Gamified e-Health Solution to Promote Postnatal Care in Morocco

Lamyae Sardi[1], Ali Idri[1,2(✉)], Taoufik Rachad[1], Leanne Redman[3], and Hassan Alami[4]

[1] Software Project Management Research Team ENSIAS, Mohammed V University, Rabat, Morocco
lamyasardi@gmail.com, rachad.taoufik@gmail.com, ali.idri@um5.ac.ma
[2] CSEHS-MSDA Mohamed VI Polytechnic University, Ben Guerir, Morocco
[3] Reproductive Endocrinology and Women's Health Lab, Pennington Biomedical Research Center, Baton Rouge, LA, USA
leanne.redman@prc.edu
[4] Faculty of Medicine, Mohammed V University, Rabat, Morocco
mhalami3@hotmail.com

Abstract. The postnatal period is a critical phase in both the lives of the mothers and the newborns. Due to all the inherent changes that occur during this period, quality care is crucial during this period to enhance the wellbeing of the mothers and the newborns. In Morocco, the neglection of postnatal care services are often associated to poor communication, financial difficulties and cultural barriers. Mobile technology constitutes therefore a promising approach to bridge this gap and promote postnatal care. In order to improve the effectiveness of mobile technology, gamification has become a powerful feature to boost motivation and induce fun and interactivity into the mobile solutions' tasks. Based on a previous review on mobile applications for postnatal care available in app repositories, a set of requirements have been identified to build a comprehensive mobile solution that cater the needs of both the mothers and the newborns. These requirements have, then, been enriched with real needs elicited at maternity Les orangers that belongs to the University Hospital Avicenne of Rabat. Along with the functional and non-functional requirements, gamification aspects have been also analyzed. After the analysis and design phases, a pilot version of the solution called 'Mamma&Baby' has been implemented using android framework. 'Mamma&Baby' is a mobile solution dedicated to assist new mothers during their postnatal period. As future work, it is expected to fully integrate the gamification elements into the solution and conduct an empirical evaluation of the overall quality and the potential of the solution with real puerperal women.

Keywords: Postnatal care · m-Health · Gamification · Quality evaluation

© Springer Nature Switzerland AG 2020
O. Gervasi et al. (Eds.): ICCSA 2020, LNCS 12252, pp. 931–946, 2020.
https://doi.org/10.1007/978-3-030-58811-3_66

1 Introduction

The postnatal period is a challenging phase in the lives of both mothers and newborns [1]. Commonly defined as the first weeks following childbirth, the postnatal period may last up to six months after delivery [2]; until the new mother regains her pre-pregnancy body shape, heals completely and builds a strong bond with her newborn baby.

Given the inherent physiological, psycho-emotional and social changes that occur during this period [3], an optimal care and a close attention to both mothers and newborn babies are needed to maintain and promote the health of the mother and her newborn baby and avert a substantial proportion of maternal and perinatal complications [4]. Postnatal care is therefore provided to meet the individual needs and preferences of the mothers and their newborn infants. It should be palliative and supportive for the mother to bolster her abilities to successfully adjust to motherhood [5]. According to international guidelines on reproductive health, postnatal care covers integrated maternal and newborn care practices that are provided in the health facility following childbirth, at home during the first crucial week, with subsequent visits to the facility during the remaining days and/or weeks of the postnatal period, when the mother is better able to leave her home. Postnatal care is also about empowering the mother to care for her baby and herself in order to promote their long-term physiological and emotional well-being [6]. Vaginal care, targeted postpartum hygiene and nutrition, newborn care and counselling on family planning and exclusive breastfeeding are the most preeminent pillars of postnatal care [7].

Albeit the critical importance of postnatal care in the lives of mothers and newborns, it consistently has the lowest coverage of interventions on the continuum of maternal and infant care. In this respect, postnatal care in Morocco is sub-optimal, hence substantially contributing to increasing maternal and infant mortality rates in the country. Poor communication, lack of awareness and information, financial difficulties are among the most prevalent factors hampering the utilization of postnatal care services [8]. A potential intervention that could reduce some of these modifiable factors is the incorporation of mobile technology.

In general, mHealth (mobile health) which refers to the continuous care delivered by mobile technology has been proven to have tremendous appeal in such it promises significant improvements in quality, convenience, reach and cost. With the outstanding technological advancements over the last decades, researchers have been more prompted to investigate ways of expanding and developing effective mHealth projects [9]. A significant attention is being drawn to leveraging mobile technology in the promotion of reproductive health care services including contraception and family planning, pregnancy monitoring and postnatal care [10–12]. As stated in a recent review most of postnatal care apps available in app repositories overlook addressing mothers needs during the postnatal period, specifically as regards to postpartum weight monitoring, mental wellbeing support and family planning [12].

