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Trustworthiness in mHealth information services: an assessment of a hierarchical model with mediating and moderating effects using partial least squares (PLS)

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Abstract

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Keywords

services, assessment, model, trustworthiness, mediating, information, hierarchical, moderating, effects, partial, least, squares, pls, mhealth

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Trustworthiness in mHealth Information Services: An Assessment of a Hierarchical Model with Mediating and Moderating Effects Using Partial Least Squares (PLS)

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The aim of this research is to advance both the theoretical conceptualization and empirical validation of trustworthiness in mHealth (mobile health) information services research. Conceptually, it extends this line of research by reframing trustworthiness as a hierarchical, reflective construct incorporating ability, benevolence, integrity and predictability. Empirically, it confirms that PLS (partial least squares) path modeling can be used to estimate the parameters of a hierarchical, reflective model with moderating and mediating effects in a nomological network. The model shows that trustworthiness is a second order, reflective construct which has a significant direct and indirect impact on continuance intentions in the context of mHealth information services. It also confirms that consumer trust plays the key mediating role between trustworthiness and continuance intentions, while trustworthiness does not have any moderating influence in the relationship between consumer trust and continuance intentions. Overall, the authors conclude by discussing conceptual contributions, methodological implications, limitations and future research directions of the study.

Introduction

Trust in information services is becoming a vitally important topic as the ubiquitous technology becomes more pervasive in our everyday lives (Kelton, Fleischmann & Wallace, 2007). Empirical research in this field has gained an increased attention in the last decade to facilitate both adoption and continuance of digital information services (Gefen, Karahanna, Straub, 2003). Though trust has been well explored in many information technology (IT) & e-commerce studies (Brown, Poole, & Rodgers, 2004; Gefen et al. 2003; Gefen & Straub 2004; Grabowski & Roberts, 1999; Ishaya & Mundy, 2004; Jarvenpaa & Leidner, 1999; Lewicki & Bunker, 1995; Lewis & Weigert 1985; Luo et al. 2010; Pavlou & Gefen, 2004; Schneider, 1999; Skosgrud, Benatallah, & Casati, 2003; Teo & Liu 2007; Tyler & Degoe 1996; Viegas, Kohno, & Potter, 2001), trustworthiness has received little attention (Colquitt, A. J., Scott, B. A., LePine J. A. 2007, Serva, M.A., Benamati, J.S., Fuller, M.A., 2005). These two concepts are often viewed synonymously; however, there lie an apparent distinction in terms of their cause and effect relationships (Colquitt et al. 2007, Serva et al. 2005). Whereas trust is defined as a general willingness to depend on another in situations of risk (Mayer, Davis, and Schoorman, 1995; Rousseau, Sitkin, Burt, 1998), trustworthiness is defined as a set of beliefs about the other party that facilitates willingness. Drawing on the theory of reasoned action (TRA), researchers have explored the critical role of trustworthiness (trusting beliefs) in consumer decision making because trusting beliefs (trustworthiness) lead to trusting attitude (consumer trust), which lead to trusting intentions or behaviour (Serva et al. 2005; Colquitt et al. 2007). Though the significance of trustworthiness in consumer decision making has been cited in the extant literature; however, it is beset by conflicting conceptualizations, inadequate understanding of the relationships between trustworthiness, its components, and consequents (Colquitt et al. 2007; Kelton et al. 2008; Mayer et al. 1995; Rousseau, 1998; Serva et al. 2005). Therefore, this study intends to explore trustworthiness within the context of a new paradigm of an emerging IT artifact, that is, mobile health (or, mHealth) information services. We define mHealth as the use of mobile communications—such as PDAs and mobile phones—for health services and information (UN foundation & Vodafone foundation 2009). Focusing on this emerging IT artifact, we propose that trustworthiness is composed of four distinct beliefs dealing with *ability*, *benevolence*, *integrity* and *predictability* of the mHealth service provider. In addition to other beliefs, we have added *predictability* because consumers expect that mHealth service providers will behave reliably in delivering medical information services (Gefen & Straub 2004). It is noteworthy that trustworthiness is a context-dependent multidimensional construct, whose relevant significant dimensions depend on the circumstance of the interaction

(Butler 1991; Gefen 2000; Lewis 1985). The importance of trustworthiness in mHealth services has gained much attention because the ultimate viability (continuance) of this innovative IT artifact still depends on confirmation of its trusting beliefs. If the system fails to achieve trustworthiness, it will remain underutilized, be bypassed, or used as a measure of last resort (Aker et al. 2010a; Andaleeb 2001; Dagger, Sweeney, & Johnson 2007; Gefen & Straub 2004; Rogers 1995). This is so because, given its critical role in mHealth information services, this study intends to reconceptualize the beliefs of trustworthiness construct and predict its impact on consumer trust and continuance intentions in a nomological network.

In this study, we have framed trustworthiness as a higher order model. The usefulness of hierarchical modeling is quite evident both in covariance based structural equation modeling (CBSEM) and component based SEM (Partial least squares or, PLS) (Chin 2010). Generally, it is used in modeling a level of abstraction higher than those first order constructs under multidimensional reflective or formative framework (Chin & Gopal 1995; Wetzels, Schroder, Oppen, 2009). Here, hierarchical reflective approach refers to an overall attitude in which each dimension reflects separate attitudinal dimension, whereas formative approach represents an aggregation of individual beliefs into a single summary representation (Bagozzi 1985, 1988; Chin & Gopal 1995). This study frames trustworthiness as a higher order reflective model, which is also known as a molecular model (Chin & Gopal 1995), superordinate construct model (Edwards 2001), principal factor model (Jarvis, MacKenzie & Podsakoff 2003), latent model (Law, Wong & Mobley 1998), common latent construct (MacKenzie, Podsakoff, & Jarvis 2005) and factor model (Wetzels et al. 2009). Though conceptual and empirical contribution of hierarchical reflective model has been cited in numerous CBSEM studies, however, component based SEM (PLS) has been under researched and still most of the literature remains largely fragmented (Wetzels 2009). Thus, this study adopts PLS path modeling in estimating the hierarchical model (Chin 2010; Lohmoller 1989; Noonan and Wold 1983; Petter, Straub & Rai, 2007; Wold 1982; Wetzels et al. 2009) because it leads to higher theoretical parsimony and lower model complexity (Edwards 2001; Law et al. 1998; MacKenzie et al. 2005; Wetzels et al. 2009). Furthermore, with the help of PLS path modeling, this study aims to explore hierarchical trustworthiness construct with mediating and moderating effects under a nomological network. To the best of our knowledge, there is a paucity of research on the use mediating and moderating effects under hierarchical modeling. Thus, this study will give researchers a platform to detect and

estimate both confirmatory and contingent relationship under such modeling using PLS (Chin, Marcolin, Newsted 2003; Greenwald, Pratkanis, Leippe & Baumgardner 1986).

Overall, our main objective is, first, to clarify and advance the theoretical conceptualization of trustworthiness construct and determine its impact on consumer trust and continuance intentions within mHealth context. Second, to establish the methodological rigor of hierarchical trustworthiness construct with mediating and moderating effects using PLS path modeling. The organization of this paper is as follows: The next section focuses on the literature review & the theoretical background for our study. Then, we conceptualize the research model and propose our hypotheses. The subsequent section describes our research methodology and empirical findings. Finally, we discuss the implications of our research in terms of theoretical and practical contributions, and provide the concluding remarks.

Literature Review

mHealth Information Services

mHealth is a new paradigm of an emerging information technology (IT) artifact. As an extension of eHealth, mHealth has inherently provided greater flexibility and mobility in healthcare information services (Ahuwalia & Varshney 2009; Akter et al. 2010; Chatterjee, Chakraborty, Sarker, Sarker & Lau, 2009; Junglas, Abraham & Watson 2008; Luo, Li, Zhang & Shim 2010; Muntermann 2009; Ngai & Gunasekaran 2007; Sneha & Varshney 2009; Varshney 2008). Electronic healthcare (or, eHealth) is defined as the embryonic convergence of wide-reaching technologies to provide direct access to healthcare providers, care management, education, and wellness (DeLuca & Enmark, 2000). On the other hand, mHealth is defined as an application of wireless technologies to transmit and enable various data contents and information services which are easily accessible by users through mobile devices such as mobile phones, smart phones, PDAs, laptops and Tablet PCs (UN foundation & Vodafone foundation 2009).

