Patient empowerment through mobile health: Case study with a Brazilian application for pregnancy support

Gustavo V. Delgado1 | Rodrigo B. de Carvalho1 | Chun W. Choo2 | Ramon S. Leite1 | José M. de Castro1

Abstract
This paper analyzes how mobile health applications contribute to the empowerment of health service users. The theoretical foundation includes m-health, user empowerment, and value co-creation. Quantitative and qualitative methods were used to investigate the Kangaroo application (Canguru, in Portuguese), which targets Brazilian pregnant women and seeks to make women empowered for a healthy pregnancy. The free app is a healthcare social network designed by a health-tech startup and a reference Brazilian hospital. It has already supported 350,000 pregnant women, and more than 200 health professionals. The data collection effort comprised application log analysis of 6 months of records of 99,709 users, mobile-based survey with 429 women and 16 interviews. The results showed that the functionalities of the personal and social dimensions mapped in the application explain 85.5% of the user empowerment. The app social features impacted 2.4 more than the personal functionalities. The quantitative analysis concluded that there was no moderating effect of styles of value co-creation practices on the relationship between empowerment and its dimensions. The theoretical contribution is associated with the discussion of the influence of personal and social dimensions of m-health to the user empowerment.

KEYWORDS
health informatics, mobile health, user empowerment, value co-creation

1 INTRODUCTION

The health market is characterized by its complexity since new technologies, medicines, diseases and treatments may appear in a dynamic pace. Furthermore, health institutions usually face a triple aim challenge: (a) improving the individual experience of care; (b) improving the health of populations; (c) reducing the per capita costs of care for population (Berwick, Nolan & Whittington, 2008).

The combination resulting from the evident pressure of rising costs, the epidemiological profile change and the necessary reorganization of health services has attracted the attention of healthcare solution providers in order to broaden access and reduce costs (Lee & Han, 2015). This context has also stimulated service innovation, allowing not only quality improvement, but also breakthroughs in greater efficiency and cost reduction (Thakur, Hsu & Fontenot, 2012). Nonetheless, physician-centered systems have achieved limited impacts on health outcomes
value and also presents the research model and its hypotheses; section 3 provides details about the methodological approach, the empirical analysis units, as well as the strategies for data collection and analysis; section 4 is for the description and analysis of the data. Finally, the last session brings the discussions about the theoretical and empirical contributions. This study was approved by the Brazilian Research Ethics Committee, since it involved interview with pregnant women and access to health data.

2 | THEORETICAL BACKGROUND

The background considers the following themes to support the research model: (a) customer empowerment, where the “customer” is the patient or healthcare user; (b) m-health, pointing out the attributes that contribute to the empowerment of health service users and (c) service innovation, focusing on co-creation value. A research model is proposed with hypotheses for the investigation concerning the user empowerment in the m-health context.

2.1 | Healthcare user empowerment

Healthcare users are usually seen as passive receivers in the more traditional studies of health services (Aujoulat, D'hoore & Deccache, 2007). On the other hand, the health user empowerment perspective assigns them a more active role (Almunawar et al., 2015) in their relationship with service providers, encouraging them to take responsibility for their own health, culminating, also, in decision-making and consequences monitoring. Nonetheless, there is a significant concern about the qualitative consequence of such empowerment due to a possible non-adherence to health treatments as a consequence of a shared decision, such as recent digitally mobilized parent groups against mandatory vaccination campaigns (Camacho, De Jong & Stremersch, 2014).

Empowerment is a concept widely used in the Social Sciences and can be understood as a process, as a result or as a process and a result (Pires, Stanton & Rita, 2006). Empowerment may be considered as a process, since it contributes to critical thinking and autonomous action, but also as an outcome, when the result of this process translates an improvement feeling in personal effectiveness (Anderson & Funnell, 2010).

Empowerment was addressed by several studies in the literature (Almunawar et al., 2015; Anshari, Almunawar, Low, Wint & Younis, 2013; Aujoulat et al., 2007), but empowerment measurement needs further studies,
because universal instruments could be insufficient, since they may not consider variables related to the local cultures and contexts (Wallerstein, 2006). Gagnon and Rennick (2009) proposed to review and identify questionnaires that measure empowerment and demonstrate better evidence of reliability and validity, recognizing empowerment as a multidimensional construct applicable to both individuals and organizations. In their studies, the authors observed that there was a significant diversity of theoretical basis for the measurement of the empowerment construct.

Barr et al. (2015) conducted a new systematic review on patient empowerment assessment. The authors stated emphatically that there is no consensus on the best way to effectively demonstrate patient empowerment, endorsing the absence of a common instrument for measuring empowerment between different health services. Limited comparative capacity between empowerment assessment instruments is still remarkable (Gagnon & Rennick, 2009). The particularities associated with the context, the health conditions or the treatments are elements that directly interfere in the elaboration of questionnaires aimed at measuring the patient's empowerment.

