Measuring value-in-context with mobile app services

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ABSTRACT

Purpose –New technologies provide a high-definition film of resources and interactions over extended periods of time, offering information about both the structure and content of relationships. The internet is evolving rapidly with the transition from sharing in Web 1.0, to contributing user generated content in Web 2.0, to collaborate in the semantic Web 3.0. The role of the actors is transforming in this connection from a concept of user to a concept of co-creator. With this progress merging computational social science represents a turn toward the use of large archives of naturalistically-created behavioral data.

Service-Dominant Logic (S-D Logic) unifies the transactional and relational perspectives of integrating resources from various sources to co-create value. Actors are seen as resource integrators, what leads to an evolved and scaling value concept of value-in-context. Complexity of context is identified as a challenge to measure the phenomenon of value-in-context. Data collected with mobile app services could be a source for data needed to do social science that was so far too expensive or didn't scale very well. The new ubiquitous digital traces facilitate quantitative modeling on a large scale. What data may be collected and used to measure context and value-in-context by using mobile app services?

Design/Methodology/Approach – First, a literature review is made related on S-D Logic, context, value-in-context, and value-in-context measurement. Second, data gathering and value-in-context measurement will be validated and enhanced by a case study on three for-free-mobile apps (WhatsApp, Snapchat and Instagram).

Findings – A model of context(s) is evolved to represent four components on context in physical and virtual environments. Data from mobile app service are a source to measure context and in case of resource integration between these components value-in-context. Six themes about measurement of context and value-in-context for mobile app services are introduced with indicators and scale.

Research limitations – As limitation are identified and discussed: Interdisciplinary cooperation between computer scientists and social scientists, control over data, privacy and ethical data concerns, quality of data and data interpretation, as much as costs to collect, integrate context-awareness at the mobile application level.

Practical implications – The paper may give exemplified insight to practitioners on how uniquely and phenomenologically determined value by the beneficiary can be measured and understood in a scaling manner. Practitioners may use the method, adapt it in their ecosystem, and identify how value is co-created in their specific context.

Originality/Value – The first proposal of scalable measurement of value-in-context in mobile app services conceptualized with Service-Dominant Logic.

Key words value-in-context, context, measurement, mobile app services, Service-Dominant Logic.

Paper type – Case study.

1. Introduction

S-D logic unifies transactional and relational perspectives by integrating resources from various sources and the co-creating of value between two actors as resource integrators (Brodie et al., 2011). The resource integrator perspective of actors enables an evolved and scaling value concept of value-in-context. The notion of context became an integral part of S-D Logic when the perception of value shifted from value-in-use concept to value-in-context concept (Vargo and Lusch, 2008). Since then, more conceptual work has illuminated how context frames exchange and markets (Chandler and Vargo, 2011). Actors are connected to other actors and resources on different levels of a service ecosystem: from dyadic interaction on the micro-level to shared networked institutions on the macro-level (Ford and Mouzas, 2013). The service-ecosystem approach also begs the question of the evaluation of value and how value-in-context is measured.

Resource-integration process happens in a space and time dependent context. Tommasetti et al. (2015) point to numerous studies relative to issues in value co-creation measurement (Randall et al., 2011; Xie et al., 2007; Payne et al., 2008; Yi and Gong, 2013; Neghina et al., 2014). Each study indicates appropriate research directions, approaches and eventual gaps, in order to analyze in depth this complex construct. Complexity of value-in-context is identified as a challenge and leads some researchers (Helkkula et al. 2012; Smith et al., 2009; Sanchez-Fernandez and Iniesta-Bonillo, 2007) to consider the multidimensional phenomenon of value-in-context as not objectively, reasonably or scalably measurable.

The intention of this paper is to find an understanding of context (Pohlmann and Kaartemo, 2017). A glance is thrown on different components of context and the modes of information in these contexts by proposing a model of context(s). It is about understanding and using context, especially with the opportunities new technologies like mobile app services offers. In mobile app services environment, the context is highly dynamic (Shen and Cheng, 2012). Beside the dynamic, the high diversity of resource-data has to be considered. Diversity of resources may be a challenge to describe the resource, allow users to access resources in a network, adapt them, check the fit, obtain the right resources at the right time and finally integrate the fit of resources in a unique context (Akaka et al., 2012). Mobile app services may offer along the digital user-generated trace the opportunity to measure the process of co-creating value-in-context. Data, gathered by mobile app services, has the potential to enhance social science in research that was so far too expensive or didn't scale very well (Homans, 1974).

The purpose of this paper is to investigate how value-in-context can be measured with the potential mobile app services offers. This paper wants to shed light on the following ontological and methodological questions (Hart, 2005): (1) what is value-in-context? And (2) what methods and techniques should be adopted for measuring context and value in context by using mobile app services? Methodically a two-step analysis serves as framework. First, a literature review is made related on S-D Logic, context, value-in-context, and value-in-context measurement by mobile app services. Second, data collection for context and value-in-context measurement will be validated and enhanced by a brief case study on three mobile apps (WhatsApp, Snapchat and Instagram) to exemplify what data the providers collect, and how this data can be used to measure context and value-in-context. Finally limitations of data collection and interpretation by mobile app services, practical implications and future research ideas will be discussed.

