Chapter 4

Moving towards Sustainable Electronic Health Applications

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Additional information is available at the end of the chapter

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Abstract

Electronic healthcare applications, both web-based and mobile health (mHealth) provide new modalities for chronic disease. These tools allow patients to track their symptoms and help them manage their condition. The sustainability of these tools is often not considered during their development. To ensure these applications can be adopted and sustainable, where policy differs amongst states and provinces, we must present the benefits of our findings to highlight the justification for its development. For technology to be sustainable it has to utilize infrastructure that is secure, stable and to be agile so that it can be deployed quickly with minimal interruption to patients, family members and healthcare professionals.

Keywords: sustainability, self-care, eHealth, mHealth, technology, co-design

1. Introduction

Within the healthcare industry, innovation remains to be the leading force in the quest to balance health care quality and costcontainment [1]. Mobile health (mHealth) applications are one of the fastest growing segments in drive for innovation in the health care sector. With the rising use of mobile phones, mHealth applications (apps) provide individuals with a simple and accessible way to manage their health at the tip of their fingers [1].

Unfortunately, many mHealth interventions continue to be developed without the consideration of long term sustainability, which has left many apps with vast potential but nowhere to move forward. This is one of the growing problems with health app development, where in spite of the advances made with technology, apps fail to be used due to the methodological

challenges associated with designing for sustainability [2]. In this chapter, we focus on addressing the main issues app publishers face during the design process. We then outline the key components that should be included to assure the sustainability of an electronic health app.

We define the issues with innovation by three main components that include (1) end-user usability, (2) clinician and informal caregiver (spouse, children, friend) input and (3) impact of agencies outside development. Many electronic health apps fail to consider these major factors in its design, which in turn is often what limits the sustainability of its use. We believe that these three factors are essential as it evaluates the health apps design according to the user, their main members of care and finally the environment it is used. If the health app being designed does not simplify or improve the current model of care, there is no incentive for its use. Instead, the benefits associated with the app will be overshadowed by its complications or drawbacks.

This leads to our section in the chapter on designing for sustainability. We start by signifying the importance of putting the end-user first and then introduce the information system research framework that help identify user needs, design preferences and potential barriers to increase health app adoption. This is followed by the next stage of designing for sustainability, where we outline the steps to get all the potential players on board in support for the new innovation. We highlight the inevitable resistance to change that will occur, and explain the concept of 'behavioral intention' to use a technology and how this will help improve health app sustainability.

Finally, for the purpose of long-term sustainability, we expand on preparing for the expected and unexpected, by evaluating change management plans and regulations in place during health app design. Towards the end of the chapter, we develop a market and feasibility analysis framework for the adoption and scalability of the health app on a national scale. This allows us to ensure all key factors have been addressed; leaving the app design and efficacy to become unquestionable.

2. Issues with innovation

Over the past decade, there have been a number of advancements within the healthcare industry, yet there is still a strong resistance present towards the implementation of health innovation [3]. The lack of certainty in the interventions independent sustainability is one of the leading factors responsible for this resistance [4]. Electronic health apps may hold great promise for better health tracking [5], providing education [6], changing and enforcing health behaviors [7], and monitoring treatment adherence [8], however despite these benefits, they are still not being used [9]. This can be attributed due to nine key design barriers that are outlined in Chindalo et al. literature review [9] (**Table 1**).

These barriers have created a stigma around stakeholders investing in health app development. Currently, the perceived return on investment (ROI) with health apps remains low, as the issues with innovation remain high. The beneficial impact of health apps may seem promising, but from a sustainability standpoint, they fail to address the underlying question that is 'will these benefits outweigh the cost of its development?'

Barrier	Explanation
1. Apps provide information conflicting from what is received from clinicians	Patients/end-users are less likely to use an app when it conflicts with information from their clinician. They will not feel confident in the content provided or its functionality
2. Language used too complex for end-user health literacy level	Patients/end-users often have lower levels of health literacy. They require technology to be adapted to their needs or the app will not be used sufficiently
3. Manual data input required	Treatment regimens are already perceived as complex by patients/end-users. Manual data input further complicates this process, as it is exhaustive and error-prone
4. Information provided has no value/meaningless data	If the app information has no beneficiary tie to the patient (e.g. cannot order diagnostic testing or prescribe medications) then the content becomes useless
5. Daily app use not required	Health apps aiming to help patients/end-users with their treatment regimen should be used daily and in accordance with their prescribed treatment. It the health app does not require daily use, this can reduce treatment adherence as the patient will not get into the habit of using it
6. Lack of incentives to use	Any source of change is viewed as burdensome, thus, if no incentive (cost savings or social approval) for a patient/end-user to utilize the tool is present, they are less likely to use it
7. Data collected not valued by clinician	If the data collected brings forward information important for the patient/end-users care, the clinician would be more likely to promote its use. However, if there is no functional value for the data, both clinicians and end-users/patients will not use the tool
8. No way for physicians to use data collected	Health apps may collect large amounts of data, but if they cannot visualize or analyze the meaning behind the data, it comes useless
9. No way to integrate app data into electronic medical record (EMR) for analysis or follow-up	If the data collected cannot be combined with previous medical information the context required for analysis will be lost, leaving the data to be meaningless

Table 1. Design barriers associated with decreased health app usage (adapted from [9]).

