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Measurement invariance of the UTAUT constructs in the Caribbean

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ABSTRACT

This article employs confirmatory factor analysis to evaluate the factorial validity and the cross-national comparability of the UTAUT constructs with respect to mobile learning in higher education in four Caribbean countries. Except for the measurement of one factor, the UTAUT constructs exhibit adequate reliability and validity. Though full metric invariance is not achieved, cross-national comparisons of the regression relationships among the factors are still possible. In addition, non-invariant item intercepts also affect the comparisons of the factor means. Partial scalar invariance is required.

Keywords: *UTAUT, measurement invariance, Caribbean, mobile learning, technology adoption, higher education*

INTRODUCTION

The increasing use of technology in higher education leads to the increasing importance of educational technology acceptance. This is relevant to the Caribbean region where the use of e-learning systems is accompanied by numerous challenges (Waldron 2009). It is important to identify the variables that influence user acceptance as this can help in ensuring successful delivery of education. In this regard, the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003) identifies some important factors. The UTAUT model is based on the Theory of Reasoned Action (TRA) (Fishbein & Ajzen 1975), and it incorporates components of several other models inclusive of the Technology Acceptance Model (TAM) (Davis 1989) and the modified Technology Acceptance Model (TAM2) (Venkatesh & Davis 2000). The UTAUT model has become popular in technology acceptance studies, but such studies focus overwhelmingly on Western (Schepers & Wetzels 2007; Traxler 2007) and Asian countries. The appropriateness of the measurements in these contexts does not guaranteed their validity in the Caribbean region. Furthermore, the Caribbean may themselves differ in their experience with mobile technology and such differences can affect measurement comparability (Li & Kishore 2006). Both the validity and cross-national comparability of the measurements therefore need to be demonstrated rather than assumed.

This paper investigates the validity and comparability of the UTAUT constructs across four Caribbean territories. The constructs are evaluated in the context of mobile learning in higher education. Many definitions of mobile learning are currently in use. However, mobile learning is essentially learning with the aid of mobile technologies. This can occur at anytime and anywhere via mobile devices (El-Hussein & Cronje 2010). This ubiquitous element of mobile learning sets it apart from e-learning in general. Mobile devices are distinct from more traditional technologies such as a computer which requires either a fixed position (desktop) from which access to the internet can be obtained or which facilitates access only at hotspots or other specific areas (laptop) (Jeng et al. 2010). Mobile devices include for example mobile phone, tablets and others which facilitate internet access from anywhere and therefore facilitates more flexibility (El-Hussein & Cronje 2010; Hlodan 2010). In addition to providing new evidence which can guide the use of the UTAUT model in mobile learning adoption in the region, this paper provides results that are relevant to the study of technology adoption in general. They aid determination of the generalizability of the UTAUT measurements outside of the frequently studied contexts and add to the evidence about the cross-national comparability of the measures.

THE UTAUT MODEL

The UTAUT factors are Performance Expectancy (PE), Effort Expectancy (EE), Social Factors (SF), Facilitating Conditions (FC), Behavioural Intention (BI) and Use Behaviour (UB) (Venkatesh et al. 2003). PE is the extent to which the individuals believe that the technologies improve their performance. EE is the perceived ease of use. SF is the degree to which the respondents believe that significant persons in their lives think that they should use the technologies. FC is the respondents' beliefs about the extent to which organisational and technical infrastructure to support the use of the technologies exist. BI is the behavioural intention to use the technologies. UB measures the intensity of use. Given the engagement in mobile learning in the Caribbean is voluntary, measuring UB in relation to mobile learning is difficult. As such, UB is not evaluated in this paper.

The items included in the UTAUT instrument are usually adapted for the specific research domain; for example, acceptance of information systems, virtual learning environment, mobile learning in higher education acceptance and use of IT (Al-Gahtani et al. 2007; Bandyopadhyay & Fraccastoro 2007; Cheon et al. 2012; Jairak et al. 2009; Nassuora 2012; Teo 2011; Van Raaij & Schepers 2008; Wang & Shih 2009; Tibenderana et al. 2010; Attuquayefio & Addo 2014). Modifications of the items are made in this study to ensure that the content is applicable to mobile learning (see Table 1).

***Table 1:** Measurement of the UTAUT Constructs*

Construct	Code	Item
PE	PE1	Mobile Technologies are useful in education in general.
	PE2	Using mobile technologies enable students to accomplish tasks more quickly.
	PE3	Mobile technologies would improve students' performance.
	PE4	Mobile technologies would increase students' productivity.
EE	EE1	Mobile technologies are easy to use.
	EE2	Finding or using features in mobile technologies is easy.
	EE3	Learning to operate mobile technologies is easy.
SF	SF1	People who influence my behaviour think that I should use mobile technologies.
	SF2	People who are important to me think that I should use mobile technologies for learning.
	SF3	University teachers are supportive of the use of mobile technologies.
FC	FC1	In general, my University campus has support for mobile learning.
	FC2	I have the resources necessary to use m-Learning.
	FC3	I have the knowledge necessary to use m-Learning.
	FC4	Support from an individual or service is available when problems are encountered with m-Learning technologies.
BI	BI1	I intend to use m-Learning technologies in the next semester.
	BI2	I predict I will use m-Learning technologies in my courses in the next semester.
	BI3	I have a plan to use m-Learning technologies in the near future.

- Scale labels: 1 – Strongly disagree , 2 – Disagree, 3 – Neither Agree nor Disagree, 4 – Agree, 5 – Strongly Agree.
- In the items, m-Learning refers to mobile learning.
- Mobile learning, mobile technologies and the other terms used in the items were defined for the participants at the beginning of the survey and the definitions were repeated at intervals throughout the questionnaire. M-Learning means mobile learning.

In the UTAUT model, PE, EE and SF along with their interactions (in some cases) with age, gender, experience and voluntariness of use explain BI, while BI and SF explain UB (see Figure 1) (Venkatesh et al. 2003). Venkatesh et al. (2003) indicates that the model explains approximately 70% of the variance in BI. However, such a high proportion of explained variance is not usually found in other studies. Some studies have reported explained variances as low as 35% to 45% (Thomas et al. 2013; Teo 2011), but others have reported larger explained variances in the range 50% to 65% (Tibenderana et al. 2010; Al-Gahtani et al. 2007). Nevertheless, the validity and reliability of the UTAUT measurements and the utility of the model in explaining BI are widely acknowledged.

The literature on the UTAUT model includes investigations of measurement comparability. In some cases, the cross-national/cross-cultural comparability is considered (Im et al. 2011; Kang et al. 2011; Oshlyansky et al. 2007) whereas in others, measurement comparability between other groups is investigated (Li & Kishore 2006). Oshlyansky et al. (2007) show that the UTAUT items measure the same factors in several Western and non-Western countries; however, the level of comparability demonstrated (configural invariance: discussed subsequently) is not enough to permit direct comparisons of regression relationships or factor means. Kang et al. (2011) and Im et al. (2011) investigate the comparability of the UTAUT measures in greater detail between the United States and Korea and find instances of a lack of measurement comparability leading to biased regression relationships. Li and Kishore (2006) focus on groups defined in various ways; for example, gender and experience and they also find instances of measurement incomparability.