2. Literature review

Service-Dominant Logic

Starting point for a better understanding of S-D logic is its proposition of an alternative view to the traditional goods dominant logic (G-D logic). This G-D logic is characterized by (1) goods, (2) firms and (3) exchange-value centricity as well as a focus on units of output (Vargo and Lusch, 2004; Lusch and Vargo, 2014). In opposite to this perspective, S-D logic provides the transactional and relational view by (1) integrating resources from various sources, (2) exchanging service for service between actors and (3) the co-creating of value between two actors as resource integrators. This actor-to-actor perspective leads to an evolved and scaling value concept of value-in-context (Lusch et al., 2010; Vargo, 2011; Chandler and Vargo, 2011; Chandler and Lusch, 2015) and its amplification to include value-in-social context (Edvardsson et al., 2011) or value-in-cultural context (Akaka et al., 2013). Most important amongst the recent development and extension of S-D Logic has been a general zooming out to allow a more holistic, dynamic and realistic perspective of value creation, through exchange, among a wider, more comprehensive configuration of actors (Vargo and Lusch, 2016). It is possible to consider value and value creation from a number of perspectives, including but not limited to those of the service customer and service provider (Payne et al., 2008; Smith and Colgate, 2007, Lepak et al., 2007). S-D logic is in line with that view. Zooming out reveals that value creation is neither singular nor dyadic but rather a multi-resource-integrator phenomenon albeit with the referent beneficiary (e.g. customer or service provider) at the center (Vargo and Lusch, 2016).

S-D Logic is not limited to the value creation itself. The contextual nature of value creation includes institutions and other socially constructed resources. So S-D logic is also about structure and sheds light on the collaborative formation of the context itself (Akaka et al., 2012). These social-network structures are apparently purposeful, driven not only by connections between resources but also by rules governing the resource exchange (Lusch and Vargo, 2012). This idea that rules are created collectively by the actors themselves, in the process of value co-creation, goes back on Giddens (1979, 1984) duality of interplay between actors and the structures, comprising rules and resources which make up the context within which they act as structuration. Structuration suggests that rules and norms invariably shape the thinking and behavior of actors in any service system (Giddens, 1984). This formative operation subsequently determines actors´ perceptions of co-created value during service exchange (Edvardsson et al., 2012). Social structure is created continuously and changes through the flow of everyday social practices. Giddens also emphasized the control of resources. He did not view resources as given and isolated entities. Giddens positioned them within a wider social structure that includes culture, norms, interpretations, rules, and language (Edvardsson et al., 2012).

Model of Context(s)

Dey (2001) defines “context is all about the whole situation relevant to an application and its set of users”. Does this brief definition help to understand such a complex topic? Or is this definition more as Hinton (2014) says: “Context is an abstract idea, but it brings concrete challenges”. Scholars asked for a finely granulated understanding of context (Pohlmann and Kaartemo, 2017) that hopefully makes the measurement of value-in-context more workable. For doing so, we look on Bazire and Brezillon (2005) who collected 150 definitions of context from different areas of research amongst others computer science, philosophy, economy, business, etc. One of their findings is that, the variety of the definitions arises from the fact that there is no absolute context. Context is relative to something and should be studied according to its use. In addition, context can have a structure or a frame such as a network, whose institutional arrangements may share relations.

Another approach to understand context is by using different modes of information (Hinton, 2014). This concept brings in account that with new technology context becomes more disrupted and

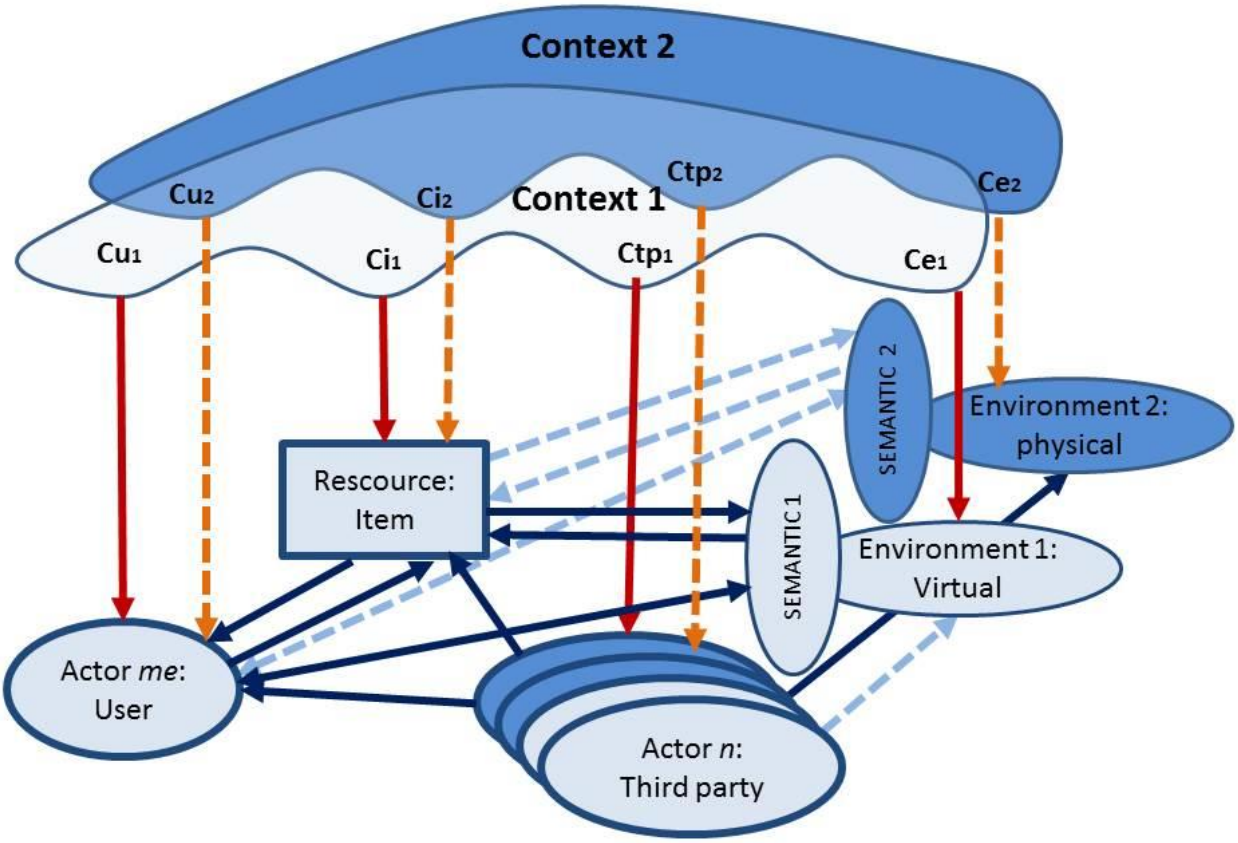
detached from the physical clues and makes it even more complicated than it used to be. In today´s life service may be offered on different channels as e.g. offline, online, mobile or virtual. This means that context can be a tangle of analog or digital information in physical and virtual environments (Breidbach et al., 2014). Place has drifted into a strange turbulent relationship: Actor *me* can be at different places at the same time: Online, offline and mobile at once, even with different devices. And actor *me* can be described with different identifications and roles: your social security number, your login in a social media platform, your Apple-ID for your smartphone just to call some. New technologies bring us into new context. Comparable to the invention of writing in the meaning, that something said and written down in one place, could be read and therefore, "said" all over again separate from its original utterance (Hinton, 2014). So, the problem is not lack of context. It is rather context collapses with an infinite number of contexts, upon one another into one single moment of recording (Wesch, 2009).