2.2 Mobile health (m-Health)

Mobile health can be situated as a subdomain of a broader field of study called Consumer Health Information (CHI). In a systematic review of this construct, Flaherty, Hoffman-Goetz, and Arocha (2015) stated that CHI is an emerging field that uses technology to provide health information in order to improve the decision-making process about healthcare by the population, but they also concluded that there is no uniform and widely accepted definition of this research field.

According to the view of Faiola and Holden (2017), CHI comprises the study of the patient information needs and the healthcare technologies, as well as the implementation of methods to make this information accessible to consumers. This subject is also studied from the Health Informatics perspective, where m-health is related to the usage of mobile communications, such as smartphones, for health and information services (Akter, D’Ambr & Ray, 2013).

The application domain deserves special attention in the m-health subfield. Faiola and Holden (2017) highlighted the relevant number of apps available for download from the main platforms with purposes varying from chronic illnesses to well-being. Ali, Chew, and Yap (2016) stated that applications have been representing the most used way of intervention in m-health since 2012. Despite technological developments, the paradigm shift from physician-centered perspective towards patient-centered applications is far from trivial, resulting in many unsuccessful m-health projects (Lee & Han, 2015).

In the m-health domain, the prevalence of academic works from the perspective of health professionals, especially physicians, is well known and the most frequent subjects are professional education, diagnostic assistance, monitoring and remote action (Boulos, Brewer, Karimkhani, Buller & DellaValle, 2014). Studies that focus on the perspective of the healthcare user are gaining relevance as patients become increasingly active, without time or spatial restrictions, in their Relationships with the healthcare providers (Calvillo, Román & Roa, 2015). Considering the peculiarities of m-health, Akter et al. (2013) summarized its core attributes (Table 1).

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Implication</th>
<th>Support References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility</td>
<td>m-Health provides universal accessibility anywhere, anytime</td>
<td>Bauer, Reichardt, Barnes, and Neumann (2005); Kahn, Yang, and Kahn (2010); Varshney (2005)</td>
</tr>
<tr>
<td>Personalized solutions</td>
<td>m-Health provides individualized solutions addressed to specific needs for the customer profile</td>
<td>Barnes (2003); Barnes and Scornavacca (2004)</td>
</tr>
<tr>
<td>Immediacy</td>
<td>Right-time services, focusing on relevant, specific and timely information</td>
<td>Barnes and Scornavacca (2004); Kahn et al. (2010); Pousttchi and Wiedemann (2009)</td>
</tr>
<tr>
<td>Location-based information</td>
<td>m-Health provides information based on local context, with geolocation support</td>
<td>Barnes (2003); Varshney (2005); Kahn et al. (2010);</td>
</tr>
<tr>
<td>Interactivity</td>
<td>m-Health provides value co-creation through intense, reciprocal, long-term interaction</td>
<td>Barnes (2003); Kahn et al. (2010);</td>
</tr>
<tr>
<td>Mobility</td>
<td>m-Health meets temporal, spatial and contextual mobility needs</td>
<td>Chatterjee, Chakraborty, Sarker, Sarker, and Lau (2009); Kakihara and Sørensen (2001)</td>
</tr>
</tbody>
</table>

Source: Akter et al. (2013, p.182).
2.3 | Empowerment applied to mobile health

The combination of the empowerment and m-health constructs seems to be a natural trend, considering the exponential growth of health mobile applications. Appropriating the concept of empowerment to m-health context on an empirical study, Almunawar et al. (2015) developed a conceptual model composed of the three following dimensions: personal, medical and social.

The personal perspective (mPersonal) of empowerment considers the individual improvement of basic habits, physical exercise and emotional factors (Almunawar et al., 2015). The empowerment in this dimension can be accomplished by the promotion and enhancement of the user's skills to identify his/her own needs and issues, as well as finding the necessary resources to control better his/her own life.

The medical perspective (mMedical) is about the integration between the user and the health provider and the resulting decision-making (Almunawar et al., 2015). In the Brazilian context, there are clear regulatory barriers for the use of technologies or any mass media at a distance for consulting, diagnosing and prescription, limiting the use of such media solely for the purposes of enlightenment and education of society. Some of these barriers were recently reviewed and relaxed due to the current Covid-19 scenario.

The social perspective (mSocial) includes the sharing of stories and experiences among users, and also networking between patients and health providers (Almunawar et al., 2015). The users were benefited from the collective knowledge shared through this technology, obtaining support and feedback that encourage more reliable decisions upon their health.