Accordingly, the aim of the present study is to list the specifications of a comprehensive mHealth solution intended to advocate postnatal care. The completeness of this app consists of providing a functional content that combines newborn and maternal

care along with the counselling sections on all aspects underpinning the postnatal period.

In an attempt to foster engagement with the app and induce pleasant use and experience, the present study also proposes a persuasive strategy that stands upon gamification and game-like principles. Commonly defined as the use of game elements in non-game contexts, gamification is a trending discipline that has been applied, to date, in several different fields and has yielded significant outcomes in terms of sustaining users' long-term engagement and motivation, promoting healthy behaviors and inducing positive emotional states [13].

2 Related Work

Although there is a plethora of apps available to promote postnatal care, the literature published in this area is still very scarce. The use of mobile technologies in promoting reproductive healthcare is not yet extensively leveraged by researchers given that a good number of studies published in the area only focused on developing systems based on Short Message Service (SMS) in order to enhance postnatal clinic attendance [14], increase health facility contact through antenatal care [15, 16] and disseminate text messages on important aspects of antenatal care at regular intervals [17]. Despite their perceived effectiveness, these developed systems are barely ubiquitous in that their accessibility is geographically limited. To alleviate this limitation, a few studies have designed and implemented mobile applications to improve postnatal care. For instance, Moment Health app has been developed for new and expectant mothers to self-screen for mental depression and anxieties associated to the prenatal and postnatal periods. The app also provides helpful guidance and practical strategies to cope with these mental disorders [18]. Another mobile application has been proposed to improve accessibility to nutritional information and tips during prenatal and postnatal period [19]. In a wider context, Shorey et al. have proposed an mHealth app for supporting parents during postnatal period called 'Home-but not Alone' [20]. Along with providing a continuity of care, it has been reported that this app has enhanced new parents' confidence and satisfaction with regards their parenting roles and has endorsed social support and empathy. Whereas, most of the available apps for postnatal care omit pertinent features in relation to maternal care or/and baby care, the novelty of the mobile solution presented in the present study lies, particularly, in the exhaustiveness of its functional content and its persuasive strategy based on gamification principles. To the best of our knowledge, this is the first mobile solution for postnatal care to include game elements.

3 Requirements Specification of the m-Health Solution for Postnatal Care

3.1 Purpose of the Solution

Mamma&Baby is the name given to the m-Health solution for postnatal care proposed in the present study. Being fully-fledged for women during the postnatal period, Mamma&Baby is a comprehensive user-centered app that is intended to accompany new mothers throughout their postnatal journey. The central objective of this app is to promote postnatal care through the provision of helpful tips for postpartum recovery and recommendations and advices on baby care. The postnatal period is often considered as an emotional roller coaster for new mothers who require attentiveness and social support. Therefore, Mamma&Baby app promises to alleviate the emotional burden that is correlated with the postnatal period by means of social integration and counselling on mental wellbeing.

3.2 Requirements Development Process

The development of requirements is a software engineering process that consists of four main activities:

1. *Requirements elicitation*: In order to build an m-Health solution that caters the needs of women in Morocco, a few visits to the Maternity Les Orangers that belongs to the University Hospital Avicenne of Rabat has been organized to closely observe the clinical intervention in terms of postnatal care. With the consent of the director of the maternity, several interviews have been conducted with the clinical staff (i.e. Doctors, interns and nurses) at the maternity to gather the maximum of information with regards postnatal care in Morocco.
2. *Requirements analysis*: The requirements identified in the first activity have been analyzed to ensure coherence and resolve conflicts between them. A scrupulous analytic review has been performed on existing apps for postnatal care to expand the set of requirements of the solution and assure its functional completeness [12].
3. *Requirements specification*: A Software Requirements Specification (SRS) covering functional and non-functional requirements for the m-Health solution for postnatal care has been elaborated according to the IEEE 29148 standard [21].
4. *Requirements validation:* The SRS developed has been finally presented to the clinical staff of the maternity for further validation.

3.3 The SRS

Initially, the following functional requirements have been specified:

- Baby management
  - The user shall be able to add multiple babies to her profile.
  - The user shall be able to select one of her babies to track her or his activities.