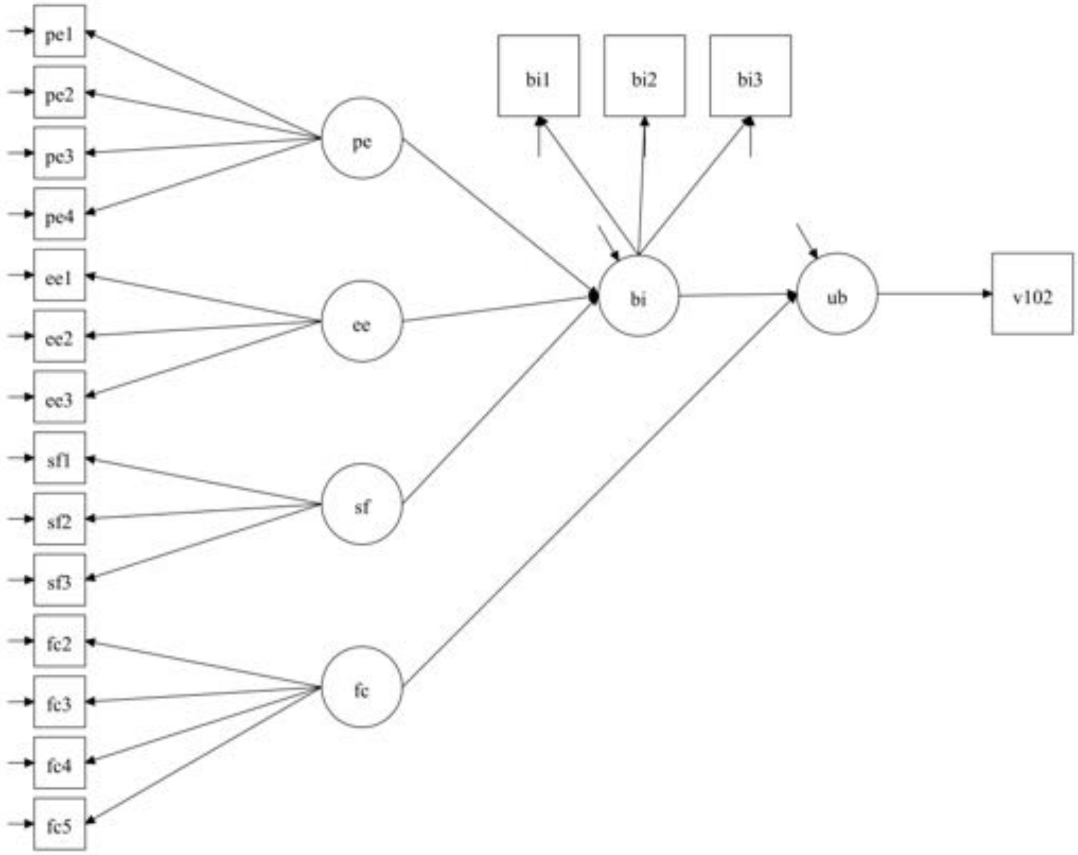

Figure 1: *Conceptual UTAUT Model*

Cross-national comparisons are often regarded as cross-cultural comparisons especially when countries which are known to differ culturally are included. This can be said of the comparisons between the United Stated and Korea (Im et al. 2011). Culture is known to affect measurements differentially and it is therefore not surprising that there are violations of comparability between such groups (Van de Vijver & Poortinga 1997). Even when the groups are not defined by culture, comparability of the UTAUT measures is not guaranteed (Li & Kishore 2006). This underscores the need for demonstrations of the absence of such measurement violations before substantive measures such as regression relationships and factor means are compared.

In this paper, the validity and cross-national comparability of the UTAUT constructs are evaluated with respect to mobile learning in the Caribbean region. In the region, mobile learning has not yet been formally adopted by universities. As such, the use of mobile technologies for education is a voluntary undertaking by both the students and the teachers. In spite of this, there is evidence to suggest that mobile learning is in use. Research on e-learning, technology and mobile learning adoption in the Caribbean region is ongoing and researchers have documented such evidence in various territories; for example, in Barbados (Gay et al. 2006), Guyana (Gaffar et al. 2011; Thomas et al. 2013), Jamaica (Reid & Levi 2008) and Trinidad and Tobago (Kalloo & Mohan 2011; Sultan & Mohan 2009). In addition, Figaro-Henry et al. (2011) note that facilitators and students are willing to embrace the use of mobile technologies for learning in the region. However, we know of only one study that provides an evaluation of the UTAUT factors. This evaluation is done with data from Guyana and the measurements appear to be valid (Thomas et al. 2013). However, this is one territory and in spite of the fact that the UTAUT model is based on several technology adoption theories and that it has been evaluated in many countries, it is still important to establish the validity of the measurements before the model is applied in a new context. Given the almost absence of evaluations of the model, the Caribbean region qualifies as a new context. Furthermore, given the evidence of violations of measurement comparability elsewhere, an evaluation of comparability in the Caribbean region where studies on technology adoption are emerging, is also an important contribution.

CROSS-NATIONAL COMPARISONS

Cross-national and group comparisons in general, assume the absence of bias and hence, the preservation of the psychometric properties or scales across the groups (Chen 2008; Meredith 1993; Schmitt & Kuljanin 2008; Vandenberg & Lance 2000; Van de Vijver & Poortinga 1997). There are three main types of bias – construct, method and item bias – that affect group comparisons (Van de Vijver & Leung 1997). This article focuses mainly on construct and item bias which result from the survey items used (Van de Vijver & Tanzer 2004) and which affects measurement comparability.

Construct bias means that the constructs measured by the items are not the same in all the groups. This is caused by several issues among which are differential appropriateness of the content of the items and incomplete overlap in the definitions of the constructs across the groups (Van de Vijver & Leung 1997). Item bias refers to measurement artefacts at the item level (Van de Vijver & Leung 1997). Item bias alos has several sources and they include incidental differences in the content of the items, poor translation and poor item formulation (Van de Vijver & Tanzer 2004). Construct and item bias may occur even when the same items are used with the same wordings due to differences in the frame of reference of the groups. These two types of bias can be detected to a large extent by evaluations of measurement invariance (MI).

MEASUREMENT INVARIANCE

MI implies independence of the observed item scores from group membership (Meredith 1993; Millsap 1995). Hence, with MI achieved, individuals with the same true standing on a construct have the same observed scores (Schmitt & Kuljanin 2008). If this does not hold, group and cross-national (group) comparisons are invalidated (Byrne & Watkins 2003; Van de Vijver & Tanzer 2004). The demonstration of MI is therefore necessitous to cross-national (and group) comparisons (Cheung & Rensvold 1999).

MI tests form a hierarchy in which the lower levels are less restrictive and are prerequisite to the higher levels. The first recommended MI test is an omnibus test of equality of the between-group variance-covariance matrix (Joreskog 1971). If this test lacks significance, the data from the different groups may immediately be pooled since there will be no group differences (Joreskog 1971; Schmitt & Kuljanin 2008; Vandenberg & Lance 2000). However, most researchers begin with the test for configural invariance instead of the very stringent omnibus test. In fact, the three levels of MI that are most often useful in group comparisons are configural, metric and scalar invariance (Van de Vijver & Leung 1997). These three level of MI are investigated in this paper.