How context is perceived, depends on the perspective. Context can be defined by the actor, but also by an item (resource), a particular environment, or eventually an observer (Bazire and Brezillon, 2005). To cover the case, that multiple observers might be components of the context, the term observer is modified in actor *n* for different, but specific third parties. The described dependency on the perspective offers the option to leave behind the focus on customer-firm exchange encounters only. This focus so far has neglected the variety of interactions that occur among other stakeholders that potentially influence or are influenced by any given exchange (Vargo and Lusch, 2012).

Important to note is that each environment has its semantic. Semantic is information created for the purpose of communicating meaning between each resource, often refer to this as "language". But semantic includes all sorts of communication such as gestures, signs, graphics, and of course, speech and writing (Hinton, 2014).

Summarizing these thoughts leads to build a model of context(s). Figure 1 illustrates the components of a situation and the different relations between those components (Bazire and Brezillon, 2005) and the modes of information determining the semantic that is used in the context (Hinton, 2014). Four perspectives on context (Cu, Ci, Ctp, and Ce) are presented in physical as well as in virtual semantics.

Figure 1: Model of Context(s)



Sources: Adaption based on Bazire and Brezillon (2005), Hinton (2014), Wesch (2009).

Components in Figure 1 are the user (actor *me*), item (resource), different third parties (actor *n*) and environment (physical or virtual). The situation may offer more resources and actors to be integrated. Separating context from situation considers that not all resources are totally relevant in a task running. Thus, the difference between context and situation depends on the relevant resources for the value creation. The context where the co-creation of value happens is constituted by relevant resources surrounding and influencing the resource-integration process of actors. Context represents only what is significant at a given moment but can belong to any of the terms of our model, depending to the task goal (Bazire and Brezillon, 2005). Beyond this context, there is a situation defined by factors and resources, which neither influence the process of resource integration nor are factors integrated in the process itself (Löbler & Hahn, 2013). This goes in line with acknowledging the heterogeneous and distinctive nature of context(s), define the particular context as a set of unique actors or resources with unique reciprocal links among each other. The ability to define context uniquely is essential, as context heterogeneity affects how resources can be drawn upon for services (Chandler and Vargo, 2011). The challenge with context is the struggle to accurately perceive the relevant relationship with other resources within an ecosystem (Hinton, 2014).

The topic context with regards to S-D Logic is seen as a motor theme for research trajectories. Contextual differences in exchange phenomena are explained by the variety of engaged actors, diversity of resources and multiplicity of institutions practices that are involved (Pohlmann and Kaartemo, 2017).To understand this challenge better, more insights in the concept of value-in-context might be helpful.

Value-in-context

Table 1 illustrates four of the fundamental premises of the S-D Logic that are directly linked to value: FP 6, FP 7, FP 10 and FP 11 plus additionally FP 9 which defines the resource-creation process (Vargo and Lusch, 2012; Vargo and Lusch, 2016).

Table 1: Selected Foundational Premises of Service-Dominant Logic involving the topic Value

# Premises	Description
FP 6	Value is co-created by multiple actors, always including the beneficiary.
FP 7	Actors cannot deliver value but can participate in the creation and offering of value propositions.
FP 9	All social and economic actors are resource integrators.
FP 10	Value is always uniquely and phenomenologically determined by the beneficiary.
FP 11	Value co-creation is coordinated through actor-generated institutions and institutional arrangements.

Source: Extract of Vargo and Lusch (2016)

In short it can be said, that value relates to the benefit(s) for some actor(s). The full understanding of value creation and determination requires a network or more generally a systems perspective (Vargo and Lusch, 2012). Value is co-created through a combination of potential resources. As the resource combinations are always changing, it implies that value creation is systemic. During this process a potential resource must contribute an improvement or an increased viability of the system, to become a resource (Akaka et al., 2012). Relevant factors in this process can be awareness, connectivity and accessibility to the resource, the ability of adaption and compatibility for the fit of the resource and finally the integration of the resource with a unique context. The process of resource integration is continuous because no actor can access all the resources it needs, and once resources are integrated the situation is temporary (Vargo and Lusch, 2012).

Since the resource combinations are always changing, the dynamic complexity could imply a somewhat impossible playing field for actors (Vargo and Lusch, 2012). Because of structuration, the outcome for at least some practices may become predictable and controllable (Vargo and Lusch, 2012). The contextual nature of value creation includes institutions and other socially constructed resources. These social-network structures are neither random nor exogenous. They relate to apparently purposeful systemic behavior, driven not only by connections between resources but also by rules that govern resource exchange (Vargo and Lusch, 2012). The variety of combinations associated with any particular resource is dependent upon the norms and meanings that guide interaction and the derivation in a particular context. Signification (meaning), domination (power), and legitimation influence schemas (norm and rules).