To ensure that resources being spent on an application are adequately being used and the above barriers are addressed, the needs, wants and expectations of the health apps primary stakeholders should be evaluated [10]. However, it is this lack of stakeholder consideration within app design that builds the three prime issues with innovation, which we describe below [1, 9].

1. **Poor end-user usability: who are you designing for?**

   The overall hype of innovation, and mHealth solutions, has led developers into a cycle where app ideas centered on addressing patient challenges seem to forget about the patient once in development [11]. Consequently, this lack of end-user engagement has led health app usage to fall to 2% amongst patients at hospitals in the US [11]. The low percentage for health app usage may seem surprising, but when a tool does not suit the needs or capabilities of the end-user, the percentage becomes less surprising and more understandable.

   Findings reveal that patients with chronic disease, such as heart failure and diabetes, have positive attitude towards using mobile technology if they are simple and effective [12].

However, the key issue here is that app developers seem to show greater motivation by the cleverness of the technology rather than the improvements in health outcomes, which often results in complicating the apps functionality [13]. Thus, in the eyes of the developer the app may seem effective, but they do not consider that the individual they are designing it for will not have the same understanding. As a result, apps will not meet user needs or capabilities, which in turn leads to the development of the first six barriers highlighted in **Table 1**. This poor product usability can be attributed due to the lack of end-user involvement or input during the development process [11]. Some would argue the most successful health apps are those that address real-life challenges in the context that the patient lives. Therefore, to assure the sustainability of a health application the question the developer must ask is not 'does it solve a problem', but rather 'does it help the patient directly'. If an application is in any way a burden, or adds more effort into their treatment, it will not be used.

2. **Lack of clinician and informal caregiver input: What are you designing it for and how will it improve clinical outcomes?**

   The primary objective for a health application is to improve clinical outcomes and reduce the level of work required, clinicians and informal caregivers (spouse, children, friend) play a pivotal role in establishing the criteria for these improvements [14]. Clinicians provide the complete medical background surrounding patient care as well as clinical workflow operations, while informal caregivers allow developers to have a magnified look into the day-to day challenges that prevent adherence and worsen symptoms [3, 14]. Both key members of care contribute substantively in increasing adherence, improving self-care, quality of life and outcomes for patients [14]. However, the reality is, numerous apps are/have been developed with either none or some clinician and/or caregiver feedback, but the inclusion of both are pivotal to assure sustainability.

   As every tool must have an objective for its development, the use of clinician and caregiver input provides developers with the necessary content to build their objective around. The lack of clinician and caregiver feedback in current health apps limits app efficacy and is responsible for design barriers seven and eight in **Table 1**. Without the consideration of both the *physiological* and *social* factors provided by clinicians and caregivers, health apps will continue to be designed around the question 'does it a solve a problem', and developers will inevitably fall short in the effectiveness of their app design [10].

3. **Fail to consider impact of agencies outside development: does it effect current operations?**

   Aside from the lack of usability considerations, other factors including, government regulations and organization operations, are also commonly neglected. The development and implementation of healthcare innovations is bounded by a set of regulations that must be followed [15]. These regulations are set in place as a standard to prevent public health risk and improve patient safety. In the United States, the Food and Drug Administration (FDA) issued a draft for the regulation of mobile medical applications [16]. However, as many of the standards currently in place are set to regulate medical devices, a large group of apps still do not fall within the categories for regulation. This leaves them to be generated without regulatory precaution or guidance, which in turn promotes the development of less effective and integrative health apps [17]. For example, one key element that would

increase app use and sustainability would the use of data integration amongst EMRs and the respective health app. This would allow the data collected to be combined with current medical information, which would potentially improve clinical outcomes and future diagnosis [9]. However, as this is not a required component within health app development, it has become a barrier, instead of a benefit, for health app usage (**Table 1**).

Nevertheless, one area of regulation all health apps must adhere to involves privacy and security of personal health information. Ensuring that the introduction of a health app does not threaten the privacy of the data obtained is one of the pillars for a sustainable health intervention. However, as many health apps are very development-focused these pivotal components are not acknowledged early on. This results in complicating the design process and restraining development in the later stage [10]. Similarly, as many workflow operations may be changed with the introduction of an electronic health app, failing to consider the necessary requirements early in design process leads implementation to become more disruptive than beneficial [18]. An effective health app design would identify the key organizational barriers and resistance points that may occur prior to actual implementation. Thus, the problems associated with security and workflow operations are built upon the underlying issue that they are not considered until the start of implementation.

Furthermore, electronic health apps may have undeniable potential to improve health outcomes in a cost-effective manner, but the underlying issues with innovation are preventing their potential from being fully utilized [15]. Stakeholders may have different objectives for the outcome of a health app, but regardless, the app designer must still address their needs regarding usability, content, safety, clinical and cost-effectiveness accordingly. There is already a resistance for innovation in healthcare; therefore, to build a model for health app sustainability, we outline a series of frameworks to minimize the occurrence of these issues.