Health information services are often inadequate in resource poor settings because they are neither accessible nor affordable, and when they are accessible, they are often dysfunctional, unresponsive to the needs of clients or, low in trustworthiness. In such settings, “ *Information critical for decision making is severely lacking because patients and*

health care workers are minimally trained and educated, and they have little or no access to point-of-care assessment tools, consulting or other forms of information support. This lack of information at the individual level means that many health risks, conditions, and illnesses are assessed inaccurately, thus leading to poor or inappropriate treatment” (Grand challenges in global health, 2010). Within this context, mHealth has emerged as a viable solution to serve the pressing healthcare needs through its high reach and low cost solutions (Akter et al. 2010a). It is seen as an enabler of change in health care sector by ensuring the right information to the right person and at the right time (Akter et al. 2010b). Consequently, a growing number of countries around the world are using mHealth to address various healthcare needs, such as, education & awareness, remote data collection, remote monitoring, communication & training, disease & outbreak tracking, diagnostic and treatment support (UN foundation & Vodafone foundation 2009).

Trustworthiness in mHealth Information Services

Though mHealth is transforming healthcare delivery around the world; however, there is growing concerns about the perceived trustworthiness of such information services due to lack of reliability of the service delivery platform, knowledge and competence of the provider, privacy and security of information and above all, their effects on consumer trust and continuance intentions (Angst & Agarwal 2009; Ahuwalia & Varshney 2009; Kaplan & Litwka 2008; Michael 2009; Norris, Stockdale & Sharma 2008; Ivatury, Moore & Bloch 2009; UN foundation & Vodafone foundation 2009; Varshney 2005). It is widely believed that if the system cannot be trusted to guarantee a threshold level of standard services, it will remain underutilized, be bypassed, or used as a measure of last resort (Andaleeb 2001; Dagger et al. 2007; Gefen & Straub 2004; Rogers 1995). There is growing evidence that perceived trustworthiness plays a central role in mHealth consumer’s purchase decision making process by influencing trust and behavioral intentions (Serva et al. 2005; UN foundation & Vodafone foundation 2009). Hovland, Janis, and Kelley (1953) identified trustworthiness as one of the motivational factors that hugely affects trust. Ring and Van de Ven (1992) suggested that managers must concern themselves with the trustworthiness of the other party because of risk in transactions. In more recent work, it is listed as a set of beliefs that influences consumer trust and behavioral intentions (Park, Barnett, & Nam, 2002; Tseng & Fogg, 1999; Wathen & Burkell, 2002). According to Gefen & Straub (2004), *“It is important especially when there is minimum control over the trusted party and expects that the trusted party will behave as expected, can serve as a substitute for formal agreements in commercial exchanges”*. In

fact, it is regarded as a vital component in any exchange when the expected outcomes are not entirely governed by rules and guarantees (Blau 1964; Gefen & Straub 2004; Kelley 1979; Thibaut 1959). Thus, trustworthiness requires more attention in mobile health services because there is a paucity of rules and procedures to regulate this service and the outcome is not instantly verifiable (Akter et al. 2010; Gefen & Straub 2004).

An Overview of Trustworthiness & Trust

Trust is a multidisciplinary perspective which has created a breadth that strengthens the broader trust literature (Bigley & Pearce, 1998; Colquitt et al. 2007; Rousseau et al. 1998). However, this interdisciplinary conceptualization often creates confusion with regard to the definition and formulation of trustworthiness & trust constructs (Colquitt et al. 2007). It also lacks clear distinction among the components contributing to trustworthiness, trust construct and their outcomes (Mayer et al. 1995, Serva et al. 2005).

Trustworthiness refers to a set of beliefs about the other party that precedes willingness to depend on them in situations of risks (Mayer et al. 1995, Serva et al. 2005) (see Table 1). McKnight et al. (2002) defines trustworthiness as the confidence of the trustor that the trustee has attributes to serve the trustee in a beneficial manner. Mayer et al.'s (1995) model, first, identified trustworthiness as a multidimensional construct and separated it from trust (Colquitt et al. 2007). Aligned with this finding, McKnight et al. (1998); Ross & LaCroix (1996), Williams (2001), Serva et al. (2005), Colquitt et al. (2007), Kelton et al. (2008) established distinction between trustworthiness and trust construct. The extant literature on trustworthiness has revolved around a variety of beliefs (see Table 2); while the recent research has primarily focused on four specific factors, that is, *ability*, *benevolence*, *integrity* and *predictability*, which may parsimoniously capture the concept of trustworthiness (Mayer et al. 1995; McKnight et al. 1998; Serva et al. 2005, Colquitt et al. 2007). Thus, in this study, we refer to these constructs as the “dimensions of trustworthiness.” Here, *ability* refers to perceived characteristics, skill and competencies of the trustee (mHealth service provider) that influence a trustor (patient) to accept or continue using a particular service (Mayer et al. 1995). Likewise, *benevolence* refers to the trustor's belief that the trustee has good willingness to serve to serve the consumers (Mayer et al. 1995). *Integrity* refers to the principles that the trustee conforms to make services acceptable by the trustor (Mayer et al. 1995). Finally, *predictability* refers to the reliability of the trustee in

providing standardized services abiding to the standard rules of conduct. Thus, we can say that trustworthiness is a multifaceted construct that captures the competence and character of the trustee (Gabarro 1978) (see Table 2).

Table 1: Definitions of Trustworthiness and Trust	
Definitions of Trustworthiness	Study
Trustworthiness refers to the trustee's motivation to lie.	Hovland et al. (1953)
Trustworthiness is a multifaceted construct that captures the competence and character of the trustee.	Gabarro (1978)
Trustworthiness refers to the beliefs (e.g., competence, integrity) upon which trust is based in fiduciary relationships.	Liberman (1981)
Trustworthiness refers to the confidence of the trustor that the trustee has attributes to serve the trustee in a beneficial manner.	McKnight (2002)
Trustworthiness refers to a set of beliefs about the other party that precedes trusting attitude.	Serva et al. (2005)
Trustworthiness, based on some attributes, strengthens the trustor's confidence that the trustee is willing and able to fulfill the trust.	Kelton et al. (2008)
Definitions of Trust	Study
Trust refers to the reliance upon the characteristics of an object, or the occurrence of an event, or the behavior of a person in order to achieve a desired but uncertain objective in a risky situation.	Giffin (1967)
Trust refers to willingness to take risks.	Johnson-George and Swap (1982)
Trust refers to a psychological state comprising the intentions to accept vulnerability based on positive expectations of the intentions or behavior of another.	Rousseau et al. (1998)
Trust is a single dimension construct dealing with a consumer's assessment that the vendor is trustworthy.	Gefen (2000)
Trust is a willingness to be vulnerable to another party, but there is no risk involved with holding such an attitude	(Mcknight 2002)

On the contrary, trust is defined as a general wiliness to depend on another in situations of risk (Mayer et al. 1995; McKnight et al. 2002a). Similarly, McAllister (1995) defines trust as “the extent to which a person is confident in and willing to act on the basis of, the words, actions, and decisions of another”. The definitions of trust offered by Mayer et al. (1995) and Rousseau et al. (1998) both include an expectation that another party will perform a particular action. Following the same tradition, Korsgaard, Schweiger, Sapienza (1995) and Hart & Saunders (1997) defined trust as the confidence that another party will behave as expected. Colquitt et al. (2007) identified that most

of these definitions have focused on two components of trust, one is '*intentions to accept vulnerability*' (e.g., Boon & Holmes, 1991; Deutsch, 1958; Govier, 1994; Zand, 1972) and the other is '*positive expectation*' (e.g., Barber, 1983; Boon & Holmes, 1991; Cook & Wall, 1980; Golembiewski & McConkie, 1975; Read, 1962; Roberts & O'Reilly, 1974). They argued that one of the basic drivers of these components is 'trustworthiness' which is a precursor to trust. According to Serva et al. (2005) "trustworthiness may instill trust, which indicates that trustworthiness and trust are distinct but related constructs". To support such association, IS researchers (e.g., Serva et al. 2005, Teo & Liu 2007) have frequently applied TRA (Fishbein and Ajzen 1975), which posits that an individual's trusting beliefs affect his/her trusting attitude, which, in turn, affect his/her trusting intentions to perform the trust related behavior.