However, there is little literature about the nature of phenomenological value and the foundations of value-in-context (Löbler and Hahn, 2013). Sanchez-Fernandez et al.´s (2009) conceptual framework describes customer value in terms of economic, social, hedonic, and altruistic categories in an effort to capture the intrinsic, extrinsic, affective, and cognitive aspects of customer value in the context of service. As a potential objection against the value-in-context concept could be seen the argument, that complexity of context is too high (Helkkula et al., 2012; Smith et al., 2009; Sanchez-Fernandez and Iniesta-Bonillo, 2007) to allow a reasonable, scalable and affordable measurement of value-in-context. Löbler and Hahn (2013) propose the ValConRIA model for measuring of value-in-context

based on S-D Logic. The model was applied with a questionnaire by asking students to think about "context/situations".

Different to the ValConRIA model, this paper is not about the measurement of value-in-context by a, the approach is rather to measure data that is generated during value co-creation through resource integrator and exchange (micro-level) and data to describe the context of the resource integration in a specific context (meso-macro-level).

Value-in-context measurement with mobile app services

As in the introduction mentioned context can be a tangle of analog or digital information in a physical or virtual environment. To untangle this, we will briefly look on the physical environment and more extensively to the virtual environment of mobile app service.

In a physical environment, context can be captured and measured by data of different analog media (e.g. text, audio, or video) or with the help of sensors (e.g. watch, weight balance, thermometer, pressure gauge, speed indicator, photometer or noise measurement). The limitation of analog data can be the volume, the variety and the velocity of data, the integration of data and a higher error rate when transmitting the data, just to mention some. These limitations can be minimized by measuring digital data of a physical structure. Recent developments in this field enable measurement of activity and interaction e.g. at the point of sales (Intel, 2017) or behavior using interval recording, sampling methods, frequency recording, or discrete categorization (Crowley-Koch and Van Houten, 2013).

In the virtual environment, context-aware computing supports the integration and interpretation of existing digital or digitalized resources. A system is context-aware, if it can extract, interpret and use context information and adapt its functionalities to the current context (Shen and Cheng, 2012). The challenge of such systems lies in the complexity of collecting, representing, processing and interpreting contextual data. To handle this complexity we will first investigate in a Case study what kind of contextual data in a mobile app environment is collectable. It is about finding out which data is available about context and about value-in-context. The collection will be ordered in different themes. In chapter 4, we will look on representing, processing and interpreting the data for measurement of context and context-in value for each theme. By doing so, limitations of measurement will be discussed.

3. Case Study

Context and data collection

Given the dearth of studies on S-D Logic in relation to measurement of context and value-in-context, an exploratory research is adopted using a qualitative cases study approach (Yin, 2009). A case study approach is particularly suitable for studying phenomena about which little is known, and in a context that still requires an understanding of fundamental factors (Denzin and Lincoln 2005).

The case study is firstly intended to shed light on the methods and techniques mobile app service provider use to collect data. As second step we analyze how the found data can be used to measure context and value-in-context. Determining factors in a definition of context can be the actor concerned by the context, its focus of attention, its activity, its situation, its environment (Bazire and Brezillon, 2005) and his relation to other actors.

To find appropriate candidates for the case studies we searched on an author-defined day (Feb. 10th, 2017) on the ranking list of "for-free apps" downloads. In the world of mobile apps ecosystems, there are two big players: Google with the Google Play Store and Apple with the Apple App Store

(Statista, 2017). We looked for apps that are represented in the top ten ranking of both stores, scored them and identified in the following order the apps (1) WhatsApp Messenger, (2) Bitmoji Avatar Emoji, (3) Facebook Messenger, (4) Snapchat, and (5) Instagram (Appendix 1). For further investigations app (1) and (3) were clustered. Both messenger apps may have different privacy policies but as they are part of the Facebook family of companies, they are able to "… share information about you within our family of companies to facilitate, support and integrate their activities and improve our services" (Facebook, 2017a). App (2) and (4) can also be clustered, as both belong to Snapchat and have identical privacy policy (Snapchat, 2017a). Summarizing, WhatsApp Messenger, Snapchat and Instagram are selected as the sample for the case study. Appendix 2 gives a schema of data that is collected by the respective apps provider. The knowledge was gained by analyzing key documents from multiple sources (Yin, 2009) such as WhatsApp Legal Info (WhatsApp, 2017a), WhatsApp´s Privacy Policy (WhatsApp, 2017b), WhatsApp Cookies (WhatsApp, 2017c), Snap Inc. Terms of Service (Snap Chat, 2017b), and Snap´s Privacy Policy (Snapchat, 2017a) as well as Instagram Terms of Service (Instagram, 2017a) and Instagram´s Privacy Policy (Instagram, 2017b). The sample size is considered appropriate. After analyzing the documents of the three cases the wealth of information allowed „theoretical saturation" for the intensions of this case study (Seale, 2004).

Data Analysis of the Case study

Thematic analysis, a method that searches for themes or patterns in qualitative data, was used for the data analysis (Braun and Clarke, 2006). Given the lack of pre-existing research around data gathering for context measurement, an inductive approach was adopted. The researcher follows the step-by-step guide for thematic analysis by Braun and Clarke (2006) which includes six phases: (1) familiarization with the data; (2) initial coding; (3) theme searching; (4) reviewing themes; (5) defining and naming themes; and (6) producing the report (Appendix 2).

A total of 6 themes was identified across the data, is documented in appendix 1 and introduced along model of context(s) in Figure 1 briefly:

Theme 1 - actor me. This is about personal data of the actor *me*, who is using the app running on the device/item (theme 2). Demographical and profile data is gathered. User profile describes user's personnel information such as name, age, phone number, address, email, profile name or ID number. Providers use standardized profile template that facilitates data cleaning, coding, and comparison across respondents (Lewis et al., 2008). For the Instagram app you can also use *Facebook Connect* also called *Log in with Facebook*. Facebook members can log in to third-party websites, applications, mobile devices and gaming systems with their Facebook identity. While logged in, the members can connect with friends via these media and post information or updates to their Facebook profile (Facebook, 2008).