3. Designing for sustainability

Prior to designing an electronic health application or any innovative health tool, we must consider the who, what, where, when and how of the intervention. Who will be using it? What will it do? Where and when will it be used? Lastly, how will it work? These questions allow the designer of the tool to recognize its primary stakeholders, the risks and costs of innovation and whether it will work with current operations in place [10]. When designing for sustainability the goal should be to bridge a practical solution for a prominent issue. Therefore, addressing these common questions has framed our guideline for moving towards sustainable electronic health applications. In this section, we start by identifying the end-user and their needs, followed by an outline to creating a user-centered health app, and finally end with the steps required to gain support for app implementation.

3.1. Putting the end-user first

Whether older adults with heart failure or adolescents with diabetes will use a health application, identifying the end-user and their needs at the start of the design process is pivotal for

the next steps towards development [19, 20]. Nevertheless, although the importance behind end-user evaluation has been signified, various studies confirm the lack of health apps available suiting their needs and capabilities [1, 21–23]. In the Delphi study, a literature review was conducted overviewing the determinants of innovation in health care organizations [24]. Their results indicated that many innovation studies failed to adjust their strategies according to feedback obtained, or that the data on the determinants was insignificant as it came from non-users [24]. In this case, the study highlights that it is not enough to simply obtain random feedback, but we must obtain useful input and apply it into the design [24].

Often times, the benefits of the end product overshadow the content required for adequate usability, leaving both the app developer and the end-user at a disadvantage. For example, by simplifying intervention processes and health education it is estimated that this will improve clinical outcomes. However, what is not considered is that the sustainability of these benefits will only be seen when the app is user-friendly and end-users can independently utilize it with confidence [25, 26]. To get to this stage, developers must recognize what components intended users need, so it becomes both easy to use and useful. Thus, to accomplish this, a user-centered framework has been developed which we summarize below.

3.1.1. Information system research (ISR) framework

As many electronic health interventions are designed according to the current healthcare system processes, this limits their impact potential compared to those that involve end-user input [27]. The ISR framework uses three research cycles, (1) relevance cycle, (2) design cycle and (3) rigor cycle, to identify user needs, design preferences as well as any barriers that will prevent the uptake or sustained use of the app [27, 28].

In the *Relevance Cycle*, developers or researchers seek out to understand the end-user in the context of their environment [19]. It is the environment that shapes the specificities behind the arising problems, the purpose of this cycle is to provide the requirements for the health app, as well as set of criteria for users to evaluate its functionality [28, 29]. Thus, to meet the goals of this cycle focus group style sessions with intended stakeholders and end-users are commonly used [27, 29]. By the end of this cycle, we should be able to answer the question, 'Does this app improve the user's environment, and how?' [28].

The heart of development occurs during the *Design Cycle*, as the content from the relevance cycle is used to build the health app and evaluate it accordingly [28]. This cycle continues in an iterative manner, where a series of designs will be generated and evaluated against the respective user requirements, until all key components are addressed. The design of the app can move relatively quickly, however, it is the continual evaluation and feedback for refinements that challenges developers [29]. Nevertheless, end-users often stop using apps that do not immediately engage them, so by repeatedly conducting prototype testing with key stakeholders, this increases the expected usability and sustainability of the end product.

Finally, the *Rigor Cycle* is the background check of the ISR framework [29]. It reviews and evaluates the current knowledge base present within the desired applications domain [27, 28]. This enhances the degree of innovation for the health apps design. In many cases, this cycle is conducted after the relevance cycle to increase the overall effectiveness of the apps design [27] (**Figure 1**).

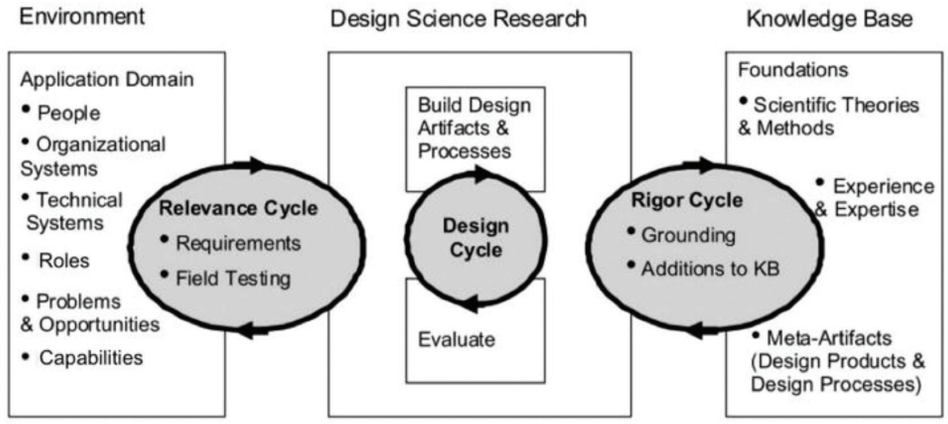

Figure 1. The ISR framework divided into three design science research cycles, (1) relevance cycle, (2) design cycle and (3) rigor cycle [28].