2.4 | Service innovation and value co-creation

According to Barrett, Davidson, Prabhu, and Vargo (2015), there is a new conceptualization of service as value co-creation through exchanges between the actors involved in the dominant logic of service. Thus, the service and not more the product becomes the common denominator of the economy. The service is part of a process of joining and reciprocal co-creation of value between providers, beneficiaries and other actors. The benefit provided by the services would be, therefore, the value that emerges from the resource interaction between the involved actors (Barrett et al., 2015; Vargo & Lusch, 2004).

Value co-creation is usually defined as the benefit obtained from the integration of resources through activities and interactions with employees in the customer's service network (McColl-Kennedy, Vargo, Dagger, Sweeney & Kasteren, 2012). The practice of value co-creation applied to healthcare domain can be grouped into certain styles (McColl-Kennedy et al., 2012). Based upon studies about the dominant logic of service, theories of social practices and consumer culture, a typology made up of five groups of Customer Value Co-creation Practice Styles (CVCPS) was proposed from the combination of activity levels (from low to high) and the number of interactions (from low to high) between different individuals (McColl-Kennedy et al., 2012), as shown in Figure 1.

![Customer Value Co-creation Practice Styles (CVCPS)](image)

**FIGURE 1** Customer Value Co-creation Practice Styles (CVCPS). Source: McColl-Kennedy et al. (2012)
Interactions are associated with the engagement ways of an individual with other actors in his/her service network, whereas activity levels are linked to co-creation attitudes such as information gathering and sharing, cooperative actions and collective learning.

The Team Management style is defined as an user who has a high level of activities and interactions with the service provider, other users, family members, also promotes self-managed activities (McColl-Kennedy et al., 2012). At the opposite extreme, interactions for the Passive Compliance style are primarily proposed by the health professional, responsible for command and guidance. In turn, the Insular Controlling style tends to have superficial interactions, although being self-focused. The Partnership style is characterized by demonstrating a medium level both in interactions with other individuals and in the activity level. The Pragmatic Adaptation style is related to a low level of activities, contrasted by a high level of interactions with other individuals, private sources and self-generated activities (McColl-Kennedy et al., 2012).

2.5 | Research model

The research model (Figure 2) was designed from the integration of empowerment dimensions applied to m-Health proposed (Almunawar et al., 2015) with the co-creation styles (CVCPS) (McColl-Kennedy et al., 2012).

The research model has one dependent variable (empowerment) and two independent variables, corresponding to the functionalities of the mPersonal and mSocial dimensions of empowerment (Almunawar et al., 2015). The independent variables are not directly measured, but they are measured from each mapped features in the m-health application (Kangaroo) and categorized in each of the dimensions of the model by Almunawar et al. (2015). The research model did not comprise the features related to the medical dimension of empowerment applied to m-health (mMedical), due to the limitation concerning regulatory boundaries existing in the Brazilian context.

Within the research model, the functionalities of the empowerment dimensions (Almunawar et al., 2015) are treated as independent variables. Such proposition is justified by the fact that the authors have not investigated how much the empowerment dimensions applied to m-health explain the empowerment itself, which is considered a dependent variable in this model. The impact of the app features linked to personal and social empowerment dimensions is crucial to understand how the m-health applications contribute to the empowerment of health service users. Thus, the following theoretical research hypotheses are formulated:

**Hypotheses 1 (H1):** Personal functionalities in m-health applications are positively associated with the empowerment of health users. (Almunawar et al., 2015)

**Hypotheses 2 (H2):** Social functionalities in m-health applications are positively associated with the empowerment of health users. (Almunawar et al., 2015)

The research model has also a moderating variable (CVCPS) that considers the relationship between the independent variables and the dependent variable. The typology suggested by McColl-Kennedy et al. (2012) consider that there are different styles of value co-creation practices, which differ according to the intensity (higher
or lower) of activities and interactions. The authors suggested that this classification is applicable to other health services. Taking in account the typology of McColl-Kennedy et al. (2012), there is the hypothesis that styles associated with greater participation in activities and interactions are positively associated with empowered users, while styles with lower participation in activities and interactions are negatively associated with empowered health service users.

**Hypotheses 3 (H3):** Customer Value Co-creation Practice Styles (CVCPS) moderate the relationship between the Social Dimension and Empowerment. (McColl-Kennedy et al., 2012)

**Hypotheses 4 (H4):** Customer Value Co-creation Practice Styles (CVCPS) moderate the relationship between Personal Dimension and Empowerment. (McColl-Kennedy et al., 2012)

### 3 | RESEARCH METHODOLOGY

Both qualitative and quantitative research strategies (mixed approach) were chosen to develop a case study of holistic nature and longitudinal cut (Yin, 2010). The case refers to a m-health application called Kangaroo (Canguru, in Portuguese) that has Brazilian pregnant women as its user community. The app was developed by a health-tech startup called Qeepme, which was founded in 2015 in Belo Horizonte (state of Minas Gerais) and was supported by the incubation process of the innovation agency of the Israelite Albert Einstein hospital in the state of Sao Paulo. This agency is called Eretz.bio and it is also sponsored by Pfizer, GlaxoSmithKline (GSK), Novartis and Johnson & Johnson. The application positions itself as a solution that makes women empowered for a healthy pregnancy, as it offers professional counseling, prenatal organization, social network for pregnant women, risk identification and access to information on topics related to pregnancy. The app is available in the main mobile platforms (Android & iOS) and a number of 99,709 app entries of female users were registered between November, 2017 and April, 2018.