- Newborn's daily habits recording
  - The user shall be able to record the daily habits of her newborn including diaper changes, feeding and sleep patterns.
  - The user shall receive alerting messages if her newborn's feeding and sleep patterns are alarming or the number of diapers changes that her newborn needs significantly exceeds the average number.
- Growth measurements
  - The user shall record the anthropometric characteristics of her newborn including weight, height and head circumference.
  - The user shall be able to track her baby growth and compare it to standard child growth percentiles.
- Health checkups and medication
  - The user shall be able to schedule appointments for postnatal and pediatric checkups. Three postnatal checkups are considered by default at the 6th day, 6th week, 6th month after delivery.
  - Given that a user has scheduled an appointment, she shall receive a push notification to remind her of the upcoming medical visits (pediatric or postnatal visits).
  - The user shall be able to manage and record medications.
  - The user shall receive reminders of medication intake.
- Immunization
  - The user shall be able to track her newborn's vaccines.
  - The user shall be able to consult the immunization schedule as recommended by the ministry of health in Morocco.
  - The user shall schedule appointment for her newborn's vaccines and receive reminders accordingly.
- Postpartum recovery
  - The user shall be able to record and track her postpartum weight at any time.
  - The user shall be able to access information about postpartum recovery tips including nutrition, physical exercises and hygiene.
- Mental health
  - The user shall be able to learn more about the symptoms and signs of Postpartum Depression (PPD) and baby blues.
  - The user shall be able to acquire effective manners and strategies to cope with postpartum mental disorders.
  - The user shall be able to screen for postpartum depression by filling in a 10-item self-report measure based on the Edinburgh Postnatal Depression Scale (EDPS) [22]. Note that users can fill in this self-report only once a week.
- Community
  - The user shall be able to access the FAQ (Frequently Asked Questions) section to get answers about common doubts and concerns that new mothers have during their postnatal period.
  - The user shall be able to share her experiences and feelings with other new mothers through a forum.
  - The user shall be able to view and comment other users' posts.

- Guides
  - The user shall be able to get basic baby care tips including burping, bathing, soothing, swaddling, etc.
  - The user shall be able to access useful information on how to improve her breastfeeding experience.
  - The user shall be able to learn more about baby development milestones as regards the age of her baby.
  - The user shall be able to acquire information about signs and symptoms of potentially life-threatening postpartum conditions.
- Settings
  - The user shall be able to update her preferences with regards the unit of measurement.
  - The user shall be able to change language preferences.

Along with these functional requirements, a number of non-functional requirements have been identified to enhance the quality and design of the m-Health solution Mamma&Baby based on the international standard ISO/IEC 25010 [23] and mobile design guidelines [24]. The core aspects of quality that have been considered are as follows:

- **Functional suitability:** Mamma&Baby solution should cater users' needs through well integrated functions, useful and appropriate content.
- **Performance efficiency:** Mamma&Baby solution should take a short time to load and provide onscreen feedback to the user.
- **Availability:** Mamma&Baby solution should remain operational and accessible in a certain manner under possible circumstances (e.g. unavailable network, limited bandwidth).
- **Scalability:** Mamma&Baby solution should be able to deal with increasing use and handle more data as time progress.
- **Usability and user interaction:**
  - Mamma&Baby solution should support both landscape and portrait orientations.
  - The user should be able to understand the flow of the solution easily without further training or help.
  - Mamma&Baby solution should use intuitive and predictable navigation patterns.
  - Mamma&Baby solution should use common icons' system.
- **Visual quality:**
  - Mamma&Baby should use familiar and simple tone along with an intelligible writing style.
  - Mamma&Baby should display graphics, text and images without noticeable distortion.
  - Mamma&Baby should use a coherent color theme that recalls its purpose.
- **Security and privacy:**
  - Mamma&Baby should use a strong authentication mechanism.
  - All private data should be stored in the solution's internal storage.
  - Mamma&Baby must protect any stored sensitive personal data from unauthorized access.
  - Mamma&Baby should ensure encrypted communications.

  - Mamma&Baby should include a privacy policy that is detailed, comprehensive and understandable.
- **Modifiability and maintainability:** Mamma&Baby should have a readable and extendible code to easily modify functions and implement new ones to avoid increasing maintenance cost.

With the aim to make the tedious and repetitive tasks included in the solution more fun, interactive and engaging, a gamification strategy is proposed to be implemented in the solution, and typically works in the following ways:

- **Point-based scoring:** Being one of the core gamification mechanics, allocating scores to users can motivate their willingness to continue to use the solution. Three point-based incentives are therefore proposed:
  - A user shall earn 15 points for filling in the self-report measure for postpartum depression screening.
  - A user shall earn 20 points for each medical appointment attended (gynecologic, pediatric or immunization visit).
  - A user shall earn 10 points for taking medication properly by marking the medication intake as complete.
  - A user shall earn 5 points for each measurement recorded; including baby growth parameters and mother's weight.
- **Badges:** These are simple virtual elements that symbolize rewards given to users for their achievements. Badges act as a target setting and as a recognition tool that motivate users to get actively involved in the solution and work hard towards gamification objectives. Four various achievements need to be completed to unlock badges and trophies as described below:
  - Once registered, the user shall receive a 'Welcome' badge.
  - A user shall be able to unlock the 'Best nursing Mamma' badge for breast-feeding her baby at least during his or her six first months.
  - A user shall be able to unlock the 'Super Mamma' badge when she attends five medical appointments.
  - A user shall be able to unlock the 'Fit Mamma' badge for losing at least 6 Kgs (13 lb) during the first six months of her postnatal period.
- **Progress bar:** It is perhaps one of the most straightforward gamification elements that displays operations' wholeness. It gives information about the progress users are making towards attaining a specific goal. In Mamma&Baby solution, the progress bar has been thought with regards baby growth measurements. In this respect, Mamma&Baby solution shall display the percentage users have completed as they enter values of their babies' vital parameters (height and weight) at a monthly basis during a twelve-month period.
- **Leaderboards:** The very presence of a leaderboard can elicit the desire to play. The simple goal of raising up the rankings serves as a powerful motivator to continue. Based on the amount of the points collected, users shall be able to see how they stack up against other users in the solution. The leaderboard is supposed to be displayed in the Community section where social interaction is endorsed.
- **Virtual goods:** Earned points can be exchanged for instant virtual rewards. Users shall be able to choose whether to redeem their points in the form of rewards and

subsequently reset their score to the remaining points or keep on accumulating points without spending them. Three virtual rewards are proposed in Mamma&Baby:

- A user shall be able to redeem '50 points' for a new display theme.
- A user shall be able to redeem '100 points' for an electronic personalized photo frame for a specific photo of her baby that she will uploads.
- A user shall be able to redeem '200 points' for a customized electronic photo album of ten uploaded photos.

4 Implementation

4.1 Tools and Technologies Used

From this initial system requirements specification, the structural and behavioral aspects of the system have been modeled using an open source UML (Unified Modeling Language) called StarUML[1]. The main purpose is to fill the gap between documents written in natural language and use cases by modeling requirements in a graphical and tabular way, which can significantly improve the requirements representation and enrich the relationship between them. In this vein, high-level requirements have been captured using Use cases and the domain model has been represented using a class diagram. The control flow drawn from an operation to another has been represented using activity diagrams. In conjunction with these UML diagrams, user interfaces have been sketched to explore the design space of the solution more fully and to openly investigate multiple design directions at low cost. In parallel, the SRS document has been transformed into logical structure, which contains detailed and complete set of specifications that can be implemented in a programming language. Afterwards, the design has been implemented into source code in Android studio being the official integration environment for Android app development. To build a powerful solution, Firebase; considered a Backend as a Service (BaaS) has been used to leverage its numerous features including real-time database, hosting, cloud storage and social authentication, among others.

4.2 User Interfaces

At the current stage of the development cycle, only the functional and non-functional requirements are fully implemented. The gamification aspects are now being analyzed in order to be incorporated in an updated version of the solution. Figure 1 depicts a few snapshots of user interfaces of Mamma&Baby. Once launched, the user will be primarily asked to complete the registration form to create a new account. When logged in, the user gets access to the home page where she can choose the section she is interested of. Six menu cards are available, assembling each of them two to four functionalities or features such as tracking baby's daily activities, setting appointments'

[1] http://staruml.io/.

reminders, learning tips on baby care, screening for postpartum depression and sharing experiences and concerns with other mothers, to cite but a few. It is possible to keep health records and tracking measurements of multiple babies, at any moment the user can switch between her tracked babies. Also, the user can change her preferences with regards language and measurement units from the drawer menu.

5 Experiment Design for Quality Assessment of the Solution

Following the development of Mamma&Baby solution and testing its different functionalities using specification-based testing, the clinical staff at the Maternity Les orangers have examined the different features and functionalities of the solution and have studied the overall content coherence in order to validate the solution from a clinical perspective. With the aim to assess the quality, effectiveness and usefulness of the solution, an experiment with real participants will be conducted at Maternity Les orangers under the close supervision of the same clinical staff already involved.

5.1 Participants and Study Procedures

Participants. A total of sixty-five puerperal women are expected to be enrolled in this experiment. These women have to fulfill the following inclusion criteria to guarantee their participation: IC1) Being aged between 20 and 45 years old, IC2) being resident in the region of Rabat, IC3) having an Android smartphone, IC4) having a moderate level of experience with mobile applications, IC5) willing to comply with the evaluation study procedures. A written informed consent form shall be administered to the prospective participants to be signed prior their effective enrollment in the evaluation. This informed consent will answer the common concerns and questions that cross participants' mind about the purpose of the evaluation, participation conditions, study procedures, confidentiality and withdrawal, before taking part of the study.