3.1.2. Creating a user-centered design: ISR and end-user co-design

The foundation of a user-centered design is centralized on three major components, (1) understanding how the device will be used, (2) curating information relevant to the end-user and (3) framing the tool in the user's environmental context and lifestyle [4]. The ISR framework allows developers to assess the needs of the end-user while evaluating current interventions in place [28]. However, the co-design method moves one step further by using a participatory approach where end-users and primary stakeholders work together on all aspects of the health apps development [30, 31]. By using the ISR framework in parallel with the co-design method, we believe this iterative process will lead towards a more effective user-centered end product over the long-term [29, 31].

Many electronic health app interventions fail to engage users in the design and usability stages [31]. In a systematic review of co-designed mHealth interventions, studies included patients in the development stages, but none assessed the intervention's effectiveness afterwards [31]. Conversely, in another study, users evaluated the interventions usability, but were not involved in its design [32]. The lack of fluidity between mHealth development and user input reduces end-user empowerment and overall app usability. The healthcare system is already burdened with various pre-mature innovation investments that have fallen short in its beneficial return. Therefore, from a sustainability standpoint, by using the ISR framework, this will allow all factors surrounding the end-user and the current knowledge base to be covered, whereas the co-design aspect will be pivotal to assure its usability.

3.2. How to get everyone on board

One of the greatest obstacles towards developing sustainable electronic health interventions involves getting primary stakeholders in support for its development and implementation [3]. This challenge has been shaped due to the three paradoxes of innovation [33]. First, the uptake of the dubious and rejection of the good. The explosion of electronic health apps created a consumer fad where a number 'breakthrough' apps left individuals in regret and stakeholders reluctant to invest again. Second, the wisdom and failings of democracy. Working with professional groups can be effective to ensure implementation of a new technology,

however, solely relying on their cooperation results in killing the product before it is even complete. Third, health systems are not able to keep up. Innovation results in causing change in an organization, but this creates challenges that innovators are often not prepared for and results in causing more disruption than improvement [33].

In order to move past these challenges we must be address the following questions:

1. What evidence is there that it will improve outcomes and how will it effect current operations?
2. Will any additional support be needed before it can be introduced?
3. How should it be monitored during introduction?

The first question allows us to determine whether the electronic health app will be worth the investment. The second and third questions are key for its sustainability, as it recognizes components pivotal for a smooth implementation procedure [33]. Breaking down the barriers built by failed innovative interventions may be difficult, but it is beyond worthwhile to develop an effective health app. Answering these questions will be essential when developing a plan to obtain stakeholder support, thus we further discuss the specific steps to break down the resistance and prepare for the change below.

3.2.1. Battling the resistance to change

With any type of change there is an inevitable build-up of resistance that is formed. This resistance is derived from the fear of failure, similar to the first paradox of innovation; executives and end-users do not want to waste their time with another unbeneficial intervention [3, 33]. With this in mind, assimilating the idea of putting a new intervention into practice will be uphill road to climb. Nevertheless, two models described below help shape the key factors and steps involved towards achieving this goal.

3.2.1.1. Technology acceptance model (TAM)

The TAM was developed to drive the use of new technology and increase its acceptance by assessing the end-users *perceived ease of use* (*PEOU*) and *perceived usefulness* (*PU*) [33, 34]. This model suggests that by clarifying that a new source of innovation will reduce the amount of effort required (PEOU) and enhance performance it will be more likely to be accepted amongst end-users and other key stakeholders [35]. Thus, in the context of health care, executives, clinicians and patients will find an electronic health app more useful and user-friendly if they are familiar with the technology [3, 34].

With this in mind, when designing an electronic health app, developers must understand what the stakeholders needs, wants and expectations are. Once this is discovered, we can adequately highlight how the health app will benefit each of them specifically. Finally, when a foundation of acceptance for the app has been established, appropriate training protocols should be instilled to prevent any former resistance from re-establishing (**Figure 2**).

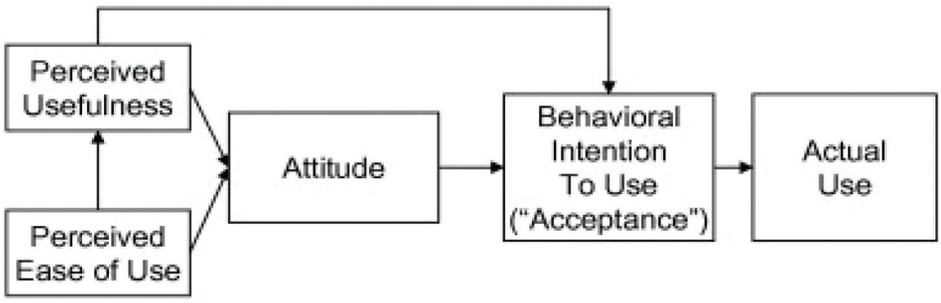

Figure 2. The technology acceptance model assessing the end-users perceived ease of use and perceived usefulness of technology to determine their behavioral intention and actual usage potential [34].