As mentioned above, trusting beliefs are different from trusting attitude, because beliefs refer to *cognition* whereas attitude refers to *affect*. According to Fishbein & Ajzen (1975), "*whereas attitude refers to a person's favorable or unfavorable evaluation of an object, beliefs represent the information he has about the object.*" Through beliefs (e.g., trustworthiness), an individual links an object (e.g., mHealth platform) to some attribute, such as, '*mHealth platform is always available*' or, '*it provides quick medical solutions*'. The object of belief may be a person, or group of people or an institution etc. and the related attribute may be characteristics, quality or trait (Fishbein & Ajzen 1975). On the other hand, through attitude (e.g., trust), a person expresses his/her feelings toward and evaluates an object (e.g., mHealth platform), such as, '*I feel that I would trust mHealth platform for reliable medical information services*' or, '*I feel that I would trust mHealth platform's promises and commitment to satisfy my medical information needs*'. The idea that beliefs form the foundation of one's attitude is also supported by the expectancy-Value model (Dabholkar 1999; Feather 1982) and the theory of attitude (Fishbein 1963, 1967; Sarnoff 1960; Thurstone 1931). Thus, aligned with the findings of these theories, Fishbein & Ajzen (1975) noted, "*The major characteristic that distinguishes attitude from other concepts (e.g., beliefs) is its evaluative or affective nature*".

Overall, it is evident that trustworthiness (i.e., beliefs) and trust (i.e., attitude) play two distinct roles in an individual's decision making process. In other words, trustworthiness acts as the antecedent of consumer trust and subsequent trust related actions, such as, behavioral intentions or intentions to continue using (Flores & Solomon

1998; Lewis and Weigert 1985; Mayer et al. 1995, McKnight et al. 2002, Serva et al. 2005). According to Colquitt et al. (2007) *“the concept of trustworthiness is clearly central to understanding and predicting trust levels.”* However, many IS studies have not clearly differentiated between trustworthiness and trust (Bhattacharjee 2002, Gefen & Straub 2004; Luo et al. 2010; Pavlou 2003; Suh & Han, 2002). For instance, the study of Gefen & Straub (2004) utilizes trustworthiness indicators (ability, benevolence, integrity and predictability), but refers to the construct as trust. Likewise, Bhattacharjee (2002) defines trust as a willingness to be vulnerable, but operationalizes indicators to measure the trustor’s ability, benevolence and integrity as a component of trust, rather than trustworthiness (Serva et al. 2005). In another recent study, Luo et al. (2010) did not distinguish between trusting beliefs (trustworthiness) and trusting attitudes (consumer trust), which significantly diverges from TRA by equating these two approaches.

Table 2: Attributes of Trusting Beliefs in previous research	
Luo et al. (2010)	Competence, integrity and benevolence
Kelton et al.	Competence, positive intentions, ethics, predictability
Colquitt et al. (2007)	Ability, benevolence, integrity, trust disposition
Teo & Liu (2007)	Reputation, System assurance and propensity to trust
Serva et al. (2005)	Ability, benevolence and integrity
Gefen & Straub (2004)	Ability, benevolence, integrity and predictability
Gefen et al. (2003)	Ability, benevolence, integrity and predictability
McKnight et al. (1998)	Competence (ability), benevolence, honesty (integrity), and predictability
Hart and Saunders (1997)	Predictability, competence, openness, caring, and good will
Dasgupta (1988)	Credible threat of punishment, credibility of promises
Good (1988)	Ability, intentions, trustee’s promises
Schurr & Ozanne (1985)	Predictability
Lieberman (1981)	Competence, integrity
Cook and Wall (1980)	Ability, trustworthy intentions
Larzelere and Huston (1980)	Benevolence, honesty
Rotter (1980)	Predictability
Kee and Knox (1970)	Competence, motives
Deutsch (1960)	Ability, intentions to deliver
Strickland (1958)	Benevolence
Butler (1991)	Ability, competence, consistency, discreteness, fairness, integrity, loyalty, openness, promise fulfillment, receptivity

Specifying Trustworthiness as a Hierarchical Reflective Model

Hierarchical constructs or multidimensional constructs are defined as constructs with more than one dimension where each dimension captures some portion of the overall latent variable (Edwards 2001, Jarvis et al. 2003; Law and Wong 1999; Law et al. 1998; MacKenzie et al. 2005; Netemeyer et al. 2003; Petter et al. 2007; Wetzels 2009). These higher order constructs have proven to be successful in increasing theoretical parsimony and reducing model complexity (Edwards 2001; Law et al. 1998; MacKenzie et al. 2005). It also assists in matching the level of abstraction for predictor and criterion variables (Edwards 2001) which has already been reflected in Chin & Gopal's (1995) study of group support systems (GSS) adoption. In their study, they introduced "molecular model" or hierarchical reflective model, in which belief toward GSS adoption is framed as a latent variable with reflective constructs. In the similar vein, Wetzels et al. (2009) recently developed a fourth order hierarchical reflective model in online experiential value to predict e-loyalty. Aligned with these explorations, in this study, we specify trustworthiness as a hierarchical model which is comprised of four reflective constructs including ability, benevolence, integrity and predictability (see Table 2).

The extant research on trustworthiness (Mayer et al. 1995; Serva et al. 2005) and measurement model specifications (Chin 2010; Edward & Bagozzi 2000; Jarvis et al. 2003; Petter et al. 2007; Wetzels et al. 2009) supports this view of hierarchical reflective modeling within the broader trust based nomological network. Also, we adopt this perspective because all the indicators in our model share a common theme and dropping an indicator should not alter conceptual domain of the construct. Besides, the correlation between any two measures is expected to be highly positive (Bollen and Lennox 1991) and internal consistency is important for such reflective constructs (Petter et al. 2007). Furthermore, such reflective measures are expected to be unidimensional, therefore, individual measures can be removed to improve construct validity without affecting content validity (Petter et al. 2007).

Table 2 : Trustworthiness as a hierarchical reflective Model (Chin 2010; Wetzels et al. 2009)

Construction of Hierarchical Model	Trustworthiness as a Hierarchical Model
<p>Figure 1 shows first order latent variables (ability, benevolence, integrity and predictability) of trustworthiness, which are related to their respective indicators (manifest variables).</p>	<p>Figure 1: First order latent variables of Trustworthiness</p>
<p>Figure 2 shows trustworthiness as a second order, hierarchical, reflective, latent variable which is constructed by relating it to the block of the underlying first order latent variables. For instance, trustworthiness is constructed by using 16 MVs (4+4+4+4) of 4 first order latent variables. This model is regarded as a hierarchical, reflective model (Chin & Gopal 1995) which explains the common variance across ability, benevolence, integrity and predictability.</p>	<p>Figure 2: Trustworthiness as a second order hierarchical reflective model</p>
<p>Characteristics of Trustworthiness as a reflective model (Petter et al. 2007):</p> <ul style="list-style-type: none"> • Direction of causality is from Latent variable (construct) to manifest variables (items) • Indicators are manifestations of the construct • Indicators are interchangeable, having a common theme and dropping of an indicator will not change the conceptual domain of construct. • Correlation between any two measures is highly positive • Indicators and constructs have the same nomological net. 	