In order to obtain a more comprehensive and contextual representation of the unit under investigation, the following types of data were used: (a) file logs; (b) structured questionnaire and (c) individual interviews. Regarding the file logs, the health-tech startup Qeepme (developer and owner of the Kangaroo app) was visited twice, for understanding and collecting database records of the case study application. For this research, the 4.3.5 version features of the application were mapped, which records are stored in a structured database and available in Google Play app store, since August, 2017.

For data extraction, a script in MySQL language was developed and applied to the application database records. A clipping of the registries of users who accessed the Kangaroo application from November, 2017 to April, 2018 was chosen, resulting in a large data frame of six complete months of records in the application database, totaling 99,709 users.

The structured questionnaire was based on the empowerment dimensions (Almunawar et al., 2015). The Kangaroo app's features were mapped and linked to each dimension proposed by the Almunawar et al. (2015). The questionnaire comprised nine statements from the sample users in a degree of compliance in 11-point Likert-type scale. The questionnaire was submitted to the women who registered in the application between November, 2017 and April, 2018, the same database corresponding to the analyzed logs. Since it was the same database, it was possible to identify the respondents profile with the co-creation styles (McColl-Kennedy et al., 2012). In order to determine the sample size (Chin, 2010) in Structural Equation Modeling (SEM) and observe an arbitrarily margin of error of 5% and an arbitrary 95% confidence interval (Lopes, 2016), the calculated minimum sample size was 383. It was possible to obtain 429 users complete answers to the survey.

Later, individual interviews (Merton, Fiske & Kendall, 1990) were conducted in a more spontaneous way and with an informal nature, since the interviewees were pregnant or recent mothers, but a semi structured script (Yin, 2010) based on the research model was applied. Sixteen interviews were conducted and recorded, resulting in an average time of 34’29’’ minutes and 334 pages of audio transcript. The quantity of individual interviews was enough to achieve the saturation criterion (Eisenhardt, 1989). The selection of respondents was intentional and the chosen women were the users with most intensity of use of the application and consequently more able to contribute with the study. The interviews were held in person with pregnant women in Belo Horizonte, Brazil and with the support of the Skype software for interviewing women in other regions. The interviews happened from June to July, 2018.

Regarding the data analysis strategy, the source content of the gathered qualitative evidences was analyzed (Bardin, 2011). The simple count of registry occurrence in database log for each mapped variable was considered, allowing the identification of the usage (yes or no) as well as the frequency of the use of certain feature (feature usage index).

Using the CVCPS typology (McColl-Kennedy et al., 2012), the app users were categorized according to the intensity (higher or lower) of activities and interaction in the
application. Such classification enabled the analysis of CVCPS as a moderating variable of the relationship between the functionalities of the empowerment dimension (independent variables) and the empowerment itself (dependent variable). The individual interviews were transcribed and organized with the support of NVivo 12 software. The content analysis of the interviews was made with the support of a previously prepared data categorization.

To identify the attributes of the application that contribute to the empowerment of its users, each excerpt attached to a feature was categorized under an attribute to m-health (Akter et al., 2013). Regarding the database analysis strategy referred to the structured questionnaire, a descriptive analysis of the variables was made, observing its relative and absolute frequencies, while in the description of the items, measures of central tendency, position and dispersion were used. Besides that, the method of Bootstrap (Efron & Tibshirani, 1994) was used to calculate the confidence intervals of averages.

SEM was used to evaluate the relationship between social and personal empowerment functionalities with the empowerment itself, applying the approach of Partial Least Square – PLS (Tenenhaus, Amato & Esposito Vinzi, 2004). The Bootstrap method was used to calculate the confidence intervals for the factor loadings of measurement and for the betas of the structural models. Dimensionality, confidentiality and convergent validation were evaluated, so the validation of the measurement model could be verified. As for the convergent validity, the criteria suggested by Fornell and Larcker (1981) was used once again. The Cronbach Alfa (CA) and the Compound Reliability (CC) were used to measure the reliability of the empowerment dimensions taken in account in this research model. R-square ($R^2$) and Goodness of Fit (GoF) were used for the adjustment quality verification. $R^2$ represents, on a scale from 0 to 100, how much the independent variables explain the dependent variables, and the closer to 100 the better. The GoF also ranges from 0% to 100%, and again the closer to 100%, the better is the adjustment (Hair, Black, Babin, Anderson & Tatham, 2009).