3.2.1.2. Diffusion of innovation (DOI) theory

The DOI theory is used to increase the adoption of technology [3]. This is one of the oldest theories, yet it remains to be continually used during innovative design. The DOI theory states that an organization will consider a technology to be innovative if it is perceived as new and relevant. It proposes that four main elements contribute to the diffusion of an idea, (1) the idea itself, (2) communication channels, (3) time and (4) a social system [36]. Similar to the TAM, the DOI theory suggests highlighting the perceived advantage and relevance of the innovations development. Therefore, in the context of electronic health apps, the benefit the of the app should be communicated amongst various influencers, and then stakeholder support must be established before the app can be readily adopted. As health apps must be widely adopted amongst all stakeholders and end-users before it can become self-sustaining, tackling this challenge will be key for the apps long-term success.

3.2.1.3. Presenting the benefits: results to support longevity

In both the TAM and the DOI theory, the key message to help obtain stakeholder support was to simply present why the app is beneficial for them. Why should they care about what we are developing? The real question developers should ask is, 'How will it help them?' This leads into one of the key components towards breaking down the barrier of stakeholder resistance and moving towards designing a sustainable health app. To adequately present the benefits of an application we must have the appropriate evidence to support our claim.

In many cases, a health app may be the first of its kind or an idea may be an advancement of a previous intervention. Regardless of whether a pilot study has been conducted to support the benefits of its use or its benefits have yet to be evaluated, the success of the product can be supported by answering the same question mentioned above, 'How will it help them'. We must outline what the problem currently is and why the development of this health app will help address it. It is not enough to state that a problem exists; it is the reasoning behind the solution that highlights the justification for its development.

Moreover, it is important to present the evidence supporting the benefits of the health app, but we must also present this support in the context of each stakeholder. Depending on the type of app being designed the stakeholders will differ, but to increase each claims value, we must understand the factors that will influence health app acceptance and evaluate them accordingly.

3.2.1.4. Testing health app acceptance: unified theory of acceptance and use of technology (UTAUT)

After assessing stakeholder needs and presenting the advantages associated with the health app, one of the next steps towards sustainability is to evaluate whether the proposed solution will be accepted amongst various users [37]. The UTAUT is a technology acceptance model commonly used to predict a user's behavioral intention to use a technology [37]. This model is based on four key components, [38].

1. **Performance expectancy:** providing an incentive to use a technology is key to ensure its acceptance. Performance expectancy is defined as the extent that the technology will benefit the end-user in completing a certain task. It is expected that increasing the health app's beneficial value, this will increase users behavioral intention. Therefore, to present these benefits, performance expectancy is constructed by four main evaluative criteria: (1) perceived usefulness: how much they will believe the technology will improve their performance, (2) extrinsic motivation: what other valued outcomes (money, fame) they will receive from its use, (3) job fit: how suitable technology is to increase performance and (4) relative advantage: benefit of new technology compared to what it will cost [39].
2. **Effort expectancy:** ease of use is a critical component of technology acceptance. Effort expectancy refers to how easy or difficult it is viewed to use the technology. Past technology acceptance models, such as TAM and DOI, have signified how applications that are simpler to use are more often accepted [40]. Thus, to reduce effort expectancy and increase acceptance rates, health apps should be less complex and instead easier to use [39].
3. **Social influence:** in many cases, the decision making process is influenced by specific individuals or the social norm. Social influence is the degree a user perceives that key individuals (family, friends) believe the use of the technology is important. This can be caused by informational influence where information from other people impact a decision or it can be normative influence where a user conforms their decision according to what is defined as 'acceptable' according to a certain group or situation. Regardless, social influence can be an ultimate determinate regarding the overall acceptance and usage of a health app [39].
4. **Facilitating conditions:** to ensure technology acceptance, users must feel its implementation is both feasible and realistic. Facilitating conditions is the degree individuals believe that existing organization and technical infrastructure is present to support its usage. These conditions can vary depending on a health app's objective, but regardless, they have a significant impact on its adoption and usage [40].

These four concepts have a direct influence on the behavioral intention to use a health app. Age, gender, experience and voluntariness are also associated with indirectly influencing behavioral intention and technology usage, as they moderate the four UTAUT component

relationships. Thus, by incorporating the UTAUT within the health app design process, this will allow us to predict users' intention to adopt the app in an organizational context [38]. Nevertheless, as majority of health apps are focused on the users setting and the challenges they face, we recommend the usage of the more updated UTAUT2.

Compared to the original UTAUT, the extended UTAUT2 has shown to improve the variance in behavioral intention and technology use [38]. The UTAUT2 builds on the core UTAUT principles around extrinsic motivation, and adds three other components to improve the prediction of behavioral intention, which we describe below.

1. **Hedonic motivation:** hedonic motivation is defined as how enjoyable the technology is to use. It is used to analyze the emotional and psychological aspect of the technology, which is often overlooked by most evaluative models. The functionality of a health app will only go so far in influencing technology acceptance; it is the user experience that ultimately determines its long-term use and sustainability. Therefore, by evaluating the users internal satisfaction, this will result in improving technology usage [38, 39].

2. **Price value:** the price value determines whether the benefit of the technology is greater than its monetary cost. If the price value is high then individuals feel the benefit of use is greater than the cost of investment. However, this is not always the case and it is pivotal to assess this aspect of health app design to ensure its sustainability [38].