Theme 2 – app running on device. Mobile app services are deployed on mobile devices and are published over the Internet, wireless network or within the operators' network (Shen & Cheng, 2012). The device may determine resources capacities (e.g. memory size, battery power level, network coverage or bandwidth). Data that is collected from the device is e.g. model, device identifier, IP-Address or mobile network. Cookies are relevant to remember. The small text file is essentially an identification card and tells the server that you returned to a webpage. The file is uniquely and can only be read by the server that gave it. It remembers user´s preferences to present relevant content or personal settings, e.g. language. Cookies are also relevant to measure popularity and effectiveness of webpages. Cookies give insights about mobile vs. desktop use. Devices like smartphones enable to create information-rich content with e.g. camera or microphone (theme 3). Furthermore, the apps running on the smartphone may connect the actor with its social contacts (theme 4).

Theme 3 – resource/content. Actor *me* is able to create public or semi-public content within a bounded system (Lewis et al., 2008). Any content that the actor makes public is searchable by other users and subject to use under a respective application programming interface (Instagram, 2017a). As example, Snapchat offers a storytelling platform for different types of stories told from different perspectives. Each individual user can tell stories in *my story*. *My story* can be expanded to"… community *live stories*, or *publisher stories* created by publisher partners which provides a unique variety of personal and professional content for our community to enjoy" (SEC 2017). The expansion to *live stories* or *publisher stories* integrates third parties and may serve as an example for upcoming theme 6. Resources belong to or are co-created by actor *me* such as content (e.g. pictures, posts, comments), metadata of the content, but also financial resources like debit or credit card.

Theme 4 – social contacts. Social contacts of actor *me* are found in the address- or phonebook or email directory of the actor´s devices (-> Theme 2). The provider may combine the information collect from the actor´s phonebook with other information the provider has collected about the actor (Snapchat, 2017b). Unconnected friends are also suggested by the provider (Instagram, 2017). WhatsApp creates a favorites list of the actor´s contacts. The actor can create, join, or get added to groups and broadcast lists. Such groups and lists get associated with the actors account information (WhatsApp, 2017a). The possibility to structure contacts into groups (WhatsApp, 2017a) beyond the single bucket of „friends" helps to avoid disorientation through sudden shift in social context with e.g. co-workers, family members, or even customers (Hinton, 2014). Also search for public groups where people discuss topics may tell something about the actor is interested (Facebook, 2017b)

Theme 5 - activities. Activities are understood as a dynamic interaction between an actor, an item or other actors and recognized as the basis for the actor´s value co-creation (Löbler and Hahn, 2013). Apps give insight about the user´s interaction, likes, and use, e.g. screenshots from snaps. Cookies make it possible to track the user´s activity like opening an email and tracing links that were clicked. Insights are also gained about how the actor communicates with other. Data is tracked such as the time and date of communication, the number of messages a user exchanges with its friends, with which friends messages are exchange most, or interactions with messages (Snapchat, 2017b). Actions like new connections, notifications or likes are turned into news that is published within a user´s network (Hinton, 2014).

Theme 6 - third parties. Third parties are actors and resources in the ecosystem. Third parties can be distinguished in those of the actor *me* and those of the mobile app service provider.

As mentioned in theme 2 other actors can be a social contacts of actor *me*. It may not be clear whether a "new friend" request comes from someone actor *me* actually knows. The provider may share whether actor *me* and the requestor have contacts in common. The "find friends" features enhance to locate other actors with accounts on the app either through (1) actor *me´s* contact list, (2) third-party social media sites or (3) through a search of names and usernames in the app (Instagram, 2017b).

Third parties related to the app service provider may be companies specialized in providing other resources. The first group can be characterized to enable the service itself. In this group network providers, maps and location providers, hard- and software manufactures, analytics tool companies or social media providers are found. The second group can be characterized as third parties that help to monetize the service, like advertising partners, affiliates, app stores, companies providing payment services or parties using company´s API.

4. Findings for value-in-context measurement

In this section the collected data will be processed and interpreted. The process of identifying valid, novel, potentially useful, and ultimately understandable patterns in data is defined as data mining (Fayyad et al., 1996; Ristoski and Paulheim, 2016). Knowledge about the context can be found (1) in the primary data itself, from where it is discovered using appropriate algorithms and tools, (2) in external data, which has to be included with the problem first (such as background statistics or master file data not yet linked to the primary data), or (3) in the data analyst's mind only (Ristoski and Paulheim, 2016). The knowledge discovery process (Fayyad et al., 1996) leads from raw data to actionable knowledge and insights which are of immediate value. Generally, analysis as well as algorithms can extract and illustrate large-scale patterns from the collected quantities of data (Boyd and Crawford, 2012). The quality of the found patterns depends on the methods being employed during the knowledge discovery process, as well as the interdependencies between the process steps. To discover some hidden patterns from the data, to be interpreted and understood, these patterns often require the use of background knowledge, which is not always straightforward to find (Ristoski and Paulheim, 2016). For the purposes of optimizing a particular metric, standard techniques in machine learning such as cross-validation, feature selection, and regularization are remarkably powerful in determining which signals are useful and which are not. It is better to let the machine learning algorithm "do its job," since it is far more sensitive to statistical patterns than human intuition (Lin, 2015). If a relationship is non-existent and the perceived signal is actually noise, prospective (i.e., future) predictions will fail. This is where A/B testing comes in (Lin, 2015). Thus, the knowledge discovery process (Fayyad et al. 1996) foresees the possibility to go back to each previous step and revise decisions taken at that step (Ristoski and Paulheim, 2016).