In order to check the moderating effect of CVCPS on the relationship between empowerment and its personal and social functionalities ($m_{Personal}$ and $m_{Social}$), the models were adjusted according to the results obtained and gathered from the structured questionnaire versus the previously identified styles for the Kangaroo users. It should be highlighted that the moderating variable is only taken in account in the structural model. The model was adapted to each style individually, comparing the models by the multivariate data analysis (Hair et al., 2009). For the formal tests of comparison of factorial loads and the coefficient between styles, the Parametric Approach, with the T-test with a multi-group standard deviation (Keil et al., 2000), was applied since it was a considerably large sample size. The software used in the analysis was the R, in its 3.4.4 version.

**FIGURE 3** Features of Kangaroo Application applied to Empowerment Model (Almunawar et al., 2015). Source: Adapted from Almunawar et al. (2015)
When the pre-analysis stage was over, the exploration and codification of the content was done, according to the empowerment dimension of m-Health (Almunawar et al., 2015). Finally, it was time for data interpretation under the existing theories, observing the iteration of this process, so the generalizations were consistent enough to confront the adopted theoretical hypotheses.

4 | DESCRIPTION AND DATA ANALYSIS

After downloading the application in the mobile phone and subscribing with personal information, it is given to the Kangaroo user the choice of using its features. Each app feature was classified according to the empowerment dimension (Almunawar et al., 2015) (Figure 3). Table 2 summarizes the main features of the Kangaroo m-health application.

From the analysis of the registries in the Kangaroo database and by matching the app features with the empowerment dimensions (Almunawar et al., 2015), a mapping of the application users (Figure 4) was made for a temporal cut of the research applying the matrix model in the CVCPS typology (McColl-Kennedy et al., 2012). Hyper users were considered those who had at least one occurrence registered in the database in all the mobile app features. At the opposite extreme, users who did not have any occurrences registered in any feature were classified as Hypo users. The users considered as personal users were those who had an occurrence registered in the database in at least three of the four features classified as mPersonal and, in contrast, an occurrence in at most one of the four features classified as mSocial. On the opposite side, the Social users were those with registers in the database in at least three of the four individual activity features classified as mSocial and, on the other hand, an occurrence in at most one of the four features classified as mPersonal. Finally, Hybrid was the classification for users with some occurrence registered in the database, but not enough to be classified in the criteria of the styles previously described.

The structured questionnaire originated the creation of a database formed by ten variables. The characterization variable (co-creation styles) is a variable referring to the empowerment construct and eight variables related to personal and social functionalities (mPersonal and mSocial) of empowerment applied to m-health, as summarized by Table 3.

An analysis of the outliers was made. There was no value outside the range interval of the respective variable, not evidencing, therefore, the kind of outlier related to an error in data entry (Hair et al., 2009). The univariate outliers were diagnosed through the result standardization, so that the average variable would be 0 and the deviation standard would be 1. Observations with

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Brief description of Kangaroo features</th>
</tr>
</thead>
<tbody>
<tr>
<td>App feature</td>
<td>Empowerment Dimension</td>
</tr>
<tr>
<td>Calendar</td>
<td>mPersonal</td>
</tr>
<tr>
<td>Childbirth plan</td>
<td>mPersonal</td>
</tr>
<tr>
<td>Clinical condition</td>
<td>mPersonal</td>
</tr>
<tr>
<td>Symptom guide</td>
<td>mPersonal</td>
</tr>
<tr>
<td>Posts</td>
<td>mSocial</td>
</tr>
<tr>
<td>Comments</td>
<td>mSocial</td>
</tr>
<tr>
<td>Likes</td>
<td>mSocial</td>
</tr>
<tr>
<td>Maternity assessment</td>
<td>mSocial</td>
</tr>
</tbody>
</table>

Source: Developed by the authors.
standardized scores outside the range of |3.29| were considered outliers (Hair et al., 2009). Based on these criteria, 77 (2.25%) observations considered atypical in univariate shapes were found. The multivariate outliers were diagnosed based on $D^2$ measure of Mahalanobis. According to Hair et al. (2009), this measure verifies the position of each observation compared to the center of all observations with a set of variables, with a chi-square test being applied at the end. The individuals that present a significance of the inferior measure to 0.001 were considered multivariate outliers. According to these criteria, 12 (2.80%) atypical individuals of multivariate shape were found. It was chosen not to exclude any of the cases, considering that the observations represent valid cases of the population of Kangaroo users who answered to the structured questionnaires and that could limit the generality of the multivariate analysis, even if they were not taken in account.