Configural invariance is the lowest level of MI and it focuses on the basic form of the model. It asserts that an equal number of factors is formed in each group (Horn & McCardle 1992; Joreskog 1971) and that there is a fixed pattern of salient and non-salient factor loadings (Steenkamp & Baumgartner 1998). Although it is required for the other levels of MI, configural invariance is insufficient for group comparisons of factor means, regression and other structural relationships which are often the focus of research. Configural invariance is affected by construct bias (Van de Vijver & Leung 1997).

The next level MI is metric invariance which indicates that the measurement units (or interpretation of the items) are preserved across the groups. This is evaluated by imposing between-group equality constraints on the respective factor loadings (Dimitrov 2010). Metric invariance permits group comparisons of the structural relationships (factor variances, covariances and regression effects) among the factors, but not of the factor intercepts (means) (Dimitrov 2010). Metric invariance is affected by method and construct bias (Van de Vijver & Leung 1997). Comparisons of factor intercepts require scalar invariance which in turn requires between-group equality of the item intercepts in addition to metric invariance (Schmitt & Kuljanin 2008; Vandenberg & Lance 2000). Scalar invariance indicates that the basic item levels are equal across the groups and it is affected by construct, method and item bias (Van de Vijver & Leung 1997).

The described MI procedure implies full invariance at each step, but this does not always happen in practice. One or more items may show non-invariance and the restrictions on such items may be relaxed leading to partial invariance. For partial invariance, at least two items must be invariant – the reference indicator and one other item (Cheung & Rensvold 1999). Under partial invariance, the freed items do not contribute to the group comparisons (Byrne et al. 1989). When the bias is severe and when several items are biased, partial invariance can result in substantial changes in the meaning of the construct (Millsap & Kwok 2004). As such, it should be applied with caution and the modifications to the measurement of the constructs should be taken into consideration when the results are interpreted.

THE CARIBBEAN CONTEXT

The Caribbean region consists of developing countries that differ with respect to several variables including human development and tertiary level education (See Table 2, for information about the four territories under study.). The most recent United Nations Human Development Report identifies Latin America and the Caribbean as the most unequal region in human development globally (United Nations Development Programme 2013). For example, whereas Barbados, Jamaica, and Trinidad and Tobago have achieved the CARICOM's target 15% participation rate for tertiary education that was set in 2002, most other countries, including Guyana, have not (Tewarie 2009). The ICT rankings of the territories are also markedly different (Table 1) and there are large variations in their ICT development index[1]. Barbados and Trinidad and Tobago tend to outperform Jamaica and Guyana with Barbados being among the highest ranked countries in the world whereas Guyana is ranked quite low (International Telecommunication Union 2013). There are also large between-territory differences in the percentage of individuals that use the Internet. Apart from the need for evaluations of the UTAUT measures due to the relative novelty of the model in the Caribbean, the heterogeneity of the territories may affect the measurements.

Differences in tertiary education levels can indicate differences in ICT adoption and development (Lee 2001). Combined with the disparities in the ICT development and rankings, these realities support the view that the local conditions may create differences in experience with technology

[1] The ITU, ICT development index is a summary measure of 10 indicators which evaluate ICT access, usage and skills within a country. The scale of the index ranges from 1 to 10 and the values may be used to compare countries. The ITU, ICT rankings give the rank position compared to the other countries based on the development index (International Telecommunication Union 2013).

across the Caribbean territories. Differences in experience can in turn lead to a lack of comparability of the UTAUT constructs. In particular, experience is shown to limit the comparability of the UTAUT effort expectancy and facilitating conditions measures (Li & Kishore 2006). Experience with mobile technology can affect the frame of reference of the population leading to both construct and item bias. As a consequence, the meaning of some of the items and their average levels can vary even though the same items are administered with the same wording. We do not anticipate, that construct bias will play a major role, but we expect that item bias affects the measurements. As such, it is more likely that violations of scalar invariance will occur than violations of metric invariance.

Table 2: *Country Variables*

Country	Population Size#	Gross Enrolment Ratio (Tertiary, 2011)+	UNDP Human Development Index Rank+	Percentage of Individuals Using the Internet^	ICT Development Index*	ICT Development Rank*
Barbados	283,221	65.90	38	73.33	6.65	36
Guyana	795,369	11.90	118	34.31	3.08	105
Jamaica	2,712,100	29.00	85	46.50	3.68	93
Trinidad and Tobago	1,337,439	11.50	67	59.52	4.73	66

*ICT information is for the year 2013 and is obtained from ITU (International Telecommunication Union 2013). ^ Obtained from the ITU Indicators Database 2012 (International Telecommunication Union 2012). + Human Development Report 2013, UNDP (United Nations Development Programme 2013). # The World Bank (The World Bank 2013).

Our expectations in relation to measurement invariance, is based on the belief that the UTAUT factors will be measured adequately by the items. The UTAUT model has been evaluated widely and even though, a lack of measurement invariance is found in some cases, the model appears to be quite robust. The evidence from Guyana also indicates that with some limitations, especially in relation to the FC, the factors are adequately measured (Thomas et al. 2013). However, these results do not guarantee the validity of the measurements in the Caribbean region in general. As such, validity also needs to be demonstrated.

DATA AND METHODS

Data

This study is done with data collected from students at several university campuses within the Caribbean region. The data were collected via a web survey (See Table 1 for the UTAUT items) administered in: Barbados at the UWI Cave Hill, Guyana at the University of Guyana, Jamaica at the University of Technology and UWI Mona, Trinidad and Tobago at the UWI St. Augustine and at the UWI Open Campus, between October 2012 and February 2013. The students were contacted by email and invited to participate on a voluntary basis without any incentives. The email contacts were made through the university which ensured that the entire university student population was contacted in each case. In total, 1726 respondents completed the questionnaires: 649 (Barbados), 243 (Guyana), 262 (Jamaica: 112 (University of Technology), 150 (UWI Mona), 333 (Trinidad and Tobago), and 239 (UWI Open Campus). Because the Open Campus pulls students primarily from several territories within the Caribbean region, it is excluded from the analysis. Consequently, the effective sample consists of 1487 students. These groups are regarded as coming from the various university-territory combinations, hence, the data from the campuses in Jamaica are merged.

Table 3: *Sample Distributions*

Gender	Territory			
	Barbados	Guyana	Jamaica	Trinidad & Tobago
Male	175 (0.72)	151 (0.62)	181 (0.75)	189 (0.78)
Female	68 (0.28)	92 (0.38)	62 (0.26)	54 (0.22)

The approximate sample proportions are enclosed in brackets.

The large differences in sample sizes, would result in large power differences in the measurement models across the groups. Power will be comparatively high especially for Barbados. To address this, the sample sizes are scaled to that of the smallest group (Guyana) by making simple random selections from the data. The gender distributions of the initial data are preserved in the selections (see Table 3). However, we note that these distributions are not necessarily representative of the population distributions. For example, we know generally that there are more females than males at the University of Guyana, but the sample consists of more responses from males. In the absence of the population distributions, we are unable to apply weights (for example through iterative proportional fitting) to adjust for nonresponse due to self-selection. This is a limitation of this study. In spite of this, the results are still expected to be indicative of what can be expected of the measurements within the various country-campus contexts since the same self-selection issues affect each sample.

