location search and navigation is used in a context-aware application, users should be able to set personal waypoints and find points of interest relevant to their current needs in order to increase *personalization.* Furthermore, the use of location based services also allows for the implementation of *functional features* which users consider valuable. These are offline use of data (e.g., downloading a map for offline navigation), multi waypoint routes, reverse option for start and destination, route alternatives and precedence to more important applications. Especially the last feature is of interest for future work on context-aware services because it necessitates an integrated view on different services, their interaction and prioritization. Users further require *system availability* to be stable twenty-four-seven. Also the application itself should run without errors or crashes in any context. In order to establish *Privacy and security*, users desire control over when the app gathers context data. Although US users tend to neglect privacy and security concerns to obtain outstanding functionality, other (e.g., cultural) contexts may have formed different understandings, which have to be considered, since individual, organizational and cultural factors are suggested to

moderate the effects on ESQ [5]. In addition, *network data usage* should constantly rely on few mobile data traffic and prompt a warning in case data capacity is close to user's data plan limit.

Table 2. Requirements and design approaches derived from user reviews

Requirement/Design approach
Design
R1: Simple Design: Context-adaptive applications should have a clean and simple design. Texts should be easy to read.
D1: Use modern and straight design with color contrasts. Refrain from using comic style.
R2: High quality map data: In case the app provides location detection and navigation functionality, high quality map data (i.e., resolution and up-to-dateness) should be provided. Zooming shout be possible on maps.
D2: Refrain from using similar colors for different elements (e.g., light grey for street, dark grey for houses). Provide high-resolution and up-to-date (also continually updated) map material.
R3: Prevent map from unwanted rescaling: If location detection on maps are used, users should have control over the scaling. Unwanted rescaling should be prevented.
R4: Easy to read additional context information: In case context changes, users should receive an easy to read but non-disturbing information (e.g., speed limit warning).
Information quality
R5: Continuous context updates: Users should at any time obtain information about the context which is up-to-date.
D5: Balance between information distribution and server requests. Load new context data (e.g., map data) only when needed.
R6: Accurate context information: Users should receive accurate context information at any time.
D6: Use multiple sources of context data, such as built-in sensors, user feedback, news and information from a crowd of users. Use effective algorithms for calculating fastest routes.
R7: Crowd participation: In case of sharing context information with the crowd, users should be able to easily participate.
D7: Give users easy access to crowd activities. Motivate crowd to participate.
Ease of use
R8: Easy access to important menu points: Important menu points and settings should be easy to access by the user.
D8: Provide short menu on top screen with most important settings which is easy to access while concentrating on real-world activities (e.g., driving)
Personalization
R9: Personal waypoints: In case maps are used, the user should be able to store and recall personal waypoints such as points of interest.

R10: Points of interest nearby: In case location search and/or navigation is used, users should receive recommendations to points of interest nearby based on their interests and current needs. Users should receive information and may let the app navigate to the respective destination.

Functional features

R11: Multi waypoint routes: In case navigation is used, users should be able to set routes with more than one waypoint.

R12: Reverse option for start and destination: If route planning or navigation is provided, users should be able to easily toggle start and destination.

R13: Route alternatives: If navigation is used, users should choose from different route alternatives. ETA should be provided for the routes, too. Route alternative selection should also be available just-in-time, especially when context changes (e.g., traffic jam dissolves).

D13: Calculate different route alternatives and ETA and provide the top two to three to the user. Users can then select the most appropriate route for them by clicking on one alternative.

R14: Precedence to more important applications: In case apps are started that need access to hardware resources (e.g., incoming phone calls need access to speaker and microphone), users should be able to configure the app so it gives precedence to these applications (e.g., by stopping voice directions for navigation).

R15: Offline data: Users should be able to download static data (such as map material or points of interest) to use them with context functionality (e.g. navigation) when no network access is available.

System availability

R16: 24/7 service availability: Users should be able to access the service whenever they want.

D16: Optimize network, system and service stability. Come as closest to 100% availability as possible.

R17: App stability: Users should be able to run all functionalities of the app without failures, crashes and data losses in any context. Updates of the app should not lead to loss of data.

Privacy/Security

R18: Limit context detection: The app should not gather context information from users, when it is not directly needed for the functionality the user executes. Users should further be able to completely turn off context detection.

Network data usage

R19: Use few network data: In case no WiFi is available, the app should not use more mobile data capacity than needed for the current functionality.

R20: Data exhaustion warning: Users should be warned in case network data capacity is high and close to the limit of the user's data plan.

Table 2. (cont.)

6 Conclusion and Outlook

In this work, we investigated how ESQ as main determinant of e-service satisfaction is established for mobile navigation services. By conducting a qualitative content analysis of user reviews for mobile navigation apps, we identified requirements and first design approaches to meet or even exceed customer's expected service experience and thus achieve high ESQ. However, future studies, qualitative as well as quantitative, must show if our categories comprehensively explain the effects of ESQ for context-aware (navigation) services and if requirements and design approaches identified in this study are applicable in a practical development context. Positioning ourselves in the field of ESQ, we are, to the best of our knowledge, the first who not only investigate ESQ from a purely empirical but also from a design perspective. Since reviewing and eliciting requirements from user comments in app stores is an upcoming approach in the field of requirements engineering [34, 36], building up on previous methodical work seems appropriate for our endeavor. However, since our sample is limited we can only shed light on a subset of possible ESQ requirements and design approaches that possibly hide in the mass of user reviews. Future research should investigate other app stores, such as the windows store, as well as cultural contexts other than the US to triangulate our findings. From a theoretical viewpoint, we propose to challenge ESQ theory-building approaches by introducing an inductive approach of qualitative category development. We suggest that ESQ as highly individual, perception-based construct cannot be fully explained by quantitative research only. We show that even a consolidated model of ESQ [5] cannot fully be applied on each case of interest. By further investigating more cases of context-aware services, (e.g., disaster warning systems), a theory covering ESQ for context-aware services will emerge. Furthermore, the accumulation of empirically grounded requirements and design approaches for ESQ-oriented design of such services can be considered as nascent theory of design and action [37]. We further contribute to requirements, software and service engineering practice, since we elaborate on what to consider when designing mobile navigation services with regard to ESQ. User reviews increasingly become an important source for evaluating design approaches and identifying opportunities for improvement. By comparing three good practice designs and consolidating both positive and negative design aspects, we elicit requirements that address contemporary customer needs and enable software and service engineers to establish high ESQ by design.

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