Using PLS to Assess the Hierarchical Trustworthiness Model

PLS path modeling (or, Component based structural equation modeling) allows for estimating the hierarchical model in order to achieve more theoretical parsimony and less model complexity (Chin 2010; Edwards 2001; Law et al. 1998; MacKenzie et al. 2005, Wetzels et al. 2009). As discussed earlier, this study focuses on a higher order reflective model, which consists of constructs involving more than one dimension and indicators are manifestations of construct (Edwards 2001; Jarvis et al. 2003; Law and Wong 1999; Law et al. 1998; MacKenzie et al. 2005; Netemeyer, Bearden, & Sharma, 2003; Petter et al. 2007, Wetzels et al. 2009). Particularly, in this case, PLS can be used to avert the limitations of covariance based SEM with regard to distributional properties, measurement level, sample size, model complexity, identification and factor indeterminacy (Chin 1998; Fornell and Bookstein 1982, Wetzels et al. 2009). Besides, it is suitable for our study because it can give more accurate estimates of mediating and moderating effects by accounting for the measurement error that attenuates the estimated relationships and improves the validation of theories (Chin et al. 2003, Helm, Eggert & Garnefeld 2010, Henseler & Fassott 2010). Also, PLS works better when the objective is ‘prediction’, the model is relatively complex, and the phenomenon under study is new or changing (Chin & Newsted 1999). Overall, it ensures robust solutions in estimating complex relationships among variables (Chin 2010).

<i>Table 3: Estimation of Trustworthiness as a Hierarchical Model Using PLS</i>	
<i>First Order model</i>	<i>Second order model</i>
$y_i = \Lambda_y \cdot \eta_j + \varepsilon_i$ $y_i = \text{manifest variables (e.g., measures or indicators)}$ $\Lambda_y = \text{loadings of first order latent variable}$ $\eta_j = \text{first order latent variable (e.g., ability, benevolence, integrity and predictability)}$ $\varepsilon_i = \text{measurement error of manifest variables}$	$\eta_j = \Gamma \cdot \xi_k + \zeta_j$ $\eta_j = \text{first order factors (e.g., ability)}$ $\Gamma = \text{loadings of second order latent variable}$ $\xi_k = \text{second order latent variable (e.g., trustworthiness)}$ $\zeta_j = \text{measurement error of first order factors}$

Therefore, in our study, PLS can be used to estimate the hierarchical model using the repeated use of manifest variables (Guinot, Latreille, & Tenenhaus, 2001; Lohmoller 1989; Noonan and Wold 1983; Tenenhaus, Vinzi, Chatelin, & Lauro, 2005; Wold 1982). It is noteworthy that the scores of latent variables are determinate in PLS path

analysis; therefore, the scores of lower order latent variables (e.g., ability, benevolence, integrity and predictability) can subsequently be used as manifest variables for the higher order construct (e.g., trustworthiness) (see Table 3).

Developing the Conceptual Framework

Our study extends existing research by reconceptualizing trustworthiness as a hierarchical, reflective construct and examining its impact on consumer trust and continuance intentions. Drawing from TRA, we propose that an individual's composite *trusting beliefs* (ability, benevolence, integrity and predictability) in the form of *trustworthiness* affect his/her *trusting attitude* (consumer trust), which results in *continuance intentions* of mHealth services. We propose 'continuance' as an outcome construct because it is frequently pronounced as one of the critical components to ensure sustainability of mHealth services (Aker et al. 2010). According to Bhattacharjee (2001b, pp. 351-352) "long-term viability of an IS and its eventual success depend on its continued use rather than [its] first-time use." Limayem et al. (2007) supports this view by suggesting considering ICT implementation as a success when a significant number of users have moved beyond the initial adoption stage and using ICT on a continued basis. Thus, in our research model, each component of trustworthiness reflects a unique belief, while the set provides a solid and parsimonious foundation for hierarchical trustworthiness modeling in a nomological network. The research model and hypotheses are shown in figure 3.

Figure 3. Research Model and Hypotheses

Components of Hierarchical Trustworthiness Model:

Ability

According to Mayer et al. (1995), “*Ability is that group of skills, competencies, and characteristics that enable a party to have influence within some specific domain*”. It highlights the task and situation-specific nature of the construct in the research model. In the context of mhealth, it is defined as the knowledge, skills and general wisdom of the health professionals needed to provide medical information services (Gabarro 1978). The mHealth platform may be highly efficient in some technical area (e.g., system availability); however, the front line health professionals might have little aptitude, training, or experience in providing services to patients over mobile phone (Mayer et al. 1995). It is noteworthy that if the provider does not know its market and its objectives, has little ability, or, does not serve patients’ needs well, accomplishing trustworthiness will be much harder (Gefen et al. 2003).

Benevolence

We define benevolence as the extent to which the mHealth service provider is believed to serve patients with good intentions, apart from any profit motives. It is synonymous with *loyalty, openness, caring, or supportiveness* (Colquitt et al. 2007; Mayer et al. 1995). It increases customer satisfaction and retention (Gefen 2002; Zeithaml, Berry & Parasuraman 1996) by reducing social uncertainty or, possibility of any undesirable behavior, such as, the possibility that the mHealth service provider is operating to gain any short term profit, whereas the patient wants to establish long term relationship (Gefen & Struab 2004). It is developed to create an emotional attachment to the service provider, with caring and supportiveness fostering a sense of positive affect (Colquitt et al. 2007). Thus, perceived benevolence plays an important role in trustworthiness because it motivates the trustor to exhibit positive trusting attitude (Mayer et al. 1995).

Integrity

Integrity refers to the extent to which mHealth service provider is believed to confirm moral and ethical principles. Sitkin and Roth (1993) recognize it as “value congruence”, Lind (2001) identifies it as “fairness & moral character” and Colquitt et al. (2007) treats it as honesty, fairness and justice. According to Mayer (1995), integrity also focuses on “... *credible communications about the trustee from other parties, belief that the trustee has a strong sense of justice, and the extent to which the party's actions are congruent with his or her words all affect the degree to which the party is judged to have integrity*”. For instance, a dishonest mHealth information service provider may

misuse patients' personal information and could track his personal identity without prior approval. In case of health services, failure to conform integrity may result in intrusion to privacy. Integrity may reduce a range of socially unacceptable behaviors (Gefen & Straub 2004). It represents a very rational reason to trust someone, based on fairness and moral character, to reduce uncertainty (Lind, 2001).

Predictability

Predictability refers to the degree to which mHealth service provider is expected to behave reliably in delivering services on time by abiding to standard practices (Gefen & Straub 2004, Butler, 1991; Coutu, 1998; Zaheer, McEvily, & Perrone, 1998). It is based on previous knowledge (Coutu, 1998; Lewicki & Stevenson, 1997) or relational consistency (Doney & Cannon, 1997; Rempel et al., 1985; Rousseau et al., 1998). It is more relevant to measure continuance in services consumption (Mcknight et al. 2002). It plays a crucial role in reducing uncertainty (Lewis & Weigert, 1985) and enhancing confidence (Mayer et al. 1995). It also reflects reliability (Giddens, 1990; Hardin, 2001; Muir, 1994), consistency (Butler, 1991), or behaving as expected (Luhmann, 1979; Seligman, 1997; Sheppard & Sherman, 1998). In case of mHealth services, the behavior of the provider and availability of the service platform can directly affect the service outcome. Thus, predictability should be a significant characteristic of trustworthiness in order to ensure right time availability of the mHealth platform and standardized services by the physicians.

Hypotheses Development

Trustworthiness predicts consumer trust and downstream trust related actions (Serva et al. 2002). Thus, to embed hierarchical trustworthiness construct in a nomological network, we have associated it with consumer trust & continuance intentions of mHealth services. The objective of this network is to establish theoretical linkages among the constructs in such a manner so as to ensure 'fit' and capture the essence of the model (Straub et al. 2004). We present that the hierarchical trustworthiness construct has a significant positive impact on consumer trust and continuance intentions of mHealth services. In this relationship, consumer trust, as a mediator, influences the relationship between trustworthiness and continuance, whereas trustworthiness, as a moderator, affects the role of consumer trust in predicting continuance.