Given the focus on MI, it is necessary to discuss the inclusion of UWI campuses in three of the four territories (Barbados, Trinidad and Tobago, and part of Jamaica). Although three of the campuses come under the UWI brand, they exist in different territories which are at different stages in their ICT and economic development (see Table 2). The country conditions such as physical resources and experience with and access to ICT resources are expected to influenced the conditions at the campuses. This is expected to create sufficiently different local conditions despite the common university name. However, that the possibility of influences of the UWI brand is not eliminated is a limitation of the current study since this can result in measurement invariance. This is particularly relevant to Barbados and Trinidad and Tobago where students from only UWI campuses are included in the samples.

Methods

Several methods for evaluating MI are available, but Multi-Group Confirmatory Factor Analysis is both the most powerful and the most popular method (Meuleman et al. 2009). In the analysis, the respondents' ratings are regarded as continuous and the models are computed with robust maximum likelihood estimation using Mplus 7.11. In the models, the covariances among the UTAUT factors are freed (see Figure 2).

Configural invariance is judged from the basic form of the measurement models when they are estimated separately in each group. Only the factor loadings and the residual variances implied by the UTAUT constructs are initially estimated (see Figure 2). If modifications are required, they are discussed. Once the adequately fitting models are established in each group, they separate models are combined and estimated simultaneously to provide the baseline, configural invariance model. For metric invariance, the respective factor loadings are equated with each other across the groups. Modifications to the equality constraints on the factor loadings are allowed if warranted, but this is done in a stepwise manner. To evaluate scalar invariance, equality constraints are imposed on the respective item intercepts across the groups in addition to the equality constraints on the factor loadings. Only the intercepts of items whose loadings are invariant are included in the evaluation of scalar invariance.

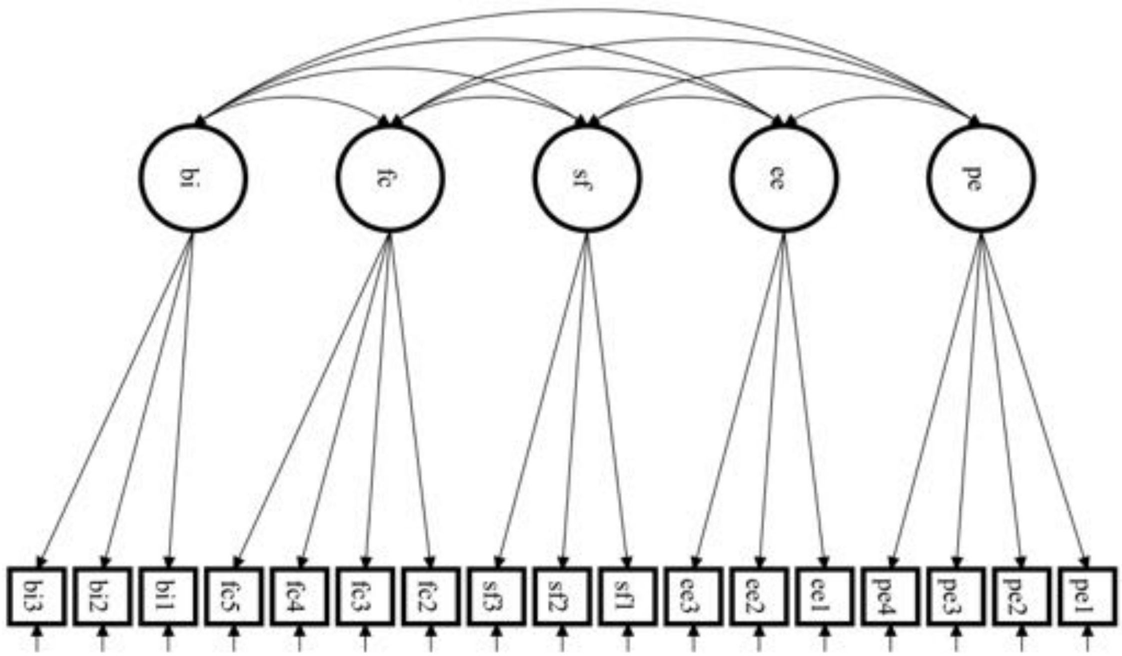

Figure 2: *The UTAUT Measurement Model*

The simultaneous model estimations are done in three stages. In the first stage, all the two-group combinations are evaluated. This results in the evaluation of six models consisting of two groups each. In the second stage, the three-group combinations are evaluated; four models in total. Finally, in the third stage, a four-group model consisting of all the territories (Barbados, Guyana, Jamaica and Trinidad & Tobago) is evaluated.

Before MI is assessed, the reliability and factorial validity of the UTAUT constructs in each group are evaluated. Cronbach's alpha greater than or equal to 0.70 is taken as indicative of adequate reliability (Hair et al. 2006). The results of the model estimations also enable evaluation of the practical significance of the factor loadings; standardised loadings greater than or equal to 0.70 are regarded as ideal. Factor convergent validity is achieved if the average variance extracted (AVE) is greater than or equal to 0.50, and discriminant validity is achieved if the square root of the AVE is greater that the factor correlations (Fornell & Larcker 1981). These are discussed for the model in each territory separately before joint estimation.

The fit of the models is evaluated based on alternative fit indices since the chi-square statistic is too sensitive for large sample sizes. In particular, the Root Mean Square Error of Approximation (RMSEA) less than or equal to 0.06, Comparative Fit Index (CFI) greater than or equal to 0.95, and the Standardised Root Mean Square Residual (SRMR) less than or equal to 0.05 are regarded as indicative of adequate global fit (Byrne 2012; Hu & Bentler 1999). To determine the level of MI achieved, the relative fit of the nested models are judged based on the change (Δ) in the fit indices. In particular, $\Delta RMSEA \geq 0.01$ and $\Delta CFI \geq 0.005$ indicate significantly poorer fit for metric, scalar and strict invariance whereas $\Delta SRMR \geq 0.025$ indicates lack of metric invariance and $\Delta SRMR \geq 0.005$ indicates poorer fit for scalar (sample sizes less than 300) (Chen 2007). These criteria are used in combination and the decisions are based on a majority of the indices (Sass 2011). In spite of a strong research tradition of using global fit indices to evaluate factor models, misspecifications may still occur when these indices indicate adequate fit (Saris et al. 2009; Van der Veld 2008). Such misspecifications can be detected with the use of the program Jrule for Mplus 0.91 (Oberski 2008). Jrule (judgment rule) for Mplus, is a program that takes the Mplus output as its input and it uses a combination of the expected parameter change, modification index and power (all obtained or calculated automatically from the Mplus output) to detect parameter misspecifications (Saris et al. 2009; Van der Veld 2008). In this study, high power is set at 0.80 and Type I error at 0.05. The misspecification is set to 0.10 for error covariances and at 0.40 for factor loadings.

RESULTS

Construct Validity

For each group, the initial model with the five UTAUT factors fits adequately with respect to the RMSEA and the CFI. The fit is a bit poorer with respect to the SRMR but not poor enough to cause great concerns (see Table 4). The models are therefore accepted as fitting adequately in general, however, reliability and validity of the factors are examined furtherqw.