The distribution of users in the adapted CVCPS (McColl-Kennedy et al., 2012) shows a prevalence of the “partnership” style, that is, a characteristic of hybrid use of the application, containing record of use in the

**TABLE 3** Acronyms related to the structured questionnaire

<table>
<thead>
<tr>
<th>Empowerment Dimension (Almunawar et al., 2015)</th>
<th>Acronym</th>
<th>App feature</th>
<th>Related question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Dimension Functionalities</td>
<td>PF1</td>
<td>Calendar</td>
<td>I feel empowered for being able to register my pregnancy appointments in the Kangaroo calendar.</td>
</tr>
<tr>
<td></td>
<td>PF2</td>
<td>Childbirth plan</td>
<td>I feel empowered for being able to create my birth plan in Kangaroo.</td>
</tr>
<tr>
<td></td>
<td>PF3</td>
<td>Clinical condition</td>
<td>I feel empowered for being able to register my Clinical condition in Kangaroo.</td>
</tr>
<tr>
<td></td>
<td>PF4</td>
<td>Symptom</td>
<td>I feel empowered for being able to register symptoms from my pregnancy in Kangaroo.</td>
</tr>
<tr>
<td>Social Dimension Functionalities</td>
<td>SF1</td>
<td>Posts</td>
<td>I feel empowered for being able to post messages in Kangaroo, and interact with other pregnant women.</td>
</tr>
<tr>
<td></td>
<td>SF2</td>
<td>Comments</td>
<td>I feel empowered for being able to register messages in Kangaroo, and interact with other pregnant women.</td>
</tr>
<tr>
<td></td>
<td>SF3</td>
<td>Likes</td>
<td>I feel empowered for being able to react to likes about posts and comments in Kangaroo.</td>
</tr>
<tr>
<td></td>
<td>SF4</td>
<td>Maternity Evaluation</td>
<td>I feel empowered for being able to evaluate maternity hospitals through Kangaroo.</td>
</tr>
<tr>
<td>Empowerment</td>
<td>-</td>
<td>-</td>
<td>I feel empowered for being able to use Kangaroo to manage my pregnancy.</td>
</tr>
</tbody>
</table>

Source: Developed by the authors.
features bounded to both social and personal dimensions of empowerment. These are users with a wider and more horizontal use and view of the application, representing the kind of behavior that Kangaroo creators expect.

It can be emphasized that the items presented factorial loads greater than 0.50. The measures of validity, quality and factorial loads were also verified. Empowerment dimensions applied to m-health presented CA or CC greater than 0.60, attending the required levels of reliability, being one-dimensional (Kaiser, 1958) and presenting a convergent validation (AVE > 0.40). The discriminant validation was achieved as well (Barclay, Higgins & Thompson, 1995).

The age groups interval of the interviewed women varied from 16 to 40 years old, being the majority of pregnant women (8 in total, or 50% of the interviewed users) between 21 and 25 years old. They come from eight states in Brazil, from four different regions (only the South region was not part of the sample). Most of the pregnant who were interviewed live in the southeast region (seven pregnant or 43.7% of them) or in the northeast of Brazil (6 pregnant or 37.5% of the interviewed women). Concerning education, most of them state having finished college education or being currently in college (10 pregnant or 62.5%).

The evaluation average in the Likert-type scale (from 0 to 10) for the app features were slightly lower to the users classified as hyperactive users of Kangaroo. This aspect shows that pregnant women with a more intense and frequent use of the application tend to be more critical in their opinions and evaluations. However, the sporadic use of Kangaroo does not result in a lower perception of empowerment by users, since the evaluation average of the application features are compatible to the users classified in other profiles, excepting the users rated as hyperactive users who have a more critical behavior.

Among the main objectives and contributions of Kangaroo for the empowerment of pregnant women, the application is pointed as a safe reference of information for answering questions during pregnancy, as said by interviewee E02: “my goal is to have my questions answered, so many questions. I think it is helping me a lot, because, as soon as I post a question, many people answer, I even get answers from a nurse, who always answers me”.

It is expected that the application contributes with qualified information, which can be given by health professionals as well as by other more experienced pregnant women, because they have been pregnant longer or have previous experience in motherhood.

The interaction with other pregnant women and also with health professionals had a relevant occurrence in the contextualization of the app use, as reported by the E14 interviewee: “when I got pregnant, I downloaded the app, so that I could chat to other girls, also to know exactly in which week of the pregnancy I was, and ask questions to the nurses in the group”.