Trustworthiness, Consumer Trust & Continuance Intentions:

As discussed earlier, the theory of reasoned action (TRA) reflects observed relationships among beliefs, attitudes, and behavioral intentions by analyzing the psychological processes (Ajzen and Fishbein, 1980). It asserts that an individual's beliefs determine his/her attitude and, in turn, attitude determines the person's behavioral intentions. Following this theoretical base, we assume that ability, benevolence, integrity and predictability form trusting beliefs (trustworthiness), which ultimately determines trusting attitude (trust) and continuance intentions. In fact, one trusts someone because he/she is trustworthy, and one's trustworthiness inspires trust and its consequences (Flores and Solomon 1998; Colquitt et al. 2007). As a result, we identify trustworthiness as a belief, confidence or sentiment about the mHealth service provider's likely behavior, which is posited to have a direct association with consumer trust (Serva et al. 2005; Colquitt et al. 2007; Kelton et al. 2007) and indirect association with continuance intentions (Belanger & Carter 2008; Chow & Holden 1997; Teo & Liu 2007; Macintosh & Lockshin, 1997). In addition, we are interested to explore whether trustworthiness has any direct impact on continuance intentions. This association is hypothesized because a consumer's continuance behavior (or, loyalty) is believed to be influenced by his/her trusting beliefs (Belanger & Carter, 2008).

H1: Trustworthiness has a significant positive impact on consumer trust in mHealth information services.

H2: Consumer trust has a significant positive impact on continuance intentions of mHealth information services.

H3: Trustworthiness has a significant positive impact on continuance intentions of mHealth information services.

Mediating Role of Trust

Mediation is defined as a situation when the predictor (trustworthiness), first, has a significant influence on the mediator (consumer trust); second, the mediator (consumer trust) has a significant influence on the criterion variable (continuance intentions) and finally, the predictor (trustworthiness) has a significant influence on the criterion variable (continuance intentions) in the absence of the mediators' influence (consumer trust) (Barron & Kenney 1986). The extant research has asserted that consumer trust serves the mediating role between trustworthiness and behavioral intentions (Flavián, Guinalíu, Gurrea 2006; Jarvenpa et al. 2000; Kelton et al. 2008; Mayer et al. 1995; Teo et al. 2007). The logic is that if the consumer perceives that the provider's trustworthiness (ability, benevolence, integrity and predictability) is sufficient, he/she will experience positive trusting attitude which will ultimately

enhance his/her continuance intentions (Mayer et al. 1995). Aligned with this finding, other researchers (e.g., Colquitt et al. 2007; Kim et al. 2008; Kee & Knox, 1970; Mayer et al. 1995; Ross & LaCroix, 1996; M. Williams, 2001) have suggested that consumer trust mediates the relationship between trustworthiness and intention to continue using. Thus, we posit that:

H4. Consumer trust mediates the relationship between trustworthiness and continuance intentions (mediating effect).

Moderating Role of Trustworthiness

Trustworthiness has frequently been cited to have a moderating impact on the relationship between consumer trust and continuance intentions (Belanger & Carter, 2008). We define moderating variable as “.... a variable that affects the direction and/or strength of the relation between an independent or predictor variable and a dependent or criterion variable” (Barron & Kenny 1986, p. 1174). In fact, moderation occurs when predictor and moderator have a joint effect in accounting for incremental variance in criterion variable beyond that explained by main effects (Cohen & Cohen 1983). In this study, trustworthiness is identified as a moderator because when it is high, consumer trust becomes even more vital to continuance intentions (Mayer et al. 1995). As such, the variation in trustworthiness influences the strength or, the direction of a relationship between consumer trust and continuance intentions (Barron & Kenny 1986). Thus, it is important to understand the impact of trustworthiness as a moderator to explore the complex interdependencies among variables (Chin et al. 2003; Homburg & Giering 2001). It is also imperative to examine the influence of a hierarchical moderating construct (trustworthiness) on the relationship between consumer trust and continuance intentions. Hence, we posit that:

H5: Trustworthiness moderates the relationship between consumer trust and continuance intentions (moderating effect).

Research Methodology

Research Setting

This study applies PLS path modeling to assess the hierarchical trustworthiness model in mHealth information services. It has selected mHealth because the extant research indicates that trustworthiness plays a critical role in this context to shape consumer trust and continuance intentions (Akter et al. 2010, Chattergee et al. 2009, Luo et al. 2010, Sneha et al. 2009). Specifically, this study is based on a popular B2C mHealth setting in Bangladesh, which is well known as ‘mobile telemedicine services’ or, ‘mobile health hotline services’ in the developing countries. We define this service as a personalized and interactive health service over mobile phone in order to provide ubiquitous and universal access to medical advice and information (Akter et al. 2010). Under this platform, a user can easily access this service by simply dialing some unique digits (e.g. 789 in Bangladesh) from his or her mobile phone and can receive medical information, consultation, treatment, triage, diagnosis, referral and counseling from registered health professionals (Akter et al. 2010; Ivatury et al. 2009). Currently, more than 24 million subscribers of *Grameen Phone* in Bangladesh have access to such mHealth services under B2C framework. We have selected *Grameen mHealth* for several reasons. First, it is the leading mHealth platform in Bangladesh, which has been providing this service since 2006. Second, it has 100% network coverage all over the country which allows anyone to access mHealth service from anywhere. Third, it has more than two hundred thousand mobile phone kiosks (rental mobile phones) around the country which ensures access to mHealth service to anyone at anytime. Finally, this particular mHealth platform (i.e., mobile telemedicine/mobile health hotline) has become very popular in Bangladesh as well as in the developing world (e.g., India, Pakistan, Mexico, South Africa, Peru etc.) for delivering right time medical information services at an affordable cost (Ivatury et al. 2009, Akter et al. 2010).

Research Method

The hierarchical trustworthiness model proposed in this study reflects positivist notion as it formulates an empirically testable theory to establish ‘law like generalizations’ (Orlikowski & Baroudi, 1991), such as, *ability, benevolence, integrity and predictability* are integral components of hierarchical *trustworthiness* construct, which predicts *consumer trust* and *continuance intentions* in mHealth settings. Since this study is going to measure a causal network of relations, so *an empirical study* was conducted in a natural setting using human subjects (Jenkins, 1985). Under the empirical study, *cross sectional survey* was adopted to elicit specific information from any given sample of population elements only once (Malhotra 2004). In terms of survey interaction, *in-home and location intercept*

techniques were adopted as they provide maximum response rates in comparison with postal mail, telephone and online survey in a developing country context (Andaleeb 2001; Malhotra 2004).

Sampling

Data was collected from two major divisions (i.e., *Dhaka* and *Khulna*) of Bangladesh under a WHO (World Health Organization) global mHealth assessment project from January 07 to March 17, 2010. In the absence of lists for drawing a random sample, four hundred interviews were planned from two urban areas (*Dhaka city & Khulna City*) and three rural areas (*Netrokona, Keranigonj and Kaligonj*) using area wise cluster sampling. Areas were selected in a manner such that different socioeconomic groups were represented. From each area, first, thanas were selected randomly; then, streets/villages were selected from each thana; and finally, residential homes were selected from each street/village. In order to obtain a probability sample, systematic random sampling was applied so that each sample unit/element had an equal chance of being selected (Andaleeb 2001, 2008). The population was defined as the patients who had experience of using mHealth (hotline) services in the past 12 months. In urban areas, assuming most people have access to mHealth through their own mobile phones, respondents were selected from residential homes after asking some quick screening questions. And in the rural setting, *location intercept* was used in addition to *in-home technique* because, people who do not have their own mobile phones generally access to mHealth from ‘a local mobile phone kiosk’. Approximately 15% of the total samples were from these kiosks. In all survey interactions, interviewers were given a letter of introduction from a reputed university containing the phone number for respondents to see that the study was authentic. Those who agreed to be interviewed were explained the academic purpose of the study with adequate assurance of anonymity and freedom of not answering particular questions or withdrawing opinion from the interview at any stage. Both self completion and interviewer filled survey techniques were used in order to receive higher valid response. A total of 223 surveys were ultimately completed. Of the total number of surveys, seven were considered problematic and excluded, because of excessive missing data, don’t know answers, or N/A answers, and response biases. Finally, 216 surveys were analyzed.