Table 4: *Within-Country Models*

Country/ Group	χ^2	Degrees of freedom	RMSEA	CFI	SRMR
Barbados	211.14	109	0.06	0.95	0.06
Guyana	220.14	109	0.06	0.95	0.06
Jamaica	200.57	109	0.05	0.97	0.06
Trinidad & Tobago	207.66	109	0.05	0.96	0.06

Except for SF and FC in Guyana, the reliability (Cronbach's alpha) of each of the scales for each construct in each group is above 0.70 (Table 4). The reliabilities of SF and FC in Guyana (0.65 and 0.66 respectively) are only marginally lower. Hence, the reliability of each scale in each group is adequate.

Turning attention to the size of the factor loadings (Table 5), we observe that many of them exceed 0.70, but that some are lower. These loadings in combination with the factor level convergent validity (AVE: Table 5) and the discriminant validity (Table 6) lead to a few remarks about the factors. Firstly, the respective indicators are all valid measures of PE, EE and BI and both the convergent and discriminant validity of these factors are confirmed since the average variance extracted (AVE) exceed 0.50 and their correlations with the other factors are lower than the square root of the average variance extracted. Secondly, the third indicator of SF (SF3) has limited validity in each group; especially Barbados and Guyana where the loadings fall below 0.40. In spite of this, both the convergent and discriminant validities of the factor (SF) are adequate owing largely to the very high validity of the two remaining items. Thirdly, the validity of the first and fourth indicators of FC (FC1 and FC4) are relatively low except for FC4 in Jamaica. However, both items still appear to be useful measures of the construct since in each case, the factor loading exceeds 0.40. This factor also shows limited convergent validity overall especially in Guyana (AVE = 0.34), but it provides unique information since it also shows adequate discriminant validity.

Table 5: *Item Loadings*

Item	Barbados					Guyana					Jamaica					Trinidad & Tobago				
	PE	EE	SF	FC	BI	PE	EE	SF	FC	BI	PE	EE	SF	FC	BI	PE	EE	SF	FC	BI
PE1	0.68					0.66					0.68					0.72				
PE2	0.78					0.68					0.75					0.75				
PE3	0.79					0.86					0.87					0.86				
PE4	0.79					0.88					0.86					0.79				
EE1		0.86					0.83					0.85					0.84			
EE2		0.86					0.89					0.91					0.90			
EE3		0.82					0.81					0.86					0.78			
SF1			0.86					0.80					0.91					0.86		
SF2			0.92					0.88					0.88					0.97		
SF3			0.36					0.28					0.51					0.44		
FC1				0.60					0.51					0.53					0.57	
FC2				0.80					0.70					0.75					0.77	
FC3				0.70					0.56					0.68					0.75	
FC4				0.57					0.55					0.70					0.47	
BI1					0.95					0.92					0.97					0.94
BI2					0.92					0.81					0.90					0.92
BI3					0.85					0.79					0.74					0.84
AVE	0.58	0.72	0.57	0.45	0.82	0.60	0.71	0.50	0.34	0.71	0.63	0.76	0.62	0.45	0.77	0.61	0.71	0.62	0.43	0.81
Alpha	0.84	0.88	0.73	0.77	0.93	0.85	0.88	0.65	0.66	0.87	0.87	0.90	0.80	0.76	0.90	0.86	0.88	0.78	0.74	0.92

Factor loadings are the fully standardised loadings of the models in separate estimations. AVE – average variance extracted. Alpha – Cronbach Alpha.

Table 6: *Discriminant Validity*

Group	Construct	PE	EE	SF	FC	BI
Barbados	PE	**0.76**				
	EE	0.07	**0.85**			
	SF	0.07	0.08	**0.75**		
	FC	0.07	0.09	0.09	**0.67**	
	BI	0.05	0.06	0.07	0.06	**0.91**
Guyana	PE	**0.77**				
	EE	0.07	**0.84**			
	SF	0.06	0.07	**0.71**		
	FC	0.09	0.10	0.08	**0.58**	
	BI	0.06	0.07	0.08	0.08	**0.84**
Jamaica	PE	**0.79**				
	EE	0.08	**0.87**			
	SF	0.07	0.07	**0.79**		
	FC	0.07	0.07	0.08	**0.67**	
	BI	0.07	0.06	0.06	0.07	**0.88**
Trinidad & Tobago	PE	**0.78**				
	EE	0.07	**0.84**			
	SF	0.07	0.08	**0.79**		
	FC	0.07	0.09	0.09	**0.66**	
	BI	0.05	0.06	0.07	0.06	**0.90**

The square root of the AVE is placed on the diagonal and is highlighted. The off-diagonal elements are the correlations between the respective factors.

Comparability of the UTAUT Measures

By accepting the model for each group, we have in essence verified configural invariance. The basic form of the model is the same in each group and the models confirm to the specification of the UTAUT theory. In the next stage, factor models contain two groups each are evaluated. The configural invariance models are obtained by simultaneous estimation of the pairs under consideration.

The results for the two-group models (see Table 7) indicate that full metric and scalar invariance are achieved for the comparisons of Jamaica and Trinidad & Tobago, Jamaica and Barbados, Barbados and Trinidad & Tobago. In the evaluation of scalar invariance between Barbados and Trinidad & Tobago one item intercept (PE1) has a high modification index. At the same time, the power of the Jrule test for this path is larger than the 80% threshold while the expected parameter change (EPC) is not very large. The test therefore appears to be too sensitive in this case, and hence the large modification index for the parameter is ignored.

Whenever, Guyana is included in a two-group evaluation, violations of MI are encountered. Full metric invariance of the measurements is observed when Guyana is compared to Jamaica and Trinidad & Tobago, but when compared to Barbados the loading of the second indicator of EE (EE2*: Finding or using features in mobile technologies is easy.*) is higher in Guyana indicating that the validity of this item as a measure of EE is lower in Barbados than Guyana. Nevertheless, given that the loading is generally large and that the expected change in the parameter is not (0.17), the bias resulting from comparisons based on this non-invariant item is not expected to be large.

Table 7: *Measurement Invariance Evaluation*

Model	χ^2	df	$\Delta\chi^2$	Δdf	$RMSEA$	$\Delta RMSEA$	CFI	ΔCFI	SRMR	$\Delta SRMR$	Mod. Ind.	EPC	Power	Path
							Two-Group Models							
Groups: Jamaica and Trinidad & Tobago														
Configural	408.21*	218			0.050		0.962		0.057					
Metric	427.53*	230	19.32	12	0.050	0.000	0.961	-0.001	0.063	0.006				
Scalar	456.72*	242	29.18*	12	0.051	0.001	0.956	-0.005	0.064	0.001				
Groups: Jamaica and Barbados														
Configural	411.70*	218			0.055		0.959		0.060					
Metric	431.13*	230	19.43	12	0.052	-0.003	0.958	-0.001	0.067	0.007				
Scalar	473.94*	242	42.80*	12	0.055	0.003	0.950	-0.008	0.072	0.005				
Groups: Jamaica and Guyana														
Configural	420.65*	218			0.052		0.956		0.060					
Metric	437.95*	230	17.30	12	0.051	-0.001	0.956	0.000	0.066	0.006				
Scalar	510.12*	242	72.16*	12	0.058	0.007	0.939	-0.017+	0.074	0.008	45.36	-0.42	0.36	FC1:GY
Pscalar1	454.50*	241	16.54*	11	0.051	0.000	0.954	-0.002	0.068	0.002				
Groups: Guyana and Barbados														
Configural	431.26*	218			0.055		0.949		0.062					
Metric	458.41*	230	27.15	12	0.055	0.000	0.946	-0.003	0.072	0.010	12.64	-0.17	0.56	EE2:BB