3. **Habit:** habit is the degree individuals automatically perform tasks due to learnt behaviors [38]. This construct was added to the UTAUT2 as it helps assess whether user-activity will be sustained. Often times, there is a fall out in health app usage due to the tasks becoming burdensome. Thus, if we were able to make these tasks more like a reflex than an extra step, this would reduce the effort required and improve technology acceptance (**Figure 3**).

With the addition of these factors to the UTAUT2, this helps tailor the health app evaluation to users in their context, which in turn helps improve its overall acceptance (**Table 2**). In many cases, it is these factors that prevent the sustainability of a health app. App publishers are focused on eliciting a behavior change or improving clinical outcomes, so they tend forget about the individual in their context. To reduce the resistance to change and move towards acceptance, it is the responsibility of the app publisher to ensure that the tool they are introducing is not only effective, but also it is 'fun', affordable, easy and relatable, or else it will simply not be used. Therefore, we believe by using the UTAUT2 principles during health app design, this will allow for the development of a more effective product, and will lead into a smoother transition phase during implementation.

3.2.2. Preparing for the expected and the unexpected

The implementation of any new source of innovation will come with many challenges that are both expected and unexpected, however, being prepared for both is what ensures optimal sustainability. We highlight below two of the major areas that result in impeding health app implementation, which is (1) regulations and (2) change management. Both are essential to incorporate during the design plan of a health app, we describe the detailed steps we recommend to tackle both areas effectively.

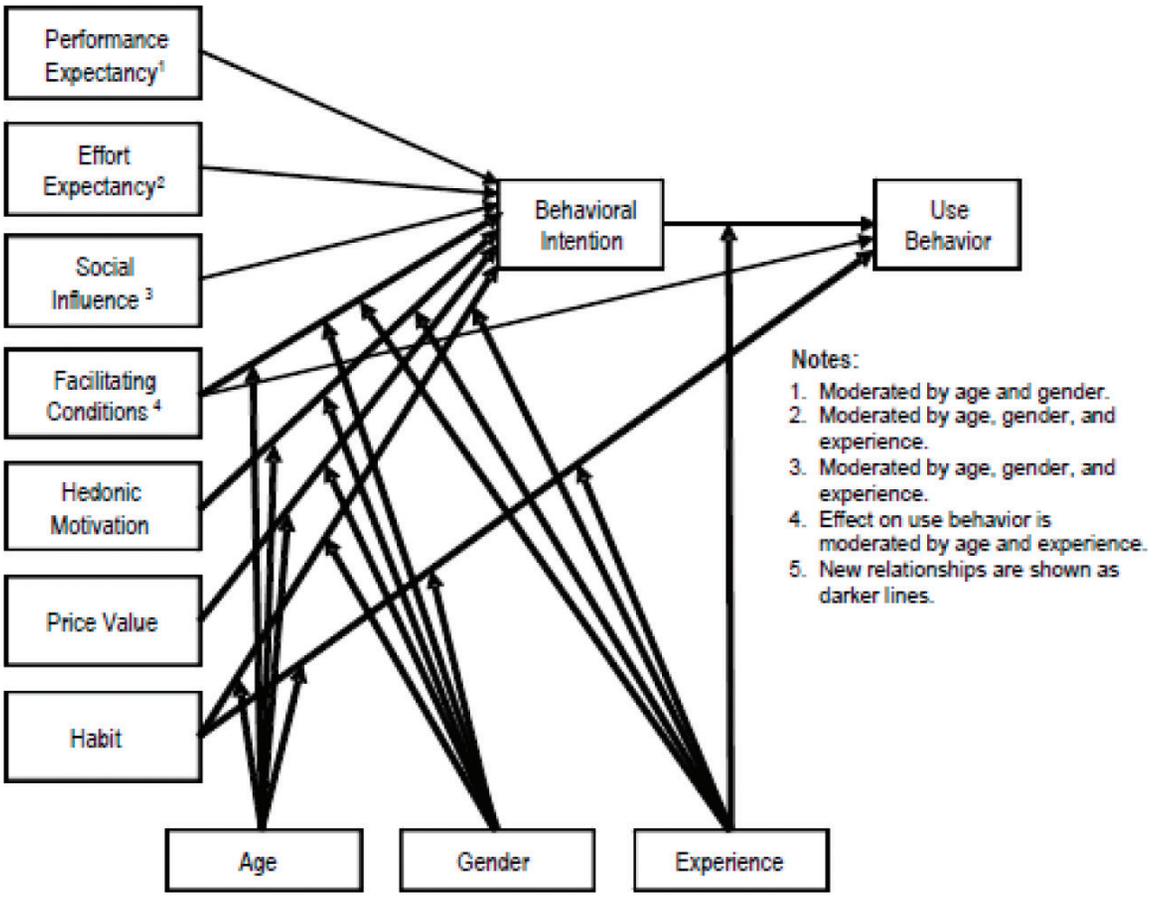

Figure 3. The UTAUT2 model with addition of hedonic motivation motivation, price value and habit to determine behavioral intention and technology use. All factors contribute in influencing behavioral intention to use except for 'facilitating conditions' and 'habit' which directing effect use behavior [38].