Evaluation Study Procedures. Before starting the experiment, all the participants enrolled will be initiated to the solution. The purpose and the main functionalities included in the solution will be explained in details and a quick video demonstration will be displayed to the participants to have a concrete idea on how to use the solution. Afterwards, the participants will be requested to have the Mamma&Baby solution running on their Android smartphone for up to six months of their postnatal period. They will have to complete all the tasks' instructions presented in Table 1 at a regular basis so that they will be able to provide a credible and well-founded feedback about the overall quality of the solution. After six months of use, the participants will be asked to complete two self-report questionnaires of quality assessment of the mobile solution.

5.2 Assessment Criteria

In order to assess the quality of the resulting gamified solution, two self-report questionnaires will be at disposal of the participants at the end of the experiment. The

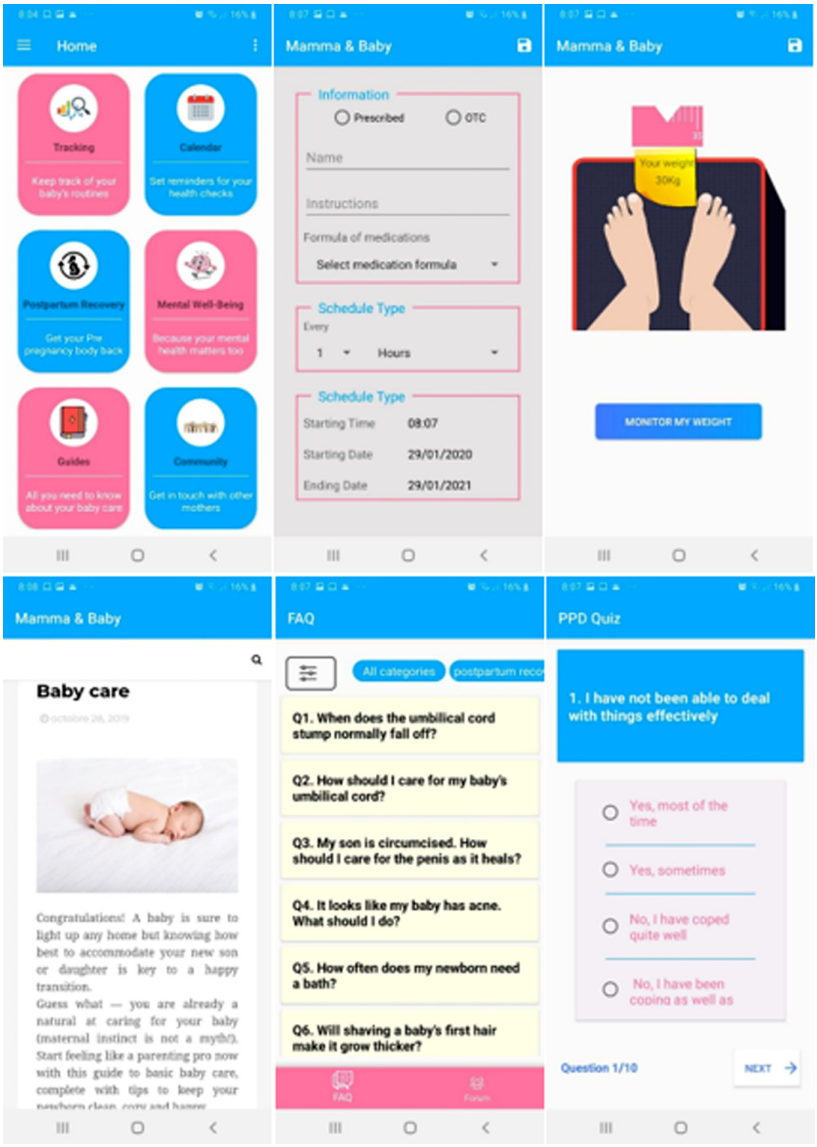


Fig. 1. Screenshots of users' interfaces of the solution 'Mamma&Baby'

effectiveness and potential of the solution in promoting postnatal care and improving access to postnatal care services in Morocco will also be evaluated through a short questionnaire in which they will be asked to give their remarks and suggestions to improve the quality of the solution.

Product Quality. It refers to the degree to which a product or a service fits patterns of users or customers' expectations and preferences. The international standard IEC/ISO