Model	χ^2	df	$\Delta\chi^2$	Δdf	RMS	ΔRMS	CFI	ΔCF	SRMR	ΔSRM	Mod. Ind.	EPC	Power	Path
Pmetric1	443.93*	229	12.67	11	0.054	-0.001	0.950	0.001	0.067	0.005				
Pscalar1	586.00*	240	142.07*	11	0.069	0.015+	0.913	-0.037+	0.082	0.015+	63.10	0.35	0.62	FC1:BB
Pscalar2	508.60*	239	64.67*	10	0.060	0.006	0.935	-0.015+	0.075	0.008	31.00	-0.26	0.57	FC3:BB
Pscalar3	472.09*	238	28.16*	9	0.056	0.002	0.945	-0.005	0.069	0.002	11.88	-0.12	0.84	BI3:BB
Groups: Guyana and Trinidad & Tobago														
Configural	427.77*	218			0.054		0.952		0.060					
Metric	446.91*	230	19.14	12	0.053	-0.001	0.952	0.000	0.066	0.006				
Scalar	530.03*	242	83.12*	12	0.061	0.008	0.932	-0.020+	0.075	0.009	37.11	0.31	0.49	FC1:TT
PScalar1	485.09*	241	38.18*	11	0.055	0.002	0.944	-0.008	0.070	0.004	10.49	-0.17	0.47	FC3:TT
Pscalar2	472.56*	240	25.66*	10	0.054	0.001	0.947	-0.005	0.068	0.002	10.98	-0.12	0.78	BI3:TT
Groups: Barbados and Trinidad & Tobago														
Configural	418.82	218			0.054		0.956		0.059					
Metric	430.23	230	11.41	12	0.052	-0.002	0.957	0.001	0.064	0.005				
Scalar	462.23	242	32.00*	12	0.054	0.002	0.952	-0.005	0.067	0.003	12.54	-0.12	0.85	PE1:TT
Three-Group Models														
Groups: Guyana, Barbados and Trinidad & Tobago														
Configural	638.91*	327			0.054		0.953		0.060					
Metric	677.01*	351	38.11	24	0.053	-0.001	0.952	-0.001	0.069	0.009	11.67	-0.20	0.41	EE2:BB
Pmetric	661.95*	34	23.05	22	0.052	-0.002	0.954	0.001	0.066	0.006				

Model	χ^2	df	$\Delta\chi^2$	Δdf	$RMSEA$	$\Delta RMSEA$	CFI	ΔCFI	SRMR	$\Delta SRMR$	Mod. Ind.	EPC	Power	Path
		9												
Pscalar1	827.09*	371	165.14*	22	0.063	0.011	0.928	-0.026+	0.078	0.012+	61.39	-0.58	0.27	FC1:GY
Pscalar2	744.60*	369	82.65*	20	0.056	0.004	0.943	-0.011+	0.072	0.006	24.85	0.28	0.42	FC3:GY
Pscalar3	708.07*	367	46.12*	18	0.054	0.002	0.949	-0.005	0.069	0.003				
Groups: Guyana, Jamaica and Trinidad & Tobago														
configural	628.35*	327			0.052		0.957		0.059					
Metric	666.41*	351	38.05	24	0.051	-0.001	0.956	-0.001	0.067	0.008				
Scalar	769.14*	375	102.73*	24	0.058	0.007	0.939	-0.017+	0.074	0.007	51.42	-0.51	0.29	FC1:GY
Pscalar1	722.30*	373	55.89*	22	0.053	0.002	0.950	-0.006	0.070	0.003	11.94	0.19	0.43	FC3:GY
Pscalar2	708.10*	371	41.69	20	0.052	0.001	0.952	-0.004	0.068	0.001	12.75	-0.11	0.91	BI3:TT
Groups: Guyana, Jamaica and Barbados														
Configural	631.81*	327			0.053		0.955		0.061					
Metric	674.43*	351	42.62	24	0.052	-0.001	0.953	-0.002	0.071	0.010				
Scalar	844.98*	375	170.56*	24	0.063	0.011	0.927	-0.026+	0.081	0.010+	65.07	-0.60	0.27	FC1:GY
Pscalar1	760.73*	373	86.30*	22	0.057	0.005	0.942	-0.011+	0.078	0.007	24.11	0.26	0.46	FC3:GY
Pscalar2	723.64*	371	49.21*	20	0.054	0.002	0.948	-0.005	0.074	0.003	14.31	-0.11	0.95	BI3:BB
Groups: Jamaica, Barbados and Trinidad & Tobago														
Configural	619.35*	327			0.052		0.959		0.059					
Metric	652.36*	35	33.01	24	0.051	-0.001	0.959	0.000	0.066	0.007				

Model	χ^2	df	$\Delta\chi^2$	Δdf	$RMSEA$	$\Delta RMSEA$	CFI	ΔCFI	SRMR	$\Delta SRMR$	Mod. Ind.	EPC	Power	Path
		1												
Scalar	721.73*	375	69.37*	24	0.054	0.003	0.951	-0.008	0.071	0.005	12.31	-0.16	0.60	FC3:BB
pscalar1	707.52*	373	55.16*	22	0.053	0.002	0.953	-0.006	0.070	0.004	11.15	0.13	0.74	BI3:JA
Pscalar2	694.64*	371	42.28*	20	0.052	0.001	0.955	-0.004	0.069	0.003	13.75	0.13	0.84	PE1:BB
Four-Group Model														
Groups: Jamaica, Guyana, Barbados and Trinidad & Tobago														
Configural	839.47*	436			0.053		0.956		0.060					
Metric	896.33*	472	56.85	36	0.052	-0.001	0.955	-0.001	0.069	0.009	9.19	-0.19	0.36	EE2:BB
Pmetric1	881.11*	469	41.63	33	0.051	-0.002	0.956	0.000	0.067	0.007				
Pscalar1	1069.71*	502	188.61	30	0.060	0.009	0.936	-0.020+	0.076	0.009	62.97	-0.61	0.26	FC1:GY
Pscalar2	983.85*	499	102.74	30	0.055	0.004	0.947	-0.009	0.072	0.005	22.00	0.27	0.41	FC3:GY
Pscalar1	946.66*	496	65.55	27	0.052	0.001	0.951	-0.005	0.069	0.002	13.64	0.13	0.79	PE1:BB

* significant at the 5% level. Mod. Ind. – modification index. EPC – Expected parameter change. + significant change in fit index. GY – Guyana. BB – Barbados. JA – Jamaica. TT – Trinidad & Tobago. Pmetric – Partial metric invariance. Pscalar – Partial scalar invariance. The chi-square tests for the nested model – $\Delta\chi^2$ – are done with a Bonferroni correction for multiple tests. Therefore p-value = $0.05/\Delta df$ for an overall 5% test.