3.2.2.1. What regulations?

When implementing any new intervention into the health care industry there are a series of regulations that must be reviewed [15]. The FDA and Health Canada have issued a set of restrictions when developing an electronic application used as a medical device; however, most health apps do not fall under this category [17]. Nevertheless, one aspect of regulation all health apps must oblige to involves privacy and security. As many health apps are mobile phone based, this creates a challenging situation where more data can be obtained but data privacy is not secure. Policymakers are still in the works of establishing specific criteria required for patient safety, however we have listed a series of components that should be included within the health apps design to protect data integrity and prevent any unexpected threats.

(1) Data Sharing and Consent Management—Who can share my data

All data shared must have consent, as well as meet the Health Insurance Portability and Accountability Act (HIPAA) standards for data sharing [17].

(2) Access Control and Authentication—Who can access data

To assure that only the approved individuals can access the data, an authentication procedure should be implemented. With most health data, data encryption and a respective login passcode are usually required.

(3) Confidentiality and Anonymity—Who knows it's my data

Depending on the level of consent and the data obtained, most personal data should remain confidential and possibly anonymous if used for public-health purposes [17].

Higher degrees of data security protocols can be implemented into health app designs, however, we believe that by incorporating these three aspects of privacy and security, this will make the app more desirable for both its end-users and its respective stakeholders during development. Ultimately, being prepared with the proper security measures gives stakeholders the confidence in the product, and will ease the process of change management.

			1	2	3	4	5
Performance expectancy	PE1	I find the health app useful in my daily life					
	PE2	Using the health app increases my chances of achieving things that are important to me					
	PE3	Using the health app helps me accomplish things more quickly					
	PE4	Using the health app increases my productivity					
Effort expectancy	EE1	Learning how to use the health app is easy for me.					
	EE2	My interaction with the health app is clear and understandable					
	EE3	I find the health app easy to use					
	EE4	It is easy for me to become skillful at using the health app					
Social influence	SI1	People who are important to me think that I should use the health app					
	SI2	People who influence my behavior think that I should use the health app					
	SI3	People whose opinions that I value prefer that I use the game					
Facilitating conditions	FC1	I have the resources necessary to use the health app					
	FC2	I have the knowledge necessary to use the health app					
	FC3	The health app is compatible with other technologies I use					
	FC4	I can get help from others when I have difficulties using the health app					

			1	2	3	4	5
Hedonistic motivation	HM1	Using the health app is fun					
	HM2	Using the health app is enjoyable					
	HM3	Using the health app is very entertaining					
Price value	PV1	The health app is reasonably priced					
	PV2	The health app is a good value for the money					
	PV3	At the current price, the health app provides a good value					
Habit	HT1	The use of the health app has become a habit for me					
	HT2	I am addicted to using the health app					
	HT3	I must use the health app					
	HT4	Using the health app has become natural to me					
Behavioral intention	BI1	I intend to continue using the health app in the future					
	BI2	I will always try to use the health app in my daily life					
	BI3	I plan to continue to use the health app frequently					

Table 2. UTAUT2 questionnaire used to evaluate health app acceptance amongst end-users.

3.2.2.2. Change management is key for smooth sailing

With the introduction of any new intervention this will result in causing changes in workflow that in some cases may be disruptive. These challenges are expected, but to assure the implementation process runs smoothly, a set of change management plans can be pre-developed [41]. To develop a proper strategy, we must consider three primary levels of change management.

(1) Individual change management: how people experience the change and what their needs are to successfully make the transition.

(2) Organizational/initiative change management: what are the primary groups that will directly be impacted and what changes will need to be completed respectively.

(3) Enterprise change management capability: this is the overall organizational approach to managing change. It usually involves executive discussion, and reflects the organizations capability to allow and embrace change. This level is key as top-down support has a direct relationship on how a change will be perceived at the lower levels.

All three levels of change management can be addressed through the three-phase change management process (**Figure 4**) [41]. Phase 1, prepare for the change, we must determine who will be impacted by the change and what level of support we will need to smoothly move forward. During this phase, it will be key to understand all the challenges that will be in play, as

Figure 4. The change management process indicated by three phases (1) preparing for change, (2) managing change and (3) reinforcing change [41].

we will need instill that the perceived usefulness will remain to be stronger. Phase 2, manage the change, focuses on supporting the individuals impacted by the change. With respect to the implementation of health apps, this phase would be heavily focused on the end-users and what additional training that may be required to increase its perceived ease of use and prevent resistance from re-establishing. Phase 3, reinforcing change, evaluates the current status of the intervention to identify any issues and address them accordingly. This phase is key for the long-term sustainability of the health app as it ensures the change is maintained and provides evidence to support its benefits [41]. By following this three-phase change management plan, the health app design process will move more efficiently and will lead to a higher adoption rate.

4. Ensuring adoption and scalability

Moving from end-user usability and primary stakeholder needs, app publishers must also consider the underlying factors for national adoption. State or province specific regulations, needs, and resources available are likely to differ across a country. Thus, for optimal scalability, technology should be agile enough to utilize the infrastructure that is in place without causing disruption.