Table 1. Tasks' participants

Tasks	Participants will be instructed to	Participants will be informed that
Task 1: Sign up/Create an account then log in	–Enter their personal information (Full name, phone number, weight, type of delivery, email, password) –Enter baby's details: Name, gender, birthday –Use their login credentials (email and password) to sign in	–The details entered should be accurate –Their personal details will be kept secured in our database
Task 2: Record regularly their baby's routine activities	–Have their smartphones at hand to record their baby's habits (feeding/sleep) with an accurate timing –Switch breasts multiple times when nursing and record the time spent on each breast until the breastfeeding session is over –Track daily diaper output –Get their baby's growth (height, weight and head circumference) measured at a monthly basis at each checkup or at any pharmacy,	–All the records made can be visualized on plots –Month-over-month measures can be compared with the OMS charts
Task 3: Set reminders for health checks appointments and medication intakes	–Enter information about their postnatal checkups' appointments or those of their baby's pediatric visits –Set a reminder for their appointments –Mark complete when the appointment is attended and add note if needed/preferred –Set a reminder to take their meds	–All the information related to the doctor visits or the medications should be correct
Task 4: Track the vaccine schedule and set reminders for upcoming shots	–Set reminders of upcoming vaccines in advance –Record/mark as complete the vaccines that babies received	–All the vaccines presented in the vaccine schedule are mandatory and should not be delayed or skipped
Task 5: Monitor postpartum weight	–Track their postpartum weight regularly	–All the postpartum weight measurements are graphically displayed
Task 6: Screen for postpartum depression	–Screen for PPD at least two times during the first 6 months after delivery	–Their answers to the quiz's questions should be honest

(*continued*)

Table 1. (*continued*)

Tasks	Participants will be instructed to	Participants will be informed that
	–Seek medical attention immediately is the quiz's result shows a possible presence of PPD symptoms	and correct to receive the most accurate feedback
Task 7: Become a member of new mothers' community	–Share their problems/concerns with other new mothers	–Their posts will be visible to all users
Task 8: Learn more about postnatal period	–Use our guides to acquire more information about numerous aspects of postnatal period such as: baby care, postpartum recovery, danger signs, postpartum mental health, etc. -Quickly get the answer to the most commonly asked questions by puerperal women	

25010 defines a model for software product quality that is composed of eight characteristics which are further subdivided into sub-characteristics that are related to static and dynamic properties of the software product [23]. Several studies have used this model to evaluate health solutions as for cardiology [25, 26], blood donation [27] and pregnancy monitoring [28]. Four characteristics pertaining to this model have been considered to develop the product quality questionnaire which are: Functional suitability, Operability, Reliability and Security. These characteristics have been found to significantly affect the quality of mHealth solutions [26–28]. The number of items per each characteristic depended on both the number of its sub-characteristics and the degree of its impact's relevance on the quality of the software product. However, despite having only three sub-characteristics, eleven items have been developed for functional suitability characteristic. In fact, functional suitability is one of the most important quality characteristics as it entails the ability of a software product to match the needs and requirements of its users [29].

On the other hand, operability has also included eleven items given its numerous sub-characteristics that are mainly focused on the degree to which the software product is attractive, easy to learn and appropriate to use [23]. Five additional items have been determined to cover reliability which bears on the capability of a software product to perform failure-free operation for a specified period of time. Security, for its part, has comprised three items primarily relying on data integrity, confidentiality and privacy. Considering the personal and sensitive information used and shared in healthcare solutions, several security and privacy concerns have arisen and have significantly disturbed the course of the software development cycle. This has obliged the developers to take into consideration a number of security requirements from the early stages

of the software development [30]. Table 2 in Appendix summarizes the items of the product quality questionnaire. The possible answers to these items are either Yes/No or a 5-point Likert scale. The corresponding score to each of these answers are provided in Table 3 in Appendix. The resulting participants' scores will be obtained for each characteristic by summing all the scores obtained for their underpinning sub-characteristics. Further, they will be classified into five categories: i) very high if the score is between 4.5 and 5; ii) high if the score is between 3.5 and 4.5; iii) moderate if the score is between 2.5 and 3.5; iv) low if the score is between 1.5 and 2.5; v) very low if the score if between 1 and 1.5.

Quality-in-Use. The concept of quality in-use corresponds to the user's perception of the quality of the software product in its context of use. It can therefore be used to validate the degree to which the software product meets the users' needs [31]. According to the ISO/IEC 25010 standard, the quality in-use model is decomposed into the following five characteristics: Effectiveness, Efficiency, Satisfaction, Freedom from risk and Context coverage [23]. Given the gamification aspects that are expected to be implemented in the solution before the evaluation, an adapted model of the quality-in-use model presented in the ISO/IEC 25010 standard has been used to define the questions of the quality-in-use assessment questionnaire. The QU-GamSoft model has be constructed taking into consideration the specific elements in gamified software [32]. A total of thirteen items has been developed to cover three characteristics, namely: Effectiveness, efficiency and satisfaction as shown in Table 4 in Appendix.

These characteristics have been found to be significantly influenced in gamified software [32]. Effectiveness refers to the accuracy and completeness with which users achieve specified goals owing to the engagement caused by the gamification elements whereas efficiency designates the resources exploited as regards the completeness with which users achieve those goals [23]. Besides, satisfaction implies the extent to which user needs are satisfied and fulfilled when gamified software is used in specific context of use.

