

Acceptance Model for Biometric Based Health Informatics (BIOBHI)

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Abstract—The Kenya Health Information System (HIS) strategic plan 2009-2014 demand the health professional implement the HIS. This was with little to regard to stimulating attributes. The need to unearth these stimulants to adoption was the motivators of this study. User adoption is essentials in order to realise the benefits of the health Informatics, however a number of implementation barriers have impeded their widespread use. The health worker personality traits are some of the stimulants that have been found to influence the adoption of Information Technologies. One of these technologies is the use of biometric based health informatics. The aim of this paper was to develop a model that may be used to evaluate the personality traits and there influence on acceptance of new technologies. In attempting to meet this objective, survey questionnaire was distributed to 200 health worker trainees of level 5 hospitals in Nyanza, Kenya. Of these 163 were returned and used for analysis and development of the model. This study developed the model BIOBHI using structured Equation Model and LisRel Software.

Keywords—Biometric; Health Worker; Informatics; Personality Trait; Nyanza.

Abbreviations—Actual Usage (ACTUAL); Agreeableness (AGREEAB); ANalysis Of VAriance (ANOVA); Behavioural Intention to Use (BEHA); Biometric Based Health Informatics (BIOBHI); Conscientiousness (CONSC); Extraversion (EXTRAV); Multivariate ANalysis Of VAriance (MANOVA); Neuroticism (NEURO); Openness to Change (OPEN); Perceived Ease Of Use (PEOU); Perceived Usefulness (PUSEFUL); Positive ATTitude (PATT).

I. INTRODUCTION

THE personality traits of health workers together with how and to what extent they intended to use the biometric-based health informatics was examined. This was motivated by 1) most great research has been conducted in developed countries but limited number of studies have focused on acceptance of technology in developing countries especially, Kenya. 2) Among the well-known models of technology acceptance have some inconsistency for example on the external variable to the model. 3) the model of technology acceptance that have been developed, modelled and extended in developed countries have not been used in developing countries like Kenya and 4) no published model of technology acceptance focused on personality trait on usage of biometric based health informatics. There are important questions associated with determining the reasons behind their usage behaviour, intention and actual usage. The objective of this study was to investigate what significant determinants influenced health workers' acceptance of health informatics. These determinants (personality traits) are expected to play important roles in explaining health worker behaviours on use of technology.

Structural Equation Modelling (SEM) was used to analyse the hypothesized causal relationships by Napaporn (2007) when examining the technology acceptance model of internet usage by academics within Thai Business School. SEM was a comprehensive analysis method. The SEM can be used to model interactions, correlations between independent variables, measurement errors and their correlations. Also SEM can be used to determine the relationship between multiple latent independent and dependent variables [Morton, 2008; Werner, 2010].

This study set out to make contribution to the body of knowledge: 1) It provides a clear description of relevant aspects about health workers in level 5 hospitals in Nyanza, Kenya. 2) It provides a relatively clear description and understanding of models and theories of technology acceptance that has been synthesized from theoretical and practical viewpoints. 3) It provides the overall picture and details of biometric based health informatics implementations in level 5 hospitals in Nyanza, Kenya. 4) It illustrates the effects of some personality traits as independent variables along with Moderators (perceived usefulness and perceived ease of use) on the influence of key determinants toward usage biometric based health informatics

II. LINE OF ATTACK FOR THE STUDY

In this study the impact of moderators on the generated model was investigated. This study also examined if conscientiousness, openness, extraversion, neuroticism and agreeableness impacted on dependent variables toward acceptance of biometric based health informatics. This study adopted survey questionnaire. These fundamental relationships has been superlatively analysed by Structural Equation Modelling (SEM). Due to this, SEM was used to analyse the data and helped to generate the models using LISREL software. According to Warner (2010) the use of LISREL provides users with powerful and easy-to-use software. The LISREL also created more realistic models than using standard multivariate statistics or multiple regression models alone. By using LISREL, users can specify, estimate, assess, and present the model in an intuitive path diagram to show anticipated relationships among variables.