Table 4: Demographic profile of respondents					
Items	Categories	%	Items	Categories	%
Gender	Male	57.9	Age	18-25	25.3
	Female	42.1		26-33	31.5
Location	Urban Rural	44.5		34-41	21.2
		55.5		42-49	16.9
Income (per month in US \$)	< \$ 70	50		50+	5.1
	\$ 71- \$141	18.5	Occupation	Working full time	38.4
	\$ 142 - \$212	12.5		Working part time	34.3
	\$ 212 +	19		Housewife	15.7
				Others	11.6

The sample demographics in Table 4 indicated a diverse cross-section of population. Of the respondents, 55.5 percent were from rural areas; 50 percent had income less than \$ 70 per month; 57.9 percent were male; 25.3 percent were between 18 and 25 years, 31.5 percent were between 26 and 33 years, 21.2 percent were between 34 and 41 years and remaining 22 percent were older than 42 years. Of the total number of respondents, 38.4 percent considered themselves as full time employees, 34.3 percent were part time employees, 15.7 percent were housewives and remaining 11.6 percent were unemployed.

Measurement Instruments

The questionnaire consisted of previously published multi-item scales (see Table 5) with favorable psychometric properties (Gefen & Straub 2004, Serva et al. 2005; Teo & Liu 2007). We developed the primary version of the questionnaire in English, and then we translated the measures into the local language (Bangla). The local version was retranslated until a panel of experts agreed that the two versions were reasonably comparable (Andaleeb 2001). All of the items were measured in a structured format on a seven-point likert-type scale, ranging from “strongly disagree” to “strongly agree.” Before the final study, we conducted a pretest over 10 samples to ensure that the question content, wording, sequence, format and layout, question difficulty, instructions and the range of the scales (5-point vs. 7-point) were appropriate. Upon response from the pretest, we made minor adjustments to refine the final version of the questionnaire.

Table 5: Operationalizaition of constructs (Trustworthiness)		
Latent Constructs	Definitions	Measures
Ability	The extent to which mHealth information service provider is believed to have the necessary knowledge and skills to provide such services.	Adapted from Gefen (2002)
Benevolence	The extent to which the mHealth information service provider is believed to serve the patients with good intentions.	Adapted from Gefen (2002)
Integrity	The extent to which the mHealth information service provider is believed to confirm moral and ethical principles.	Adapted from Gefen (2002)
Predictability	The extent to which mHealth information service provider is believed to perform reliably or consistently in order to fulfill all promises.	Adapted from Gefen & Straub (2004)
Consumer trust	Users' overall trusting attitude toward the mHealth information service provider.	Adapted from Gefen (2002), Serva et al. (2005), Teo & Liu (2007)
Continuance	Users' intentions to continue using mHealth information services.	Adapted from Bhattacharjee (2001b)

Findings

In order to assess the hierarchical model of trustworthiness, we used PLS Graph 3.0 (Chin 2001) to estimate the parameters in the outer and inner model. In this case, we applied PLS path modeling with a path weighting scheme for the inside approximation (Chin 1998; Tenenhaus et al. 2005; Wetzels et al. 2010). Then we applied nonparametric bootstrapping (Chin 1998; Efron and Tibshirani 1993; Tenenhaus et al. 2005; Wetzels et al. 2010) with 500 replications to obtain the standard errors of the estimates. In estimating the higher-order latent variables, we used the approach of repeated indicators suggested by Wold (cf. Lohmoller, 1989, pp 130-133). As such, the second order factor (trustworthiness) is directly measured by indicators (or, manifest variables) of all first order factors (ability, benevolence, integrity and trustworthiness) (Chin et al. 2003; Wetzels et al. 2009). In order to ensure better operationalization of the model, the study uses equal number of indicators for each construct in the first order model (Chin 2010; Chin et al. 2003).

Common Methods Variance

When variables are latent and measured using cross sectional survey method, common methods variance (CMV) can be a problem. In order to address this problem, we applied Harman one-factor test (Podsakoff & Organ, 1986) on six first order latent variables in our research model. This test found no significant biases in the dataset because there was no common factor loading on all the measures. Therefore, CMV was not considered a major concern in this study.

Measurement Model Results

In order to check the properties of the measurement scales, we conducted confirmatory factor analysis (CFA) to assess reliability, convergent validity and discriminant validity of the scales (Table 6). As shown in the table, most item loadings were larger than 0.7 and significant at .01. All AVEs, CRs, and Alphas exceeded the cut off values of 0.5, 0.7, and 0.7, respectively (Bagozzi & Yi, 1988; Gefen et al., 2000; Nunnally, 1978). The lowest CR (0.91) and AVE (0.720) are for benevolence; however, all those values compellingly exceeded their recommended threshold values. Thus, we ensured convergent validity because all the indicators load much higher on their hypothesized factor than on other factors (own loading are higher than cross loadings) (Chin 1998, 2010). In addition, in Table 7, we calculated the square root of the AVE that exceeds the intercorrelations of the construct with the other constructs in the model in order to ensure discriminant validity (Chin 2010, 1998; Fornell and Larcker 1981). Thus, the measurement model was considered satisfactory with the evidence of adequate reliability, convergent validity and discriminant validity and was employed for testing hypotheses and proving the research model.

Table 6: Psychometric Properties for First Order Constructs					
Constructs	Items	Loadings	Alpha	CR	AVE
Ability	Grameen mHealth is competent in providing health information service.	0.952	0.943	0.959	0.855
	Grameen mHealth performs its role very well.	0.959			
	Grameen mHealth understands the needs of patients it serves.	0.891			
	Grameen mHealth is knowledgeable in providing health information service.	0.896			
Benevolence	Grameen mHealth is ready and willing to assist me.	0.852	0.870	0.911	0.720
	Grameen mHealth's intentions are benevolent.	0.854			
	Grameen mHealth has good intentions towards me.	0.895			
	Grameen mHealth is well meaning.	0.792			
Integrity	Promises made by Grameen mHealth are reliable.	0.950	0.933	0.953	0.837
	I would characterize Grameen mHealth as honest.	0.951			
	Grameen mHealth keeps its commitment.	0.940			
	Medical information Services given by Grameen mHealth are its best judgment.	0.812			
Predictability	I am quite certain that I can receive Grameen mHealth's service whenever I need.	0.943	0.934	0.953	0.837
	I am quite certain that I can receive Grameen mHealth's service wherever I need.	0.896			
	I am quite certain that Grameen mHealth is always available.	0.962			
	I am quite certain that I can receive medical information service from Grameen mHealth right away.	0.856			
Trust	I trust Grameen mHealth.	0.923	0.933	0.952	0.832
	I feel that I would trust Grameen mHealth for reliable medical information services.	0.917			
	I feel that I would trust Grameen mHealth's promises and commitment to satisfy my medical information needs.	0.945			
	I feel that I would trust Grameen mHealth's behavior to meet my expectations.	0.864			
Continuance	I intend to continue using Grameen mHealth to get medical information services.	0.946	0.945	0.964	0.901
	My intentions are to continue using Grameen mHealth than use any alternative means (e.g., traditional health systems)	0.946			
	I will not discontinue my use of Grameen mHealth service.	0.956			

Table 7: Mean, Standard Deviation, Intercorrelations of the latent variables for the first order constructs								
Construct	Mean	SD	Ability	Benevolence	Integrity	Predictability	Trust	Continuance
Ability	5.465	1.186	0.925*					
Benevolence	5.745	1.044	0.715	0.850*				
Integrity	5.080	1.319	0.693	0.684	0.915*			
Predictability	5.595	1.187	0.681	0.612	0.665	0.915*		
Trust	5.378	1.242	0.799	0.798	0.698	0.680	0.912*	
Continuance	5.184	1.605	0.756	0.684	0.683	0.626	0.762	0.949*

*square root of the AVE on the diagonal

Assessment of the Hierarchical Trustworthiness Model

As discussed earlier, this study specifies trustworthiness as a second order hierarchical reflective construct, which consists of 4 first order reflective constructs (ability, benevolence, integrity and predictability) representing 16 (4*4) items. Thus, the degree of explained variance of this hierarchical construct is reflected in its components, that is, ability (80.1 %), benevolence (73 %), integrity (76.9 %) and predictability (72.3 %) (See Table 8). All the path coefficients from trustworthiness to its components are significant at $P < 0.01$. Here, the CR & AVE of trustworthiness are 0.962 and 0.615 respectively, which are well above the cut off values.