Unlike the efficiency and effectiveness characteristics, satisfaction is further divided into sub-characteristics including: enjoyment, usefulness and user trust [32]. The scoring system for this questionnaire is exactly similar to that of the product quality evaluation questionnaire. Accordingly, Table 5 in appendix displays the possible answers to this questionnaire's items along with their corresponding scores.

The Appendix can be found at the following link: https://www.um.es/giisw/Mamma&Baby/Appendix.pdf.

Potential. The potential of the solution in promoting and improving postnatal care in Morocco will be assessed through the participants' evaluation of a few aspects of the solution as presented below:

- The solution provides valuable information on parenting and baby care.
- The solution offers useful advices and recommendations about postpartum recovery.
- The solution helps to track the vaccine schedule of your newborn.
- The solution leverages socialization in a way that it allows you to share your experiences with others.

Participants are invited to freely choose a value between 0 and 100% that better accommodate their perception with respect to these aspects. An additional open question is included in the questionnaire to give to the participants the opportunity to make critics, remarks and suggestions to enhance the overall quality of the solution.

5.3 Research Questions

The results of this empirical evaluation will be used to answer the following research questions:

RQ1. To What Extent the Solution Adheres to Quality Characteristics?
The aim of this question is to determine the degree of fulfillment of product quality characteristics (e.g. Functional suitability, Reliability and Security) by the solution. The overall average score for each product quality characteristic will be analyzed to answer this research question.

RQ2. To Which Degree does Gamification Elements Enhances the Quality-in-Use of the Solution?
This research question aims to investigate the importance of gamification aspects in improving user experience and user satisfaction with the solution. In order to answer this question, the overall score obtained in the quality-in-use assessment will be analyzed.

RQ3. Is there a Compliance Between the Solution's Product Quality, its Quality-in-Use and its Potential as Perceived and Reported by the Participants?
The goal of this research question is to compare between the perceived product quality and quality-in-use of the solution and its potential as reported by the participants. First, the correlation between the overall scores obtained in the product quality and quality-in-use assessments will be studied. Then, these overall scores will be contrasted, one by one, with the results of the solution's potential assessment. This will likely indicate whether the potential of the solution in improving postnatal care is tightly linked with its overall quality and vice versa.

6 Conclusions and Future Work

This paper presents the requirements specification of a gamified solution intended to promote postnatal care in Morocco. On the one hand, the elaboration of the SRS has been presented and the functional and non-functional requirements have been pointed out. The gamification aspects that are expected to be, soon, implemented into the solution have also been listed. On the other hand, the experiment design of quality evaluation of the solution with real participants has been thoroughly described. This evaluation will consist of regularly performing a set of tasks during a 6-months of use, followed by completing three distinct questionnaires on the solution's product quality, quality-in-use and potential. The results that will be obtained from these questionnaires will be scrutinized to determine the overall quality of the solution and the importance of

gamification in yielding better outcomes. Further, these results will be used to guide the improvement process of the solution according to the participants' feedback.

For future work, it is, first, intended to complete the implementation of the solution by the integration of the gamification aspects. Second, it is planned to enforce this experiment design through conducting the evaluation with puerperal participants. Third, it is expected to answer the research questions, previously mentioned, based on the results obtained from the empirical evaluation study.

Acknowledgments. This work was conducted within the research project PEER, 7-246 supported by the US Agency for International Development. The authors would like to thank the NAS and USAID for their valued support.

References

1. World Health Organization: Postnatal Care for Mothers and Newborns Highlights from the World Health Organization 2013 Guidelines. https://bit.ly/31NSv4t
2. Romano, M., Cacciatore, A., Giordano, R., Rosa, B.La: Postpartum period: three distinct but continuous phases. J. Prenat. Med. **4**, 22–25 (2010)
3. Datta, S., Kodali, B.S., Segal, S.: Maternal physiological changes during pregnancy, labor, and the postpartum period. In: Obstetric Anesthesia Handbook. pp. 1–14 (2010)
4. World Health Organization: Postpartum Care of the Mother and Newborn: a practical guide. https://bit.ly/2ROdDCX
5. World Health Organization: A Handbook for Building Skills. Counselling for Maternal and Newborn Health Care. https://bit.ly/2xmvkjE
6. Dermott, K.: Clinical guidelines and evidence review for postnatal care: Routine postnatal care of recently delivered women and their babies (2006)
7. World Health Organization: A handbook for building skills Counselling for Maternal and Newborn Health (Updated). https://bit.ly/2NxqL0C
8. Elkhoudri, N., Baali, A., Amor, H.: Postnatal care: levels and determinants in Morocco. Iran. J. Public Health. **46**, 242–248 (2017)
9. Katusiime, J., Berlin, H., Linden, U.D., Linden, G.U.D.: Supporting maternal health education in developing countries using mobile phones- results of a pilot study. In: Proceedings of the First African Conference on Human Computer Interaction, pp. 48–57 (2016)
10. Bachiri, M., Idri, A., Fernández-alemán, J.L., Toval, A.: Mobile personal health records for pregnancy monitoring functionalities: analysis and potential. Comput. Methods Programs Biomed. **134**, 121–135 (2016)
11. Bachiri, M., Idri, A., Redman, Leanne M., Fernandez-Aleman, J.L., Toval, A.: A requirements catalog of mobile personal health records for prenatal care. In: Misra, S., et al. (eds.) ICCSA 2019. LNCS, vol. 11622, pp. 483–495. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-24305-0_36
12. Sardi, L., Idri, A., Redman, L.M., Alami, H., Bezad, R., Fernández-alemán, J.L.: Mobile health applications for postnatal care : review and analysis of functionalities and technical features. Comput. Methods Programs Biomed. **184**, 105114 (2020)
13. Sardi, L., Idri, A., Fernández-alemán, J.L.: A systematic review of gamification in e-Health. J. Biomed. Inform. **71**, 31–48 (2017)
14. Adanikin, A.I., Olumnuyiwa, A.J., Adewale, A.: Role of reminder by text message in enhancing postnatal clinic attendance. Int. J. Gynecol. Obstet. **126**, 179 (2014)