III. RESULT INTERPRETATION, AND MODEL DEVELOPMENT

3.1. Constructs Reliability

Reliability is the consistency of measurements (Kothari, 2009). It refers to the consistency or dependability of a measuring the technique. Construct reliability measures the internal consistency of a set of measures rather than the reliability of a single variable. It captures the degree to which a set of measures indicate the common latent construct. Researchers use three methods to estimate the reliability of their measures: test-retest reliability, inter-item reliability, and inter-rater reliability. All these three methods are based on the same general logic. To the extent that two measurements of the same behaviour, object, or event yield similar scores, we can assume that both measurements are tapping into the same true score.

In this study, the SMC (Table 1) was used to measure the construct reliability. The SMC was referred to an item reliability coefficient. It was the correlation between a single indicator variable and the construct it measures. The SMC for an observed variable is the square of the indicator's standardised loading. The SMC of a good observed variable should exceed 0.50 although a SMC of 0.30 indicates an acceptable indicator variable.

Table 1: Squared Multiple Correlations of 10 Indicators of Latent Constructs

Latent Constructs	Squared Multiple Correlation (SMC)
Scale Agreeableness	0.186
Scale Neuroticism	0.429
Scale Conscientiousness	0.733
Scale Openness	0.546
Scale Extraversion	0.280
Behavioural	0.536
Actual usage	0.421
Positive attitude	0.286
Pdeaseofuse	0.263
Pdusefulness	0.662

The latent constructs considered for this study were ten. Of this five were independent constructs, three dependent constructs and two moderating constructs. Two of the independent constructs (scale conscientiousness (0.733), and scale openness (0.546)) have SMC that exceed 0.5. Also one dependent construct (behaviour (0.536)) and one moderating construct (usefulness (0.662)) both had SMC exceeding 0.5.

3.2. Discriminant Validity

Validity is the accuracy of a measure, and exists when the measure is a perfect representation of the variable intended to measure [Kothari, 2009]. Discriminant function analysis is one of the statistical techniques. It works with data that is already classified into groups to derive rules for classifying new (and as yet unclassified) individuals on the basis of their observed variable values. The most well-known of this technique is Fisher's linear discriminant function analysis. Discriminant validity reflects the extent to which the constructs in a model are different. It is very important to assess this validity where the constructs are interrelated. Large correlations between latent constructs (greater than 0.80 or 0.90) suggest a lack of discriminant validity.

3.3. Constructs of Research Framework

The research framework comprised nine latent constructs (five independent, two mediating and three dependent variables). A latent construct cannot be measured directly but can be represented or measured by one or more variables (indicators). An observed (measured) variable is a specific item or question, obtained either from respondents in response to questions in a questionnaire or from some type of observation. Measured variables are used as the indicators of latent constructs. In other words, indicators are associated with each latent construct and are specified by the researcher [Napaporn, 2007].

In this study, the consideration of what items belongs to a specific latent construct was based on the literature reviewed. Each construct comprises at least four items (indicator/observed variables) and no more than five items. For example Extraversion latent construct (EXTRAV) consist of five items (talkative, energetic, enthusiasm, assertive and outgoing. These ten constructs were measured by a total of 40 items, 25 items for independent constructs and 15 items for dependent variables.

3.4. Structured Equation Model (SEM) Analyses

The Structured Equation Model (SEM) is considered to be a second generation data analysis technique, although based upon general linear statistical models, it differs from first generation techniques, such as linear regression, logistic regression, multiple regression, factor analysis, ANalysis Of VAriance (ANOVA), and Multivariate ANalysis Of VAriance (MANOVA), in several ways [Morton, 2008]. While first generation techniques are limited to examining a single relationship at a time between independent and dependent variables, SEM can analyse all of the relationships in one procedure. Strength of SEM is its ability to measure indirect effects of variables through other (mediating) variables. First generation statistical approaches are simply

capable of determining whether or not a set of independent variables has an influence on dependent variable. SEM is a confirmatory, rather than exploratory approach, so is based upon theory.

The proposed conceptual path model is shown in figure 1 shows that latent variables are represented with ovals and hypothesized causal relationships are illustrated with straight, directional arrows.