For instance, in Canada, policies regarding home-care differ between provinces, leaving some provinces with funding and others with none. When introducing a health app with similar objectives to home-care, developers must consider how the app can be used independently and concurrently, without losing its value. To ensure long-term adoption and scalability, the ideal health app should be designed to seamlessly coincide with the current practices that are in place. We describe below what evaluative steps we recommend to maximize national health app potential.

4.1. Long-term sustainability: where will it work?

We have described components should be included to please various stakeholders and ensure a smooth transition process. However, true sustainability stems from its capability to be seamlessly used in multiple settings. To accomplish this, we must conduct a market analysis to understand what interventions and regulations are currently in place, followed by a feasibility assessment to determine if those factors will jeopardize its implementation on a national scale [2, 42].

Depending on the health app being developed, different factors contributing to the market will be evaluated. However, before evaluating any components, the objective of the health app must be distinguished. This will narrow the scope of market factors that we will need to consider. We will then need to determine whether the health app will be an improvement of a current intervention or if it will stand alone in its functionality. Once this has been decided, we can readily evaluate what market factors are at play by answering a set of questions as outlined in **Figure 5**. Moving forward, depending on the con-current usage of the health app the steps may differ. Nonetheless, both ends of the evaluation will move in the same direction towards evaluating app feasibility, by determining what regulations/policies are in place, how cost-effective the app will be and most importantly if there is any funding available to support its implementation (**Figure 5**). This evaluative framework regarding the market forces and feasibility will determine whether the app will be sustainable across national regulations, or if it requires substantial changes in its design construct.

In the health app industry, it is common for enthusiasm regarding innovation to overshadow the drive to tackle sustainability, let alone feasibility. In this chapter, we focused on the highlighting the importance beyond designing sustainable electronic health applications. We started by addressing what barriers regarding sustainability were present and outlined what steps were needed to avoid them. The importance of identifying the needs, wants and expectations of the health apps primary stakeholders were also signified, as we understand that it is not only

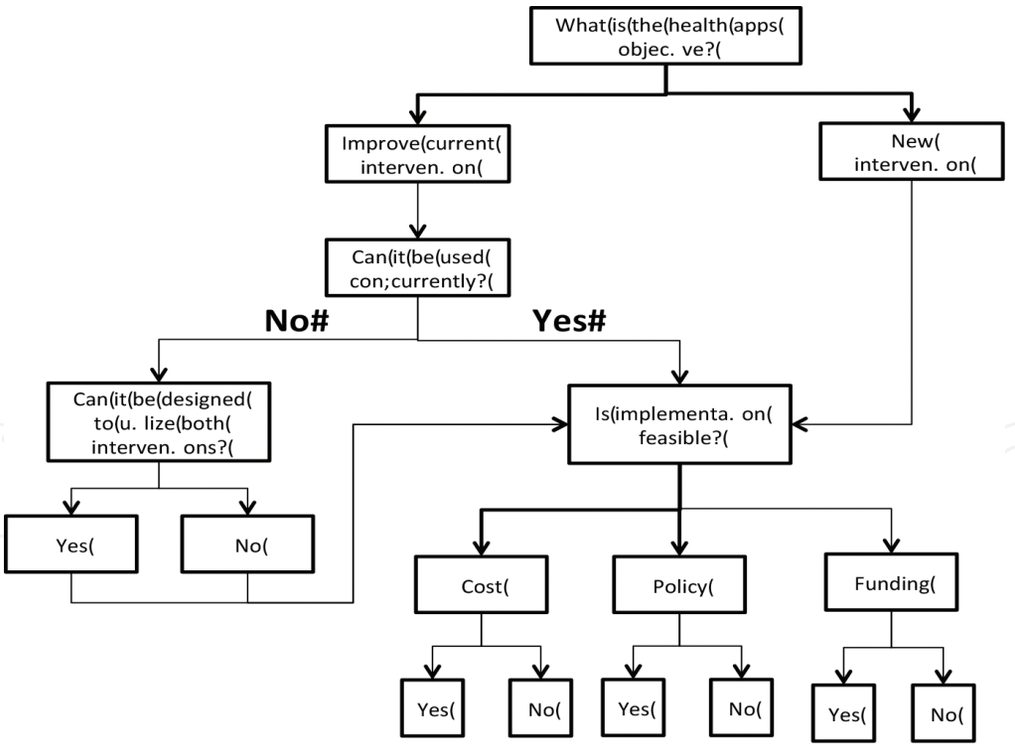

Figure 5. Market evaluation and feasibility analysis framework to help determine national sustainability of the intervention. The analysis begins by highlighting the health apps objective and determining whether it will improve current processes or introduce a new one. This leads to evaluating how the health app will function with current practices in place and if it will be suitable moving forward. In this framework, each block represents a form of analysis that is conducted, which leads to the final block that assesses overall feasibility and/or potential health app re-design/modifications needed.

important from a usability standpoint, but it shapes whether it will be sustainable across the country. Designing for sustainability may be a tiresome process, but if executed properly, the end results will bring more value than anticipated.

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