Besides the search for reliable information, the usage context of Kangaroo has specific motivations. It is the case of interviewee E01, who found out about the application while searching for maternity hospitals, and so she downloaded Kangaroo because of its feature that brings evaluations of different maternity hospitals. Overall, there were 70 extracts from the recordings of interviews which mentioned the social functionalities of Kangaroo. The quantitative result in social features occurrences is of

**TABLE 4** Comparative analysis of the m-Health attributes applied to Kangaroo features

<table>
<thead>
<tr>
<th>m-Health Attribute (Akker et al., 2013)</th>
<th>Features of personal dimension of empowerment applied to m-health (adapted from Almunawar et al., 2015)</th>
<th>Features of the social dimension of empowerment applied to m-health (adapted from Almunawar et al., 2015)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calendar</td>
<td>Symptoms</td>
</tr>
<tr>
<td>Accessibility</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Immediacy</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Local-based information</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Interactivity</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mobility</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Personalized solutions</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>

|                                      | 22       | 17       | 8          | 5                  | 28    | 22      | 6     | 14                              |

Source – Developed by the authors.
34.6% greater than the occurrences of personal features in the application. The high quantity of spontaneous comments on the application social features is compatible with the results of its extracts of the interviews, also higher than the extracts about personal features of the application.

The attributes of Kangaroo that contribute to the users’ empowerment were grouped according to the concept summarized by Akter et al. (2013). The result shows a relevant prevalence of the interactivity attribute, corresponding to 35.2% of all the occurrences. The other attributes demonstrate a balance in their distribution, floating between 9% to 16% of the total of occurrences. After analyzing how each feature of the Kangaroo application contributes to the empowerment of pregnant women in the opinion of the 16 interviewed women, it was possible to compile the distribution of the occurrences of key-attributes in a system with their respective features of social and personal dimensions (Table 4). The distribution shows that interactivity and local-based information are the predominant attributes for the social dimension of empowerment.

The content analysis applied to styles indicates that there were nuances in the usage style of Kangaroo unveiled by the individual interviews, as in the case of the users originally classified as hyperactive, who are, actually, “hidden readers” of the content (passive compliance attitude) generated by the application, which seems enough for a high perception of empowerment.

Regarding the quantitative results, it can be noticed that there was significant (Value-\(p = .000\)) and positive influence (\(\beta = 0.287 [0.21; 0.39]\)) of the features linked to personal dimension about empowerment. Thus, it can be unraveled that the greater the personal features, the greater the health service user empowerment tends to be. In addition, it can be seen that there was significant (Value-\(p = .000\)) and positive influence (\(\beta = 0.676 [0.55; 0.77]\)) of the features linked to social dimension about the empowerment. Therefore, the greater the social features, the greater the health service user empowerment tends to be.

It is worth highlighting that the impact of the social features about empowerment was about 2.4 times bigger than the personal features, corroborating to the qualitative analysis of the individual interviews. Together, the social and personal features of empowerment applied to m-health explained the 85.5% of variability of the empowerment. The model presented GoF of 84%. The reliability intervals via Bootstrap are in accordance to the results obtained via \(p\)-value, indicating higher validity of the results.

As for the moderating effect of the adapted CVCPS (McColl-Kennedy et al., 2012) on the relationship of the empowerment and its social and personal dimensions, it is possible to conclude that the interactions were not significant (\(p\)-value > .050). The model was adjusted for each one of the styles adapted by McColl-Kennedy et al. (2012). There was no significant difference of the factorial loads between styles, which indicates that the respondents of every style noticed the items in a similar way. Table 5 sums up the measurement of research hypotheses.

### Table 5  Summary of the measurement of research hypotheses

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Result</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H1</strong>: Personal functionalities in mobile health applications are positively associated with the empowerment of health users.</td>
<td>Confirmed hypotheses.</td>
<td>Significant Influence (Value-(p = 0.000)) and positive influence ((\beta = 0.287 [0.21; 0.39]))</td>
</tr>
<tr>
<td><strong>H2</strong>: Social functionalities in mobile health applications are positively associated with the empowerment of health users.</td>
<td>Confirmed hypotheses.</td>
<td>Significant Influence (Value-(p = 0.000)) and positive influence ((\beta = 0.676 [0.55; 0.77])) of features linked to social dimension about empowerment</td>
</tr>
<tr>
<td><strong>H3</strong>: Customer Value Co-creation Practice Styles (CVCPS) moderate the relationship between the Social Dimension and Empowerment</td>
<td>Hypotheses not confirmed.</td>
<td>There was no significant difference ((p)-value&gt;) Respondents of all styles noticed the items in a similar way.</td>
</tr>
<tr>
<td><strong>H4</strong>: Customer Value Co-creation Practice Styles (CVCPS) moderate the relationship between Personal Dimension and Empowerment</td>
<td>Hypotheses not confirmed.</td>
<td>There was no significant difference ((p)-value&gt;) Respondents of all styles noticed the items in a similar way.</td>
</tr>
</tbody>
</table>

Source: developed by the authors.