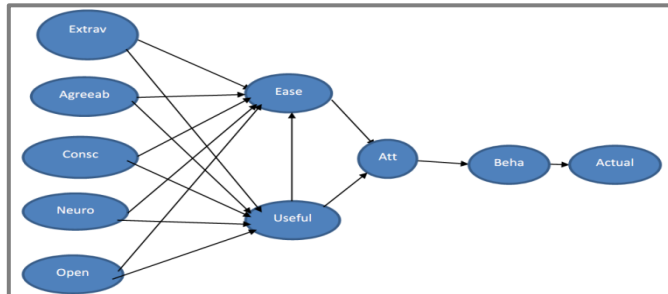


Figure 1: Proposed Conceptual Path Model

The latent independent variables include:

- EXTRAVERSION (EXTRAV)
- AGREEABLENESS (AGREEAB)
- CONSCIENTIOUSNESS (CONSC)
- NEUROTICISM (NEURO)
- OPENNESS TO CHANGE (OPEN)

The latent mediating variables used for this study include:

- PERCIEVED EASE OF USE (PEOU)
- PERCIEVED USEFULNESS (PUSEFUL)

The latent dependent variables used for this study include:

- POSITIVE ATTITUDE (PATT)
- BEHAVIOURAL INTENTION TO USE (BEHA)
- ACTUAL USAGE (ACTUAL)

As shown on figure 23 the personality traits (EXTRAV, AGREEAB, CONSC, NEURO and OPEN) directly affect PATT, BEHA, and ACTUAL mediated by PEOU and PUSEF.

SEM was used to analyse the hypothesized causal relationships. SEM is a comprehensive analysis method that can model interactions, correlations between independent variables, measurement errors and their correlations, as well as multiple latent independent and dependent variables [Napaporn, 2007]. A latent variable is an unobserved construct composed of multiple survey items, or indicators [Raafat et al., 2007; Morton, 2008]. The proposed model is complex and incorporates mediating variables; hence, SEM can be used to analyse all of the proposed relationships in one comprehensive step, while reducing the possibility for specification error.

IV. MODEL DEVELOPMENT

4.1. Model Estimation

The model under study entailed ten latent variables with 40 elements. These variables were modelled using LISREL software. The first independent latent variables and moderating variables to be modelled was the CONSC and

PEOU with chi-square of 0.33. The study by Hsiow et al., (2011) summarised the personality traits as Extraversion implies an energetic approach to the social and material world and includes traits such as sociability, activity, assertiveness, and positive emotionality. Agreeableness contrasts a pro-social and communal orientation toward others with antagonism and includes traits such as altruism, tender-mindedness, trust, and modest. Conscientiousness describes socially prescribed impulse control that facilitates task- and goal-directed behaviour, such as thinking before acting, delaying gratification, following norms and rules, and planning, organizing, and prioritizing task (Emotional Stability describes even-temperedness and contrasts) with negative emotionality, such as feeling anxious, nervous, sad, and tense. Openness describes the breadth, depth, originality, and complexity of an individual's mental and experiential life.

High levels of conscientiousness should be related to more positive attitudes toward biometric based systems. However, the desire for achievement that is characteristic of high levels of conscientiousness might result in concern over being constantly monitored by others, while those scoring lower on conscientiousness might not be concerned with having their actions monitored [Zweig & Wester, 2013].

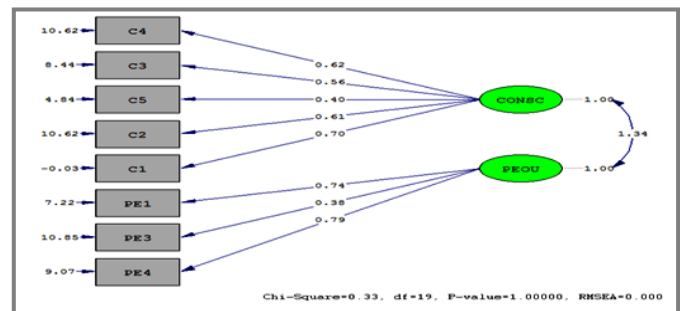


Figure 3: CONSC and PEOU Factor Covariance Model

According Sumner et al., (2011) conscientiousness was significantly positively correlated with dictionary words ($r(527)=0.129$, $p=0.003$), suggesting that the more conscientious a person is, the more likely they are to use properly spelled words, as opposed to misspellings or text speak. This argument is shared with Jian (2013) who argued that it is quite intuitive to conjecture that individuals high in conscientiousness, given their careful, responsible, and self-disciplined nature, are less likely to engage in excessive technology use while ignoring obligations and responsibilities in their work and life.