15. Ngabo, F., et al.: Designing and implementing an innovative SMS-based alert system (RapidSMS-MCH) to monitor pregnancy and reduce maternal and child deaths in Rwanda. Pan Afr. Med. J. **13**, 1–15 (2012)
16. Parvin, M.S.: An effective m-health system for antenatal and postnatal care in rural areas of Bangladesh. J. Comput. Eng. **17**, 15–19 (2015)
17. Bangal, V.B., Borawake, S.K., Gavhane, S.P., Aher, K.H.: Use of mobile phone for improvement in maternal health: a randomized control trial. Int. J. Reprod. Contracept. Obstet. Gynecol. **6**, 5458–5463 (2017)
18. Moorhead, A., Bond, R., Mulvenna, M., O'Neil, S., Murphy, N.: A Self-management app for maternal mental health. In: British HCI Conference, pp. 1–5 (2018)
19. Mduma, N., Kalegele, K.: Enhancing management of nutrition information using mobile application: prenatal and postnatal requirements. In: IST-Africa, pp. 1–7 (2017)
20. Shorey, S., Yang, Y.Y., Dennis, C.: A mobile health app – based postnatal educational program (home-but not alone): descriptive qualitative study. J. Med. Internet Res. **20**, e119 (2018)
21. IEEE 29148 Standard. Systems and software engineering—Life cycle processes—Requirements engineering (2011)
22. Cox, J., Holden, J.: Perinatal mental health: a guide to the Edinburgh Postnatal Depression Scale (EPDS). Royal College of Psychiatrists (2003)
23. ISO/IEC-25010. Systems and software engineering—Systems and software Quality Requirements and Evaluation (SQuaRE)—System and software quality models (2011)
24. Android Developers: Reference Android Design Guidelines. https://bit.ly/1nKBw8N
25. Kadi, I., Idri, A., Ouhbi, S.: Quality evaluation of cardiac decision support systems using ISO 25010 standard. In: IEEE/ACS 13th International Conference of Computer Systems and Applications (AICCSA), pp. 1–8 (2016)
26. Ouhbi, S., Idri, A., Hakmi, R., Benjelloun, H., Fernández-alemán, J.L., Toval, A.: Requirements specification of an e-health solution to improve cardiovascular healthcare services in Morocco. In: The 11th International Conference on Intelligent Systems: Theories and Applications (SITA). pp. 16–21 (2016)
27. Idri, A., Sardi, L., Fernández-alemán, J.L.: Quality evaluation of gamified blood donation apps using ISO/IEC 25010 Standard. In: 12th International Conference on Health Informatics, pp. 607–614 (2018)
28. Idri, A., Bachiri, M., Fernández-alemán, J.L., Toval, A.: ISO/IEC 25010 based evaluation of free mobile personal health records for pregnancy monitoring. In: IEEE 41st Annual Computer Software and Applications Conference, pp. 262–267 (2017)
29. Rodríguez, M., Oviedo, J.R., Piattini, A.M.: Evaluation of software product functional suitability : a case study. Softw. Qual. Manag. **18**, 18 (2016)
30. Salinesi, C., Comyn-wattiau, I.: Reusable knowledge in security requirements engineering : a systematic mapping study. Requir. Eng. **21**(2), 251–283 (2015)
31. Bevan, N.: Quality in use: meeting user needs for quality. J. Syst. Softw. **49**, 89–96 (1999)
32. Vargas Enríquez, J.A.: Evaluating the quality in use of gamified software (2016)