### 5 Discussion and Conclusions

This paper analyzed how m-health applications contribute to the empowerment of health service users. The research
model was based on the proposal of Almunawar et al. (2015), which lacked empirical work. The features of the Kangaroo application were classified in two of three dimensions of the model of Almunawar et al. (2015).

Overall, within the scope of the studied case, it can be stated that the health application Kangaroo empowers its users since it offers features related to personal and social dimensions of empowerment applied to m-health (Almunawar et al., 2015), with emphasis to the impact of the functionalities of social dimension of empowerment, which obtained 2.4 times more impact than compared to the personal dimension features. Indeed, most of the user empowerment perception comes from the networking application features. Together, the functionalities linked to the personal and social dimensions of empowerment applied to m-health explained 85.5% of the empowerment variability.

This pronounced impact of the social functionalities rather than the personal ones is due to the network formed by the pregnant users of Kangaroo. It is a specialized network that feeds and renews itself with the experience reports and situations that might occur during pregnancy. The pregnant women network grew in a structured environment, which has the mediation of specialized professionals and the support of other features, bringing information security and reliability, which are critical aspects when one searches for information on health through the Internet. The participation of specialized professionals, who moderate and interact with the app community, is valued by the users and mentioned as a differential among other health information sources available on the Web.

Through this interaction, health application users were able to self-evaluate - compared to users in a similar health situation, they have access to professional and health providers’ evaluations from the experience reports of other users, they also interact with health professionals as far as questions and concerns about their health conditions arise. Hence, health applications may fill a gap within the break between consults and health procedures. The few minutes in the physician’s office may be complemented with a relevant interaction mediated by mobile technologies, as is the case of Kangaroo.

This study started from the hypotheses of a characterization variable, which would ponder the relationship between independent variables (the empowerment dimension of Almunawar et al. (2015)) and the dependent variable (the empowerment itself). The quantitative analyses concluded that there was no moderating effect of the value co-creation styles about the relationship between empowerment and its dimensions. The model was adjusted for each styles adapted of McColl-Kennedy et al. (2012), which allowed to verify that there was no significant difference of the factorial loads between styles, indicating that the respondents of all styles notices the items in a similar way. The individual interviews corroborated with little significant CVCPS moderation as a moderating variable. This result contrasts the findings of McColl-Kennedy et al. (2012), who suggested that the CVCPS classifications are applicable to other health services.

This research results suggest that the perception of empowerment are not greater for the active users of the application. Hence, empowerment of health service users is not related to “doing”, but rather to “being able to do”. The faculty of “being able to do” and the consciousness of what one can do with the health application influences the users’ perception of empowerment more than the “doing” itself. Consequently, the application presents a community, which is partially formed by “hidden readers”, who follow passively the publications on Kangaroo. Despite the absence of detailed tracks of this user profile in the application log, the empowerment perception was similar to the users of other profiles.

In the verified dichotomy for the understanding of empowerment as a process, as an outcome, or even as a process and outcome, this investigation has provided an understanding of empowerment as a process, in which health applications contribute through features related to empowerment dimensions applied to m-health in a way that each individual is able to exercise control over decision-making. It can be inferred that the outcome expected by the app users was not related to the empowerment itself. The pregnant women, who are Kangaroo users, expected health pregnancy, that is, they expect gestational outcome according to birth planning.

However, some limitations must be highlighted. The application case study does not have features that could be addressed to the empowerment of medical dimension applied to m-health (Almunawar et al., 2015). The discussion among health service users’ empowerment through mobile technologies is limited by the regulatory barriers of the Brazilian context, which prevent the use of technologies or any means of mass communication at distance for consult, diagnosis or prescription.

It is also important to mention that the particularity of the context and its own condition or health treatment are elements that interfere directly to the elaboration of questionnaires that intend to measure the patient’s empowerment. Even though it is a representative case, the application has a very specific target audience. Consequently, the impact of the features linked to social and personal dimensions of empowerment might have different results if addressed to different health service users from the target audience of Kangaroo. Furthermore, this research did not comprise a control group of pregnant women who did not use the application.
The thematic of empowerment through mobile technologies was treated in this work under the perspective of the user only. The medical professionals (nurses and doctors who moderated or used Kangaroo) were not contemplated in this research, neither was contemplated the entrepreneur responsible for the creation and development of this application. Future researches are suggested so that other stakeholders can be covered, building an analysis of this construct under a holistic and complementary vision. Another suggestion for further study is the impact of applications such as Kangaroo in the balance of costs related to the health system. The results suggest that applications such as Kangaroo encourage no cost waste with unnecessary exams and procedures for its target audience.

Empowerment through m-health is a complex and appealing topic. The technological solutions that promote the empowerment of health service users through m-health constitute an effort of great responsibility, which involves a truly qualified staff who is able to play new roles, as a mediator, a guide and a partner of a more active, interested and critical health service user.

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