The second independent latent and moderating variables to be modelled (Figure 3) were AGREEAB and PEOU. According to Zweig & Wester (2003) people who score higher on measures of agreeableness (for example non-competitive, cooperative and hopeful) might be more favourably disposed toward monitoring technologies that purport to enhance communication and cooperation with colleagues; thus, the links between attitudes toward the technology and other variables might differ as compared with their counterparts who score lower on agreeableness.

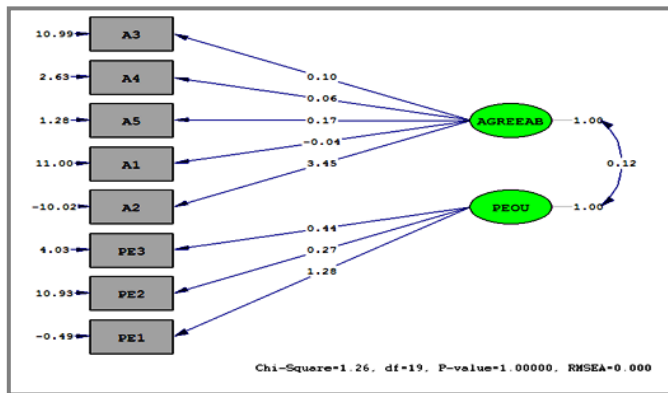


Figure 4: AGREAB and PEOU Factor Covariance Model

According to Sumner et al., (2011) Agreeableness was significantly positively associated with the number of words per sentence ($r(527) = 0.138, p = 0.002$), suggesting that the more agreeable a person is, the longer their sentences are, however, agreeableness is also significantly positively correlated with non-fluencies such as 'er', 'hmmm' and 'um' ($r(527) = 0.097, p = 0.026$), so perhaps the long sentences could be explained by these filler-type words. Agreeableness was also significantly positively correlated with positive emotion words, such as 'love', 'nice' and 'sweet'. Similarly Rosen & Kluemper (2008) concluded that agreeableness is positively associated with the perceived usefulness of social networking technology [Jahangir & Begum, 2008].

The next independent latent and mediating variables that were modelled (Figure 5) were CONSC and PUSEF with chi-square of 0.37.

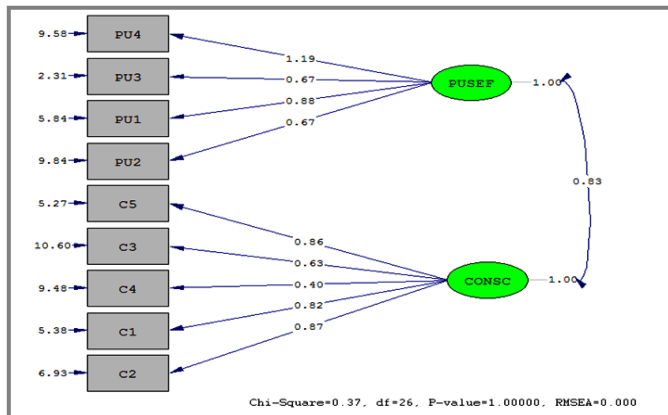


Figure 5: CONSC and PUSEF Factor Covariance Model

According to Hsiou (2011) personalities with conscientiousness, agreeableness and emotional stability have a significant impact on information sharing. It implies these three types of personalities tend to show a higher degree of knowledge sharing. Health workers who are conscientiousness tend to perform better on school and work-related tasks. Conscientiousness individuals are rule followers, and persistent, thus are hypothesized to be better able to follow directions and find that the health informatics is easier to use than their non-conscientious peers. Rosen & Kluemper (2008) argued that Conscientiousness is positively associated with the perceived ease of use of health informatics.

The next latent and mediating variables that were modelled (Figure 6) were PEOU and PUSEF with chi-square of 0.31. One of the two major constructs in TAM, perceived ease of use is often studied in technology acceptance constructs. Defined as the degree to which a person believes that using particular system would be free of effort, it has been positively associated with perceived usefulness and behavioural intentions to use technology in hundreds of studies [Rosen & Kluemper, 2008].