Table 8: Trustworthiness (CR = 0.962, AVE= 0.614)			
Ability	Benevolence	Integrity	Predictability
$R^2 = 0.801$ $\beta = 0.895$ $P < 0.01$	$R^2 = 0.730$ $\beta = 0.854$ $P < 0.01$	$R^2 = 0.769$ $\beta = 0.877$ $P < 0.01$	$R^2 = 0.723$ $\beta = 0.850$ $P < 0.01$

Assessment of the Structural Model

In Figure 4A, the results give a standardized beta of 0.840 from trustworthiness to consumer trust, 0.328 from consumer trust to continuance and .517 from trustworthiness to continuance. Thus, we find support for H1, H2 and H3.

Figure 4A: Main Effects Model	Figure 4B: Interaction Model
H1*: Trustworthiness → Consumer Trust H2*: Consumer Trust → Continuance H3*: Trustworthiness → Continuance	H4** Mediating effect of Consumer Trust H5***: Moderating effect (path d)
*significant at $p < 0.01$, **significant at $p < 0.05$, *** not significant	

Mediating Effects

In Figure 4B, we analyzed the mediating effect of consumer trust between trustworthiness and continuance intentions. In this regard, we applied Iacobucci and Dunhachek's (2003) simultaneous assessment of mediation effect, which ensures superior results to other existing methods (Helm et al. 2010). Before analysis, we adequately met up the criteria for mediation analysis as follows, first, the predictor (trustworthiness) has significant influence on the mediator (consumer trust) (H1). Second, the mediator (consumer trust) has significant influence on the criterion variable (continuance intentions) (H2). Third, the predictor (trustworthiness) has significant influence on the criterion variable in the absence of the mediators' influence (H3). Now, to establish the mediating effect, the indirect effect of $a \times b$ (see Fig. 4B) has to be significant. In this regard, we applied the z statistic (Sobel 1982) which is significant at $p < 0.05$. If the z-value exceeds 1.96 ($p < 0.05$), we can accept H4, that is, there is an indirect effect of trustworthiness through consumer trust on continuance intentions. The z value is formally defined as follows:

$$z = \frac{a \times b}{\sqrt{b^2 \times s_a^2 + a^2 \times s_b^2 + s_a^2 \times s_b^2}}$$

As shown in Figure 4A, there is a significant impact of trustworthiness on consumer trust (0.840, $p < 0.01$) as well as consumer trust on continuance intentions (0.328, $p < 0.01$) (see Appendix-1). Since there is also a significant, direct impact of trustworthiness on continuance intentions (0.517, $p < 0.01$), consumer trust is established as a partial mediator. This mediating effect of consumer trust is confirmed by z-statistic (Sobel 1982):

$$z = \frac{0.840 \times 0.328}{\sqrt{(0.328)^2 \times (0.0239)^2 + (0.840)^2 \times (0.0950)^2 + (0.0239)^2 \times (0.0950)^2}} = 3.45$$

The result supports the mediating effects of consumer trust (H4), which implies that it has an indirect influence on continuation intentions (see Fig. 4B). To estimate the size of the indirect effect, we used the VAF (Variance Accounted For) value which represents the ratio of the indirect effect to the total effect. The VAF value indicates that 34.8 % of the total effect of trustworthiness on continuance intentions is explained by indirect effect (consumer trust).

$$VAF = \frac{a \times b}{a \times b + c} = \frac{0.840 \times 0.328}{0.840 \times 0.328 + 0.517} = 0.348$$

Moderating Effects

In Figure 4B, we present the moderation analysis applying PLS product-indicator approach (Chin et al. 2003) to detect the moderating effect of trustworthiness on the relationship between consumer trust and continuance intentions. To test the possibility of such effect, consumer trust (predictor) and trustworthiness (moderator) were multiplied to create an interaction construct (consumer trust × trustworthiness) to predict continuance intentions (Chin et al. 2003; Henseler & Fassott, 2010). In this case, trustworthiness is a hierarchical construct which consists of 16 items and consumer trust is a simple latent construct consists of 4 items, thus, the interaction construct represents 64 items (16*4). The AVE and CR of this interaction variable are respectively 0.768 and 0.995, which exceed the minimum cut off value.

To test the moderating effect, we have estimated the influence of predictor on criterion variable (b), the direct impact of the moderating variable on the criterion variable (c) and the influence of interaction variable on criterion variable (d) (see Fig. 4B). The significance of a moderator can be confirmed if the interaction effect (path d) is meaningful, independently of the size of the path coefficients b and c (Henseler & Fassott, 2010). In this case, we have estimated a standardized path coefficient of -0.092 for the interaction construct (path d), which is not significant at $p < 0.05$ ($t = 1.96$). In estimating the significance of the interaction effect, we used two tailed test because there is a paucity of theoretical support whether trustworthiness enhances or diminishes the association between trust and continuance intentions (Helm et al. 2010). The effect size is calculated as follows:

$$f^2 = \frac{R_i^2 - R_m^2}{1 - R_i^2} = \frac{0.664 - 0.659}{1 - 0.664} = 0.015 \text{ (Here, } i = \text{interaction model, } m = \text{main effect model)}$$

The results show that the size of the moderating effect is small ($f^2 = 0.02$) (Cohen 1988) as well as the resulting beta changes are insignificant ($\beta = -0.092$, $t = 1.778$). Consequently, we confirm that trustworthiness does not moderate the relationship between trust and continuance intentions, and we reject H5 (see Fig. 4B).

Analysis of Global Fit Measures (GoF)

We conducted a global fit measure (GoF) for PLS path modeling which is defined as the geometric mean of the average communality and average R^2 (for endogenous constructs) (Tenenhaus et al. 2005). Following the guidelines of Wetzels et al. (2009), we estimated the GoF values which may serve as cutoff values for global validation of PLS models. In this study, we obtained a GoF value of 0.7803 for the complete (main effects) model, which exceeds the cut-off value of 0.36 for large effect sizes of R^2 . As such, it allows us to conclude that our model has better explaining power in comparison with the baseline values ($GoF_{small} = 0.1$, $GoF_{medium} = 0.25$, $GoF_{large} = 0.36$). It also provides adequate support to validate the PLS model globally (Wetzels et al. 2009).

$$GoF = \sqrt{AVE \times \overline{R^2}} = 0.7803$$

Discussion and Implications

This study has extended existing trustworthiness theory in the context of mHealth information services by capturing users' perception regarding ability, benevolence, integrity and predictability. It has successfully framed trustworthiness as a second order hierarchical construct, indicating that all four dimensions significantly reflect trustworthiness. Thus, it contributes theoretical support for Mayer et al.'s (1995), McKnight et al.'s (2002) and Serva et al.'s (2005) study, which has identified trustworthiness as a set of beliefs that lead to trusting attitude. However, the present study extends all these conceptualizations by adding '*predictability*' as a significant component of trustworthiness in the context of mHealth information service. We argue that trustworthiness is a context-dependent, multidimensional construct whose relevant significant dimensions depend on the circumstance of the interaction (Butler 1991; Gefen 2000; Lewis 1985). Thus, adding *predictability*, it has been demonstrated to what extent mHealth service providers behave reliably in delivering right time health information services to the consumer (Gefen & Straub 2004). Our results show that predictability is an important dimension in mHealth, because it ensures right time medical information services to the right person at the right place. Among all the dimensions of trustworthiness, ability ($\beta = 0.895$) is the most significant factor, followed by integrity (0.877), benevolence (0.854), and predictability (0.850) in mHealth domain. Ability, as a reflector of trustworthiness, plays

an important role in forming initial relationship with mHealth service providers. This finding is supported by Serva et al. (2005) and Gefen (2002), who believe that ability plays a critical role in experiencing new electronic services and establishing initial bondage. However, over time in more established contexts, ability is expected to become insignificant while integrity, benevolence and predictability will demonstrate strong reflections of trustworthiness. Though our results show differences in components in reflecting trustworthiness; however, we note that the differences in magnitudes were small.