Finding to theme 1 - actor me. It is about personal data of the actor *me*. Snapchat believes that one of the biggest opportunities is the ability to serve services that are personal and respectful of context, that is even more effective when paired with the right contextual understanding (SEC, 2017). Social networks are unique in the amount and detail of personal information that users regularly provide; the explicit articulation of relational data as a central part of these sites' functioning; and the staggering rate of their adoption. Actor *me* creates content. Information of the actor´s background (e.g. high school, hometown), demographics (e.g. birthday, gender), interests, political views, and group affiliations, as well as on cultural tastes (e.g. "favorite" books, movies, and music) becomes trackable with the content (Lewis et al., 2008). The mode of creating content has evolved from text, to pictures, to audio-voice, to video. Each step provides richer context-data. Snap Inc. defines itself as a camera company, stating that "images created by smartphone cameras contain more context and richer information than other forms of input like text entered on a keyboard" (SEC, 2017).

The limitations of the account data of an actor can be that accounts and users are not necessarily equivalent. Some users have multiple accounts, while some accounts are used by multiple actors. Some actors never create an app account, or simply access the service not via the app but via the web. Other accounts are 'bots' that produce automated content without directly involving a person (Boyd and Crawford 2012). Collecting personal information allows rapid access to more relevant information, but also present difficult ethical questions (Borcea-Pfitzmann et al., 2011; Pariser, 2011) and legal restrictions. At the same time personal data may be less relevant as the patterns that are recognizable by analyzing activity. Detected representations could be more important than personally identifiable data. As example using anonymous data as broad as gender and age range may be sufficient to count the potential and actual audiences for visual messages and merchandising at specific viewing times and durations to measure what was observed by the audience and for how long (Intel, 2017).

Finding to theme 2 - app running on device. There are many types of devices that are able to collect data: Amazon echo, apple watch, google glass, fitness tracker or connected cars are just examples. Smartphones as a device can improve the contextual understanding because they are personal in a way that other forms of device are not. "Users eat, sleep, and poop with smartphones every day" (SEC, 2017). Smartphones understand the world around them. Most smartphones have GPS, three-axis accelerometers, a digital gyroscope, a camera, and a microphone. With these sensors smartphones have the potential to serve as a platform for an effective behavioral technology (Crowley-Koch and Van Houten, 2013). Smartphones are able to collect data from the physical and virtual environment.

Finding to theme 3 – resource/Content. A story is told with the content like comments, photos, video or snaps an actor posts. Narrative methods are appropriate ways to measure context by analyzing the story told through the posted content (Helkkula et al., 2012). Narrative methods capture personal and human dimensions of experience over time, and take account of the relationship between individual experience and context (Clandinin and Connelly, 2000) Narrative methods are research approaches that interpret and make sense of human experience by listening (Crawford, 2009), collecting, and analyzing stories (Webster and Mertova, 2007). Narratives reveal the individual's retrospective sense making of human experiences and enable the phenomenological researcher to illuminate the implicit—as well as explicit—meaning of a particular phenomenon (Atkinson and Delamont, 2008; Smith et al., 2009). The collected data in the narrative data collection method can be used to explore how users make sense of their value experiences in a particular event (Kvale and Brinkmann, 2009).

Limitations: The enormous quantity of data can offer connections and patterns where actually none exist. The strong, but false correlation between the changes in the S&P 500 stock index and butter production in Bangladesh (Leinweber, 2007) serves as example for this incident. If a relationship is non-existent and the perceived signal is actually noise, prospective (i.e., future) predictions will fail. Even if prediction not necessarily requires understanding, understanding certainly may help (Lin, 2015). Context is hard to interpret at scale and even harder to maintain when data are reduced to fit into a model. Managing context in the light of mass generated data will be an ongoing challenge (Boyd and Crawford, 2012).

Finding to theme 4- social contacts of actor me. The study of social contacts and networks has been identified as a complementary view for conceptualizing and measuring properties of a system (Vargo and Lusch, 2012). The goal of researchers working within the network paradigm is to understand the structure of relationships (Iacobucci, 1996) Four variables have been identified as important: network size, network density, network heterogeneity, and the measure of centrality in a graph based on shortest paths (graph theory calls it betweeness centrality) (Lewis et al., 2008).

While in theme 3 the narrative data collection methods is used to shed lit on value experience depending on generated content, it is now about the relevance of social context (Kvale and Brinkmann, 2009). It is possible to locate individuals within the network, determine their role or position to vis-à-vis peers and to show the interconnectedness of actors beyond direct contacts. Through mobile app services the social context may be easier to identify than in traditional offline context (Helkkula et al., 2012). Even if it is easier to identify social context for measuring, there are some constraints to be considered:

(1) Articulated networks are those that result from people specifying their contacts through technical mechanisms like email directory or phone books, instant messaging buddy lists, "friends" lists on social network sites, and "follower" lists on other social media genres. The motivations that people have for adding someone to each of these lists vary widely, but the

result is that these lists can include friends, colleagues, acquaintances, celebrities, friends-of-friends, public figures, and interesting strangers (Boyd and Crawford, 2012).

(2) Relationships, once established, remain in place until or unless they are actively terminated (Lewis et al., 2008).

(3) Articulated networks are not equivalent to personal networks. For example, when mobile phone data suggest that workers spend more time with colleagues than their spouse, this does not necessarily imply that colleagues are more important than spouses. Measuring tie strength through frequency or public articulation is a common mistake: tie strength – and many of the theories built around (Onnela, et al.2007; Granovetter, 1973; 1983) – is a subtle reckoning in how people understand and value their relationships with other people. Not every connection is equivalent to every other connection, and neither does frequency of contact indicate strength of relationship. Further, the absence of a connection does not necessarily indicate that a relationship should be made (Boyd and Crawford, 2012).

(4) The relations displayed through social media are not necessarily equivalent to the sociograms and kinship networks (Moreno, 1951) that sociologists have been investigating. The ability to represent relationships between people as a graph does not mean that they convey equivalent information (Boyd and Crawford, 2012).