As in the case of metric invariance, full scalar invariance of the measurements is observed for the comparisons of Jamaica with each of Trinidad & Tobago and Barbados and for the comparison of Barbados with Trinidad & Tobago. Both the item loadings and the intercepts are therefore equal when these groups are compared in a pair-wise manner. Violations of scalar invariance occur whenever Guyana is paired with another territory. These violations are due generally to the intercepts of the first and third indicators of FC (FC1: *In general, my University campus has support for mobile learning.* FC3: *I have the knowledge necessary to use m-Learning.*) (Table 7). FC1 has a lower mean in Guyana than the other groups whereas the mean of FC3 is higher in Guyana compared to Barbados and Trinidad & Tobago.

An interesting result obtained from the three-group analyses is that the measurements are not fully invariant when Jamaica, Barbados and Trinidad & Tobago are estimated simultaneously. This result is interesting since there is full scalar invariance when any pair-wise combination of these groups is considered. Pair-wise MI therefore does not guarantee, MI if the elements of the pairs are estimated together. Full metric invariance of the measurements is demonstrated in the simultaneous estimation of these groups, but not full scalar invariance. Scalar invariance is hindered by the intercepts of the third indicator of FC (FC3) and the third indicator of BI (BI3: *I have a plan to use m-Learning technologies in the near future.*). The reported average level of knowledge about mobile learning technologies (FC3) is lower in Barbados whereas the students from Jamaica report a higher likelihood of having a plan to use mobile learning in the near future.

Whenever, Guyana is included as one of the three groups, the same MI violations encountered in the two-group comparisons are encountered. In each, case, full scalar invariance is hindered by the intercepts of FC1 and FC3. However, full metric invariance is obtained in the three-group models which include Guyana as long as both Barbados and Trinidad & Tobago are not the remaining two groups. When the models for these two groups are estimated simultaneously with Guyana, only partial metric invariance is achieved, due to non-invariance of the loading of the second indicator of EE in the Barbados group. However, if the models for Guyana, Jamaica and Barbados are estimated simultaneously, full metric invariance is achieved.

In some of the three-group models, BI3 and PE1 are flagged because they have large modification indices when scalar invariance is evaluated (see Table 7). However, apart from the case already discussed in which the item is indeed non-invariant, we do not regard the respective item intercepts as non-invariant in these remaining cases because the power is above 80% while the expected parameter change is not large.

The final model estimated contains the four groups under study. The results (Table 7) are largely consistent with what is already discussed, but some of the details are lost. Full MI is not obtained from the simultaneous estimation of the models for the four groups. Partial scalar invariance is achieved due to the loading of the second indicator of EE. This loading is lower in the Barbados group. The model also requires two additional modifications when scalar invariance is evaluated. These modifications are made to the intercepts of the first and third indicators of FC. The intercept of FC1 is lower whereas the intercept of FC3 is higher in Guyana.

Comparisons of the Means of the UTAUT Factors

In addition to evaluating the validity and comparability of the UTAUT factors in the Caribbean region, we provide comparisons of the average levels of the factors between the groups. The comparisons of the factor means are based on the results of the four-group model. Given that only partial scalar invariance is established, only the invariant items contribute the factor means (see Table 8).

As observed in Table 8, there are several significant differences in the average levels of the UTAUT factors between the territories, but there is also a notable lack of significant difference in many cases. PE is highest in Guyana followed by Jamaica. The students from Guyana in comparison to those from Barbados and Trinidad & Tobago in particular appear to feel more strongly about the usefulness of mobile technology in education. EE is also higher in the Guyana than both Barbados and Trinidad & Tobago. While the average level of this factor is similar between Guyana and Jamaica and between Jamaica and Barbados, the students from Jamaica feel more confident in their ability to use mobile technologies than the students from Trinidad & Tobago. There are no differences in the levels of the social factors (SF) except when Guyana is compared to Barbados and Trinidad & Tobago. In both cases, the students from Guyana report higher levels of social support. The only difference in the evaluations of the facilitating conditions occurs for the comparison of Guyana with Barbados. In this instance, the students from Guyana are less optimistic about the conditions in support of mobile learning. Finally, BI is higher in Guyana than both Jamaica and Trinidad & Tobago, but higher in Barbados than Jamaica.

Table 8: *Comparisons of the Factor Means*

Factor	Group									
	Jamaica	Guyana			Barbados			Trinidad & Tobago		
	Mean	Mean diff.	SE	t	Mean diff.	SE	t	Mean diff.	SE	t
Baseline: Jamaica										
PE	ref	0.08*	0.05	1.80	-0.17**	0.05	-3.64	-0.16**	0.05	-3.21
EE	ref	0.06	0.07	0.88	-0.11	0.06	-1.63	-0.14*	0.06	2.23
SF	ref	0.09	0.09	1.06	-0.08	0.08	-0.92	-0.06	0.08	-0.75
FC	ref	-0.04	0.10	-0.45	0.13	0.09	1.42	0.09	0.10	0.92
BI	ref	0.26**	0.09	2.96	0.16*	0.09	1.72	0.12	0.09	1.25
Baseline: Guyana										
PE		ref			-0.26**	0.05	-5.49	-0.24**	0.05	-4.96
EE		ref			-0.16**	0.06	-2.57	-0.20**	0.06	-3.17
SF		ref			-0.17**	0.08	-2.06	-0.15*	0.08	-1.84
FC		ref			0.17*	0.09	1.92	0.14	0.10	1.39
BI		ref			-0.10	0.09	-1.20	-0.15**	0.09	-1.67
Baseline: Barbados										
PE					ref			0.04	0.10	0.38
EE					ref			-0.06	0.10	-0.61
SF					ref			0.01	0.09	0.15
FC					ref			-0.05	0.11	-0.44
BI					ref			-0.04	0.09	-0.46

**Significant at the 5% level. *Significant at the 10% level. SE – Standard error. t – test statistic from the t-distribution. ref – indicates the reference group for the comparisons. The mean of the reference group is set to 0.

In the UTAUT model, BI impacts directly on technology adoption. Given the results of the comparisons of the means, the students from Guyana seem poised to adopt mobile learning. The sizes of the coefficients (0.24 to 0.26) when Guyana is compared to the other territories are also the largest of all the mean differences. Given the sizes of the t-statistics corresponding to these differences (Table 8), the effect sizes are also expected to be large.

Aside from the differences in BI, a few notable patterns emerge for the comparisons of the factor means. Firstly, Barbados and Trinidad & Tobago form homogeneous groups with respect to the means of all the factors. Secondly, Jamaica is distinguished from the other groups with respect to two factors in each case. Significant differences from Jamaica occur for PE in all cases and with respect to BI in comparison to both Guyana and Barbados. The only remaining significant difference involving Jamaica is in relation to EE with Trinidad & Tobago. Although it retains a few distinguishing characteristics, Jamaica appears to have many similarities with each of the other territories. In contrast, the results for Guyana contains several distinguishing points. The mean levels of the factors in Guyana differ from those in Barbados and Trinidad & Tobago in relation to all but one factor each. However, Guyana and Jamaica have similar means for most of the UTAUT constructs.