Furthermore, this study has investigated the distinct role of trustworthiness, trust and continuance in a nomological network, which have not been distinguished adequately in the extant literature. Consistent with prior research, we have found that trustworthiness (beliefs) has a significant impact on consumer trust (attitude) ($\beta = 0.840$), which in turn influences continuance intentions ($\beta = 0.328$). In this relationship, 34.8% of the effect of trustworthiness on continuance is mediated by consumer trust. It implies that consumer trust, as a mediating attitude, plays a significant role in predicting behavioral intentions. However, Bhattacharjee and Sanford (2006) argued that attitudes (e.g., consumer trust) may not be the only mediating factor to influence an individual's intentions. They found that other beliefs might have influence on behavioral intentions. Aligned with these findings, we confirm that trustworthiness has a significant, direct impact on continuance intentions ($\beta = 0.517$) along with consumer trust ($\beta = 0.328$), and both these constructs explain 65.9% of variance in continuance intentions. Therefore, mHealth service providers need to boost up trusting beliefs (trustworthiness) in order to create both a direct and indirect impact (through trusting attitude) on continuance intentions. We have also explored the role of trustworthiness as a moderator for the trust-continuance link. However, our empirical evidence has not supported trustworthiness as a moderator. One plausible explanation is that, in case of the interaction effect, continuance intentions is more influenced by trusting attitude than trusting beliefs (Bhattacharjee 2001); therefore, moderation power of trustworthiness as a theory is less pronounced.

Another main objective of this study was to show evidence that PLS path modeling can be used to assess a hierarchical model with moderating and mediating effects. To address this objective, we have provided an empirical illustration by developing a second order hierarchical reflective model using data from a mHealth setting. Since PLS is considered better suited for explaining complex relationships (Chin 2010; Fornell and Bookstein, 1982), the

application of PLS path modeling to this scenario has made it possible to extend the theoretical contributions of this study. Using the approach of repeated indicators (Wold 1985) in estimating the higher-order latent variable, our study has confirmed adequate measurement & structural results for the research model. It shows that trustworthiness is a second order reflective construct which has a significant impact on consumer trust and continuance intentions in a hierarchical model. It also confirms that the hierarchical reflective model with moderating and mediating effects can easily be estimated using PLS path modeling. Thus, successful application of PLS in this context with moderation and mediation effects reflects Wold's view (1985, p. 589), *"PLS comes to the fore in larger models, when the importance shifts from individual variables and parameters to packages of variables and aggregate parameters."*

The study believes that it has made a substantial contribution to theory by developing a trustworthiness- based consumer decision making model which provides a holistic view of a consumer's (or, patient's) purchase decision making process, exploring the hierarchical trustworthiness construct and incorporating its effect on consumer trust, and assessing the impact of both these factors on intention to continue using mHealth services. Since prior studies have often not adequately distinguished between trustworthiness and consumer trust, or have not explored their relationships independently or in combination with each other on continuance intentions; thus, our study provides perhaps the most comprehensive understanding to date on trustworthiness based consumer decision making model in electronic services. Overall, this study provides a useful framework by clarifying the distinct role of trusting beliefs (trustworthiness), trusting attitude (consumer trust) and trusting behavior (continuance intentions) in the purchase experience of electronic services. We also believe that the study has extended theoretical contribution significantly by applying the research model to a new setting, that is, trustworthiness based consumer decision making in the context of an innovative IT artifact, that is, mHealth services. According to Whetten (1989) *"the common element in advancing theory development by applying it in new settings.....that is, new applications should improve the tool, not merely reaffirm its utility"*.

Although this paper is focused on theoretical reconceptualization and methodological validation, our findings have implications for mHealth practitioners in general. We have evaluated four trusting beliefs and rated their importance from consumers' perspectives (see Table 8). Our results show that all the four trusting beliefs are significant to

users; however, ability and integrity were relatively more important than others in facilitating continuance of mHealth services. It signifies that mHealth platform should have the necessary competence, skills and knowledge to provide the desired healthcare service. In addition, the importance of integrity refers to the adequate focus on quality of care to serve the patients. Overall, the second order view of trustworthiness highlights the need for mHealth practitioners to inform patients that they are trustworthy across all four dimensions. Because, failing to achieve one dimension may act as the foundation to deflate other dimensions.

Limitations & Future Research Directions

This study has some limitations that should be considered for future research. First, it was carried out within a specific domain of mHealth services (mobile telemedicine services) in a specific context (a developing country), so it is uncertain to generalize theoretical findings more broadly or, to other forms of mHealth applications. We assume that cultural values might influence the continuance of mHealth services across nations. Consequently, we expect that future research will integrate cultural dimensions as moderators to completely explore the dynamics of continuance behavior in various mHealth settings (Srite & Karhanna 2006, Luo et al. 2010). Second, typical limitations are associated with the research design because of the cross sectional nature of the study. For instance, there might be existence of common method variance (Straub et al. 1995). Thus, measurement reliability can be improved by applying longitudinal analysis among different adopter groups. Furthermore, we suggest mixed methodology for future research to explore powerful variables that might help explain better prediction power of the model. While the current research model explains 65.9% of the variance in continuance intentions, we expect to further improve the prediction power by incorporating additional constructs, such as, trusting disposition of an individual, perceived reputation and size of the provider. Finally, it would be useful for future research to compare the performance between component based SEM (PLS) and covariance based SEM in terms of hierarchical modeling with moderation and mediation effects under different research conditions, such as, number of manifest variables, sample size per latent variables, distributional properties of the manifest variables etc. These conditions would provide an avenue for linking design methodologies to their ultimate effects on the development of a hierarchical model with both formative and reflective constructs.

Conclusion

Though the extant literature has identified antecedents and conceptual linkages of trust, a comprehensive focus on the dimensions of trustworthiness and its effect on consumer decision making has been surprisingly absent from the IT literature. One of the key contributions of this study is the development of trustworthiness as a hierarchical, reflective construct which better predicts consumer trust and continuance intentions. The results support the proposed model and highlight the appropriateness of hierarchical trustworthiness construct in predicting an emerging IT artifact's (mHealth) continuance in a nomological network. Though proposed in the context of mHealth services, this model may be of interest to any ICT platform which deals with a vast network of customers to provide right time information services. We also hope that this research will serve as a catalyst for action in digital information markets by encouraging both researchers and practitioners to embrace trustworthiness based consumer decision making model as a core concept in electronic commerce.

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Appendix 1 (path coefficients and T-statistics)

Paths in the Research Model	Path Coefficients	Standard error	T-statistics
Consumer Trust -> Continuance	0.328	0.095010	3.452975
Trustworthiness -> Ability	0.895	0.018099	49.458713
Trustworthiness -> Benevolence	0.854	0.022721	37.598166
Trustworthiness -> continuance	0.517	0.086778	5.956263
Trustworthiness -> consumer trust	0.840	0.023955	35.045287
Trustworthiness -> Integrity	0.877	0.022871	38.348221
Trustworthiness -> Predictability	0.850	0.027357	31.087140
Trustworthiness * Consumer Trust -> Continuance	-0.092132	0.051717	1.778