Finding to theme 5 – activities. Resources refer to all items or people becoming resources in a resource integration process (Löbler and Hahn 2013). Resource integration is an ongoing process and can be seen as a series of activities performed (Payne et al., 2008) in a specific context. The object concerned by a context can be an action or a cognitive activity (Bezier and Bertillon, 2005). The context information is based on the availability of hardware sensors and the type of context data. The main sources for sensory data are: (1) dynamic (run-time) sensory data (e.g., collected from a user interaction with the system) and (2) static sensory data mined from static information resources (Erfani et al., 2016). A common objective for the use of context information is to facilitate the interaction between a system and user task completion by capturing situation-specific information (Bettini et al., 2010). Facebook and YouTube often look at completion rate as a metric of engagement with a particular piece of content e.g. a video. For Snapchat the activity of taking a screenshots can be used as an engagement tool. A story on Snapchat is a compilation of snaps that has been posted to a story over the last 24 hours with an unlimited number of snaps or 10-second videos. Interaction of users can be measured from the first snap up to the last snap each time the story is watch.

Limitations: The notion of an active account is problematic and should be critically examined (Boyd and Crawford, 2012). The Snapchat community spends on average of 25 to 30 minutes on the app every day. On average, approximately 25% of Snapchat´s daily active users post to their Story every day (SEC, 2017). While some users post content frequently, others participate as "listeners". Listening can be distinguished in background listening, reciprocal listening, and delegated listening (Crawford, 2009). Background listening is an example of collapsing contexts, mentioned in the introduction and shown in Figure 1. Throughout a timeline, there are only a few moments requiring concentrated attention. From the perspective of creation of value-in-context listening can be considered as an activity that requires motivation and engagement. The "passive" listener also integrates resources. Available metrics for measuring listening are time (when and how long), taste (what content is listened) and location and medium (where it is listened).

Finding to theme 6 – third parties Third parties may belong to social contacts of actor *me* and are already treated in theme 2. Beyond that, other actors and actor made groups can be of interest to measure demographic patterns, affiliations, or views and opinions of groups. The structural topography of a network can be examined. Properties of the network itself, e.g. closeness, centrality or structural holes, become visible. Details about the demographic composition of population are made apparent on several dimensions. Comparisons are possible on how network characteristics are

associated with gender, ethnicity, socioeconomic status, or online activity. The network can be monitored over time and compared to other networks elsewhere (Lewis et al., 2008).

Third parties who want to monetize the service have a stronger focus on understanding the structure and dynamics of the networks. The understanding is essential to model the network, improve the service, and design future apps (Instagram, 2017b; Snapchat, 2017b; WhatsApp, 2017a). App providers may ask advertisers or other partners to serve ads or services to the device. These third parties may use cookies or similar technologies. A device identifier may deliver information to the app provider or to a third party partner, reporting how an actor browses the service and may enable to provide reports or personalized content and ads (Instagram, 2017b; Snapchat, 2017b). For advertisement partners aggregated data can assist in selecting ads relevant to the likely audience (Instagram, 2017b; Snapchat, 2017b). For example, if the aggregated data indicates that at 11 a.m. on Sunday mornings, 90% of people using the app are seniors, the advertiser may choose to display an ad relevant to that demographic (Intel, 2017).

Table 2 gives an overview of context (theme 1-4) and value-in-context measurement (theme 5-6), indicators and scales. The findings are reflected with findings in literature.

Table 2: Overview of context and value-in-context measurement, indicators and scales

Theme #	Scope	data type context	value-in-context	indicator	scale
		socio	n/a	education	ISCED-level [1]
1	actor me	socio	n/a	hometown	urban/rural
		demographic	n/a	age	years
		demographic	n/a	gender	female/male
		location	n/a	Latitude/Longitude	1° 1' 1"/1° 1' 1"
		time	n/a	run-time/day time	h,min,sec
2	app/device	cookies	n/a	use of website,app	popularity of pages
				type	wired/wireless
		network	n/a	protocol	GSM / 3G / WLAN / Bluetooth
				bandwidth	packets/second
		text	n/a	posts/metadata	numbers/lenght/time
		photos	n/a	posts/metadata	numbers/lenght/time
3	resource/	audio	n/a	posts/metadata	numbers/lenght/time
	content	video	n/a	posts/metadata	numbers/lenght/time
		stories	n/a	posts/metadata	numbers/lenght/time
		network size	n/a	contacts	numbers
4	social contacts	network reach	n/a	followers,friends	viral/organic/paid
	groups			demografics	e.g. female/male; years
		network heterogeneity	n/a	geographic	1° 1' 1"/1° 1' 1"
				interests	# of expressed interests
				likes, comments,	numbers/day
5	activity	aggregated data pattern	Actor´s engagement	views, shares,	numbers/day
				stories	completion rate/fallout rate
				retweets	answer rate/time
		composition of	n/a	socio-demografics	e.g. female/male; years
		populations		ethnicity	e.g. ethnic group, religion
6	third parties	aggregated data pattern	Actors´ engagement	posts/metadata	active/listener
				time, location	h,min,sec/1° 1' 1"
		aggregated data pattern	Actors´ engagement	interests	# of expressed interests
				purchase	# of purchase

[1] ISCED-level: International Standard Classification of Education

5. Discussion

Theoretical and practical Implications

A model of context(s) is evolved to represent four perspectives on context in physical and virtual semantics (Figure 1 Cu, Ci, Ctp, and Ce). The intention of the paper is to contrast the concerns with regards to measurability of value-in-context (Helkkula et al., 2012; Smith et al., 2009; Sanchez-

Fernandez and Iniesta-Bonillo, 2007). The granulated understanding of context (Pohlmann and Kaartemo, 2017) hopefully makes the measurement of value-in-context more workable. Therefore an approach is proposed to measure context and value-in-context with mobile app services. In a case study six themes are identified to describe context and how value-in-context for mobile app services can be measured. Outcome is that context can be measure on the singular themes meanwhile value-in-context always postulates activities or engagement between resource/actors (theme 4 and 5) The case study exemplifies the measurement and provides indicators and scale to measure both context and how value-in-context.