DISCUSSION

With the exception of the facilitating conditions factor which has relatively low convergent validity, the UTAUT constructs are recovered adequately from the data in each territory (Thomas et al. 2013). Apart from the measurement validity issues of the facilitating conditions, this finding is similar to that of Oshlyansky et al. (2007) who focus on a combination of Western and non-Western countries. The UTUAUT measures are therefore generally both valid and reliable and this supports the generalizability of the measurements to the Caribbean region. The UTAUT theory may therefore be used to evaluate mobile learning adoption in the region. However, there are some caveats to this general conclusion.

The consistently low convergent validity of the facilitating conditions factor is enough to raise concerns about the measurement of the factor. While there is a need for improvement in the measurement of FC, discarding it altogether is not recommended (Thomas et al. 2013) especially since the construct provides unique information. Closer inspection of the items reveals that they focus on a combination of sources of support that are external (FC1 and FC4) and internal to the individual (FC2 and FC3). Splitting this construct into two separate factors capturing the external and internal facilitating conditions respectively may result in more appropriate measurement of the facilitating conditions in the Caribbean region. This approach requires a modification of the UTAUT in relation to the measurement of the facilitating conditions and it should be explored in future studies. However, researchers should also attempt to identify two additional items; one to go along with FC1 and FC4 to measure external conditions and one to go along with FC2 and FC3 to measure internal conditions. This is suggested because the resulting two factors will be under-identified if only two items are used with confirmatory factor analysis. In some cases, further restrictions (loadings equal 1) will need to be imposed for the model to be estimated successfully if only two items are used.

It is also noteworthy that the expected parameter change for the first indicator of the facilitating conditions (FC1: *In general, my University campus has support for mobile learning*.) when scalar invariance is attempted is large. This suggests that in comparison to the other groups, the Guyanese students are much less optimistic about the level of support for mobile learning at their campuses. This is supported by the comparisons of the factor means. The facilitating conditions is the only construct on which the Guyanese students report a lower average than the students of any other territory. This particular observation may be reflective of the country's comparatively poor standing on the ICT development index and rank together with only approximately 34% of the population using the Internet (International Telecommunication Union 2013; International Telecommunication Union 2012).

A final caveat to the generalizability of the UTAUT measures, is the consistently low loading of the third indicator of social factors (*SF3*: *University teachers are supportive of the use of mobile technologies*). This indicator captures the influence of university teachers on the adoption of mobile learning. The supportiveness of university teachers therefore appears to play a limited role in determining the social factors responsible for mobile learning adoption in the region. This item was modified to fit the university context, but it is apparent that a replacement may be necessary for mobile learning studies in the Caribbean. In the Caribbean, mobile learning has not yet become integral to higher education and the general poor performance of the third social factors item may be due to domain specificity. It may be that the teachers are themselves less technology savvy and that the students do not look to them for inspiration in this regard. The low loading of this item in Guyana was highlighted previously (Thomas et al. 2013) and the consistency of this finding across the territories in this study, suggests that there is a need to modification of the item to improve its validity. Such modification is necessary at least for mobile learning studies, but we advise against modifying this item for the general application of the UTAUT model until it is tested more widely in the region in other domains.

The UTAUT measures are generally comparable across the territories; however, one violation of metric invariance is encountered. This is a limitation on the robustness of the measures (Byrne & Watkins 2003; Van de Vijver & Tanzer 2004). This violation of metric invariance occurs for an item that has a quite high standardised loading (greater than 0.80). We do not believe that this particular parameter will bias research results substantially. In spite of this, researchers should still be cautious about pooling data across the territories (Byrne et al. 1989). Under partial metric invariance, cross-national comparisons of structural relationships is permitted. Researchers can therefore compare the regression effects included in the UTAUT model among the territories. This is an important result since these effects are most often the subject of research. Based on the results, comparisons of structural relationships under full metric invariance can be done with any group of three of the territories except when Barbados and Trinidad & Tobago are included with Guyana.

Comparisons of the mean levels of the factors are also important. Such comparisons can indicate the relative standing of the territories on the factors so that areas of focus for mobile learning intervention may be identified. Given that only partial scalar invariance is found, comparisons of the mean levels of the factors are likely to be biased unless adjustments are made (Vandenberg & Lance 2000). In particular, only pairs of territories excluding Guyana may be compared under full scalar invariance. Once Guyana or more than two territories are included adjustments for scalar non-invariance are necessary (Byrne et al. 1989). The construct that is most affected is the facilitating conditions primarily due to the Guyana group. This construct may also show non-invariance in Barbados as observed in the three-group models. In addition, behavioural intention may also show non-invariance in Jamaica when Guyana is excluded. The reason for this is that the violations are more severe in Guyana. This is notable given that Guyana performs the poorest of the four territories on both ICT rankings and ICT development (Table 1). The difference in the ICT environment appears to indeed affect usage and user experience and thus accounts for the results obtained. The issue of usage and user experience across the Caribbean territories should be investigated in the future

Once partial invariance is invoked, the freed items no longer contribute to the substantive comparisons. This is true for the results provided on the mean differences between the UTAUT factors. The facilitating conditions is most affected and as such the results should be interpreted with care. It is also important to note that methods such as analysis of variance or the use of sum scores or averages for the UTAUT construct, ignore the measurement issues highlighted in this paper. These approaches are therefore not optimal for comparing the regression effects in the UTAUT model or the mean levels of the measures between the Caribbean territories. Methods that permit adjustments for lack of measurement invariance should be employed.

CONCLUSION

With the exception of the facilitating conditions, the UTAUT measures exhibit adequate reliability and the factors are adequately recovered in each territory. The interpretations of the items per factor are generally similar across the groups, but similarity of the item intercepts is more problematic. With potentially one adjustment, the structural relationships among the UTAUT factors may be compared, but more adjustments are required for comparisons of the factor means. Pair-wise pooling of the data across the groups is justified except for some cases in when Guyana is involved. However, once more than two groups are included, researchers should be cautious about pooling the data especially when the factor means are to being studied. We conclude overall that the UTAUT model may be used in the Caribbean region but that researchers should focus attention on improving the measurements. In particular, the UTAUT model may be modified for the Caribbean region to allow the facilitating conditions to be measured by two separate factors; one capturing the contribution of the individual and the other capturing the contribution of the environment. This represents a departure from the UTAUT theory as it relates to the measurement of facilitating conditions in the Caribbean context. However, the need for this modification should be investigated in domains other than mobile learning before it could be generalised.

LIMITATIONS

This study has three important limitations. Firstly, university campuses that come under the UWI brand entirely compose the samples of two territories. We do not anticipate this this has affected the results substantially (see description of data) but the possibility is not altogether eliminated. Secondly, response styles are not controlled (Van Vaerenbergh & Thomas 2013). Response styles are examples of method bias which can affect the extent of MI obtained and group comparisons regardless of whether or not MI is demonstrated (Thomas et al. 2014). However, corrections for response styles have not become commonplace in research and data collection instruments do not generally cater for this. Thirdly, we used student samples which is necessary for the topic investigated. As such, the results may not be generalised to other groups and to other domains. Furthermore, the issue of self-selection in web surveys may further affect the results. Researchers should examine both the impact of response styles on the cross-national comparability of the measures and the generalizability of the findings in domains other than mobile learning and such studies should include other Caribbean territories and other university campuses.

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