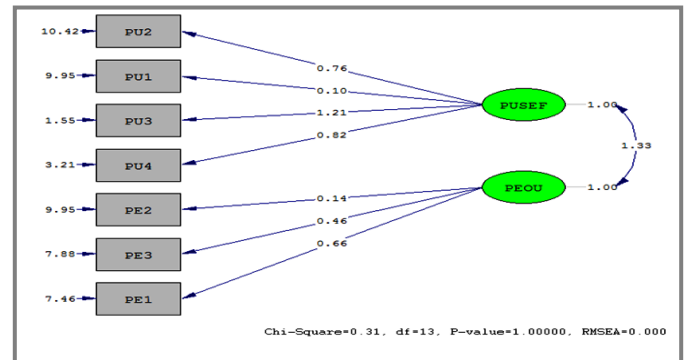


Figure 6: PUSEFPEOU Covariance Factor Analysis Model

The perceived ease of use is hypothesised to have a significant direct effect on perceived usefulness [Davis, 1991]. Between two systems that perform the identical set of finding, a user should find the one that is easier to use more use more useful. According Ethel & Maread (2003) advances in technology developments can improve service offerings, increase service efficiency, and provide functional benefits for customers. ICTs can enable consumers to enjoy the services they require with a more flexible choice of time and space. Which should provide a higher degree of satisfaction? However, there is also growing evidence of increasing customer frustration when dealing with technology-based systems, with some consumers becoming more alienated due to increasing complexity when using these systems.

According to Maarten et al., (2010) and Stefan (2008) three of these effects emerged as positive and significant predictors of friendship ties: Agreeableness, Extraversion, and Openness. In other words, individuals tend to select friends with similar levels of Openness, Agreeableness, and Extraversion. The next dependent latent and mediating variables that were modelled were PEOU and PATT with chi-square of 0.24.

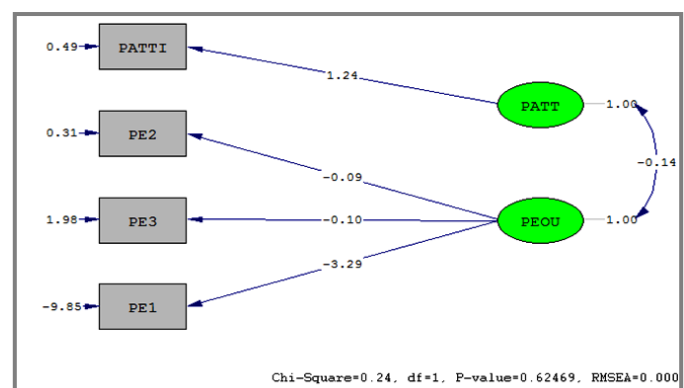


Figure 7: PEOUPATT Covariance Factor Analysis

The hypothesised conceptual path model (Figure 1 Proposed Conceptual Path Model) showed that there existed a direct relationship between the personality traits and mediating variables. The mediating variables (USEFUL) had direct relationship with mediating variable (EASE). The variable USEFUL and EASE were hypothesised to have direct relationship with dependent variable ATT and had direct relationship with BEHA that in turn had direct relationship with ACTUAL. When the conceptual path model was analysed using LISREL software, some of the hypothesised relationships were proved to converge while others not converging. Those latent variables whose path model failed to converge (Table 3) were excluded from the final model.

Table 3: Hypothesised Path Model that didn't Converge

Relationships	
EXTRAV $\leftrightarrow$ PEOU	EXTRA $\leftrightarrow$ PUSEF
AGREEAB $\leftrightarrow$ PEOU	NEURO $\leftrightarrow$ PUSEF
BEHA $\leftrightarrow$ PEOU	BEHA $\leftrightarrow$ PUSEF
OPEN $\leftrightarrow$ PEOU	ACTUAL $\leftrightarrow$ PUSEF
NEURO $\leftrightarrow$ PEOU	BEHA $\leftrightarrow$ PATT
ACTUAL $\leftrightarrow$ PEOU	ACTUAL $\leftrightarrow$ ACTUAL
AGREEAB $\leftrightarrow$ PUSEF	BEHA $\leftrightarrow$ ACTUAL
PATT $\leftrightarrow$ PUSEF	OPEN $\leftrightarrow$ PUSEF

The final model that was developed included two independent variables (CONSC and AGREEAB) and three dependent variables (PUSEF, PEOU and PATT). This model illustrates the relationship between personality traits and technology acceptance of biometric based health informatics. The model was called Biometric Based Health Informatics Acceptance (BIOBHIA) model as shown in figure 8.