Value-in-context measurement remains in principle complex but new technologies provide the potential to make measurement possible. A look at the case studies let assume the company´s data scientist are already working on the methods and academics chase after (Lin, 2015). The paper may give exemplified insight to practitioners on how uniquely and phenomenologically determined value by the beneficiary (FP10) can be mapped in a scaling manner (Vargo and Lusch 2016). Practitioners may use the method, adapt it in their ecosystem, and identify how value is co-created in their specific context.

Research limitations and further research

There are various limitations to the proposed measurement method of value in context with mobile app services. First, within academics there may still be a gap on skills between computer scientists, and social scientists both offering valuable perspectives but also a limitation in interdisciplinary cooperation (Boyd and Crawford, 2012). Second, the control over data for computational social science could easily become the almost exclusive domain of private companies (Lazer et al., 2009), as such mentioned in our case study. This may great a new kind of digital divide of data rich and data poor entities (Boyd and Crawford, 2012). Third, handling with third party data, even in an aggregated level has to take privacy and ethical norms and regulations into account (Lewis et al. 2009; Meiss et al. 2008; Intel, 2017). This may also has a limitation to what is mentioned second, the willingness of private companies to give their data to academics ((Boyd and Crawford, 2012; Lin 2015; Twitter, 2014). Fourth, the quality of value-in-context measurement may be influenced by data volume (Lin, 2015), data quality (Shen and Cheng, 2012), and data interpretation (Ristoski and Paulheim, 2016). Context is hard to interpret at scale and even harder to maintain when data are reduced to fit into a model (Boyd and Crawford, 2012). And fifth, collecting context data and integrating context-awareness at the application level is expensive. In order to reduce this cost, reuse and sharing of context information among context-aware applications must be considered from the beginning of the development cycle (Erfani et al., 2016).

As far as we know this is the first proposal of measuring value-in-context with mobile services and conceptualized with S-D Logic. The limitations provide a basis for further theoretical and empirical research in this emerging area. At a theoretical level, value-in-context, is identified as a motor theme of S-D Logic where scholars asked for a finely granulated understanding (Pohlmann and Kaartemo, 2017). Table 2 gives an overview of context and value-in-context measurement, indicator and scale. Other devices have the potential to enrich this overview and give more indicators to measure context and value-in-context.

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Appendix 1: Sample finding of for-free-apps on Google´s Playground and Apple´s App Store

Rank	Playground	points	Rank	Applestore	points	Rank	Overall Apps	points
1	Mein Vodafone	10	1	WhatsApp Messenger	10	1	WhatsApp Messenger	19
2	WhatsApp Messenger	9	2	Facebook Messenger	9	2	Bitmoji Avatar Emoji (S	13
3	ProSiebenKostenlos	8	3	Yo-Gi-Oh Konami	8	3	Facebook Messenger	12
4	Bitmoji Avatar Emoji (s	7	4	Bubble Which 3	7	4	Snapchat	10
5	YouTube Videos	6	5	Bitmoji Avatar Emoji	6	5	Instagram	8
6	Snapchat	5	6	Snapchat	5			
7	Instagram	4	7	Instagram	4			
8	Facebook Messenger	3	8	Facebook	3			

Appendix 2: Case Study Summary: Context themes and type of collected data per app/company

Context themes	Data type collected by…	WhatsApp	Snapchat	Instagram
#1 Personal data (actor me)	age	X	X	X
	e-mail address		X	X
	first name			X
	last name		X	X
	password		X	
	phone number	X	X	X
	profile picture	X	X	X
	profile/user name	X	X	X
	status message	X		
#2 item (device of actor me)	browser Info	X	X	
	cookies for preferences (e.g. language)	X	X	X
	cookies to measure effectiveness of pages	X	X	X
	cookies to measure popularity of pages	X	X	X
	cookies to remember	X		X
	cookies to show relevant content	X		X
	cookies to understand mobile vs. desktop use	X	X	X
	device identifier	X	X	
	hardware model	X	X	
	info of device´s camera & photos	X	X	X
	IP address	X	X	X
	location finder	X	X	X
	mobile network		X	X
	operating system	X	X	
	referring page/exit page	X	X	X
	time (e.g. install/access/use app)		X	
#3 Resources (belonging to actor me)	debit or credit card (if required)		X	
	metadata of content		X	
	use, display, modify, publish (…)content		X	
	user content (photos, comments…)		X	X
#4 Social contacts (of actor me)	contacts of address book	X	X	X [1]
	groups	X		

Appendix 2 (continuation)

#5 Activity (of actor me)	broadcast lists	X		
	about interaction	X	X	X
	about likes	X	X	X
	about use	X		
	e-mail tracking (opened and clicked links)			X
	hashtag associated event	X		
	run contests			X
	special offers			X 1
	transactions as…	X		X
	...delivery status	X	X	
	...payments	X	X	X

#6 Third Parties (other actors in the network of actor me)	advertising partners/ advertising networks		X	X
	affiliates (same group that company is part of)			X
	analytics tools (TP)(measure traffic and trends)	X		
	Companies distributing app/app stores		X	X
	Companies providing infrastructure/network provider	X		
	Companies providing maps and places information	X	X	X
	Companies providing news	X	X	
	Companies providing payment services	X		
	Contacts of social media sites (option)		X	X
	demographic patterns	X	X	
	for legal reasons		X	X
	In the event change of control the buyer or transferee			X
	other users/group info	X 1	X	
	parties using company´s API (Terms of Use)		X	X

X 1 = eligible option

Sources: WhatsApp Legal Info (WhatsApp, 2017a), WhatsApp´s Privacy Policy (WhatsApp, 2017b), WhatsApp Cookies (WhatsApp, 2017c), Snap Inc. Terms of Service (Snap Chat, 2017b), Snap´s Privacy Policy (Snapchat, 2017a)

Instagram Terms of Service (Instagram 2017a), Instagram´s Privacy Policy (Instagram 2017b)