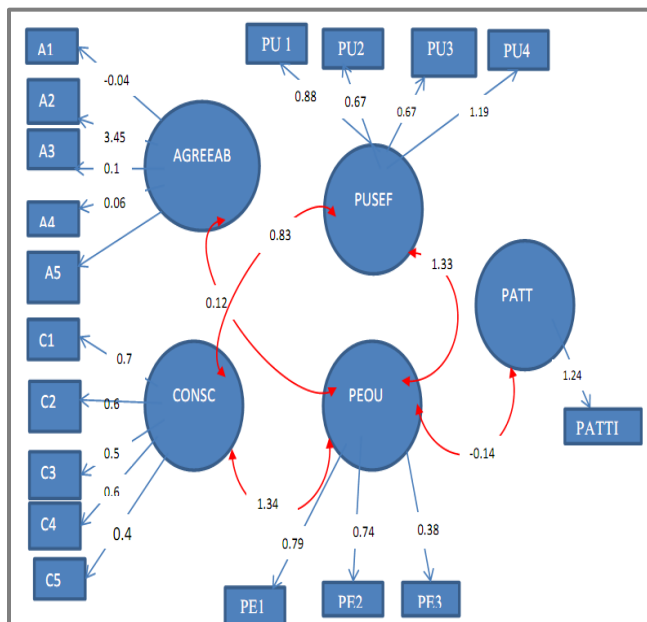


Figure 8: Biometric Based Health Informatics Acceptance (BIOBHIA) Model

According to the TAM, perceived usefulness is the degree to which a person believes that using a particular system would enhance his or her job performance. According to Davis (1991), perceived usefulness refers to consumers'

perceptions regarding the outcome of the experience, the individual's perception that using the new technology will enhance or improve her/his performance and/or the extent to which a person deems a particular system to boost his or her job. Perceived ease of use is a measure of quality [Irwin, 2002].

From the research done by Shim & Viswa (2007) the results suggested that generic system features such as those of data entry and hardware have effects on PEOU, while application-specific system features such as those of reports on call activities and inventory have effects on PU. Based upon these results, we may posit that PEOU is more likely to be influenced by generic system features, whereas PU is more likely to be influenced by application-specific system features. However this posit need to be tested in a broad context in order to provide more generalizable implications. The technology acceptance model will be useful because it is perceived by the user to be easy. Therefore, it stands to reason that a higher ease of use score will be positively correlated with a higher usefulness score.

4.2. Research Implication

From a theoretical perspective, the Biometric Based Health Informatics (BIOBHI) Model provides an understanding about the relationships of determinants and personality traits and refines the view of how personality traits relate to health workers in the cross-sectional study. Health workers acceptance and ethical was significantly influenced by the ease of use and usefulness of the health informatics systems. The easier and the more useful the technology the more acceptable it is and this affects the ethical usage.

The methodology used in this research provides guidelines for further research in this area of study. This is especially the case in the Kisii and New Nyanza Level 5 hospitals in Kenya. This included the approach of surveying individual health professionals in level 5 Hospitals; questionnaire design; testing of discriminant validity using SEM analysis with LISREL; and analysis of the proposed research model using SEM with LISREL.

V. SUMMARY

The health worker trainees had traits that determined their personality. These personality traits are generally grouped into five categories (conscientiousness, openness, extraversion, neuroticism and agreeableness). These categories also have different elements that is subject to individual health worker can be used to describe his or her personality trait.

These personality traits of the health professionals were found to influence acceptance or rejection of technology implementation especially at Kisii and New Nyanza L5 hospitals in Kenya. For example one of the technologies that are being implemented in healthcare institutions was the biometric based health informatics. However its acceptance by the health professional is among the current researches being done by both psychologist and health informatics.

The structured equation modelling was used to analyse the hypothesised relationships using LISREL software. Before the relationships were analysed, the reliability of the scaled latent variable was determined using the squared multiple correlation. The discriminant validity was also analysed to determine the accuracy of the measures and how different the constructs are.

This research considered nine latent constructs, whose indicators and specific question on the questionnaire and code. All the hypothesised conceptual path model relationships were analysed using LISREL software. It was found out that some path model converged and others didn't. Those path models that didn't converge were excluded from the final model. The latent variables, whose path model converged included CONSC, AGREEAB, PEOU, PUSEF, and PATT. The model developed using these latent variables were the Biometric Based Health Informatics Acceptance (BIOBHIA) Model. The operation and description of the model is discussed here in the next.

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