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# An Empirical Study of Cultural Dimensions and Cybersecurity Development

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***Abstract*—The purpose of the present study is to empirically investigate whether national culture has an impact on cybersecurity development. We used methods of correlation and hierarchical regression to analyse two sets of indices; the global cybersecurity index of 2015 and Hofstede cultural dimension index. The research discovered that there exist a significant correlation between cybersecurity development and the cultural dimensions as defined by Hofstede cultural theory. Five cultural dimensions were used in the study; power distance, masculinity/femininity, individualism/collectivism, uncertainty avoidance, long term/short term orientation, and the research found out that individualism and long term orientation were significantly correlated with cybersecurity development. These findings have strategic implications in helping government and decision makers fashion out relevant policies and programmes while taking into cognisance the cultural factors in the improvement of the cyberwellness profile and the development of strategic cybersecurity. Implications and recommendations for future work are further discussed.**

***Index Terms*—Strategic Cybersecurity; National culture; Cybersecurity Policies;**

## I. Introduction

The world has progressively become more information oriented over the past decades thereby increasingly exposing the average citizen, organisation and government to related risks and threats which targets either the transactional information or infrastructure. Recently the cyberspace has been transformed into global information communication technology infrastructure enabling the complex interactions of information networks and electronic objects. Nations have therefore taken advantage of the evolving domain to advance both political and socioeconomic interest, hence transforming the cyberspace into one of the national critical infrastructure that needs to be strategically secured.

The Global Cybersecurity Index according to the International telecommunication Union (ITU) is a measure of the nation states level of cybersecurity development and cyberwellness profile in five strategic dimensions ; Legal, Technical, Organisational (strategy), Capacity building and International cooperation. A recent ITU GCI survey shows that more work has been done in the legal dimension of cybersecurity globally while very little work was done in the area of capacity building and international cooperation. According to the index table, the survey also reveals that the European region are well ahead of other regions while Africa is still behind having the least index score. It was further shown through the survey that capacity building dimension has the lowest index in Africa while the legal dimension tops the index score in the European region[1] Some studies have acknowledged national culture as having a significant moderating effect on information security behaviour [2]. The empirical study carried by[3] on the effect of national culture on e-government also reveals the influence of national culture on development of e-government services. National culture has also been shown to have a lot of influence on the use, application and development of information systems. However, the development of cybersecurity, being quite a recent phenomenon is yet to have the benefit of such study that seeks to understand the influence of national culture. Our research therefore is aimed at empirically examining how national culture will impact on cybersecurity development (cyber-wellness of a nation). We intent to accomplish our task by approaching the study in a comprehensive manner beyond either organisation, national or regional perspectives. Considering the lack of empirical studies in field of cybersecurity especially as it relates to national cultures, our study therefore aims first at complementing the body of literature in this field and secondly provide an empirical support to similar research. The rest of the paper is structured as follows; In section 2 is the review of related literature on national culture. The main research question and hypothesis is presented in section 3. Section 4 discussed the dependent variables. The methodology is discussed in section 5 while the results are presented in section 6 and discussed in section 7. Finally conclusions and future works is presented in section 8

### A. Related Works

The field of study related to addressing the impact and interrelationship of culture and cybersecurity have not been well researched hence, it has not kept pace with its counter parts in Information Technology/System/Security. However information technology adoption and cultural differences between countries are highly researched subjects. The important role of cultural factors in Information Technology has been discussed in various researches [6], [4],[5]. It has also been found out that long term orientation of the Hofstede cultural dimension has a negative influence on innovation and product adoption. [6]. Another study by [16] explored the relationship between national cultures and e-government. [16] investigated how the difference in the worldwide e-government readiness level can be explained by cultural variables using the four dimension cultural index of Hofstede and e-government readiness index of 95 countries.

[2] identified national culture as having significant moderating effect on information security behaviour. The study on investigating the effect of behavioural information security governance and national culture explained why manager in individualistic, feminine countries like Sweeden tend to focus their effort on implementing control that are aligned with business activities and employees needs [2]. [3] in his empirical study of cultural dimension and e-government found out that there exist a correlation to various degrees between e-government development (using the e-government readiness index of 2010) and cultural dimensions as defined by Hofstede cultural index.

These studies of the effect of national cultures on technology adoptions, information security and e-government development offers certainly a useful analogy and guidance to our study of national culture and cybersecurity development.

### *B. National Culture and their Dimension*

[7] defined culture as a collective programming of the mind that distinguishes members of one group or category of people from others. This definition implies that patterns of thinking, feeling and potential acting on various indices of cybersecurity development is affected by culture. National culture therefore refers to the general attitude, belief systems, value and traditions peculiar to a nation. This entails that developing cybersecurity at all levels of the society largely depends on how such society view the issue of security and their attitude towards it. For instance the right to privacy which is an essential characteristic of an individualistic society [7] featured in the technical dimension of cybersecurity development as one of the indicative measures through standards and control. The most popular conceptualization of culture which has gained much recognition among various researchers is the Hofstede Cultural Framework [17]. Despite its critique on the basis of methodology used and validity of data, having relied on the interviews with IBM employees, which also raise questions about extending its findings to national culture [10], however the framework has been widely validated by more than 140 studies . It has also form the basis of most Information System research with regards to cross cultural studies [8], [9] The extensive research of Hofstede has been the mostly celebrated work in area of national culture [11]. From the analysis of the data he obtained through 116,000 questionnaires from which over 60,000 people responded from over 50 countries and for over the period 1967-1978, Hofstede identified four bipolar dimensions; Power Distance (PD), Individualism/Collectivism (I/C), Uncertainty Avoidance (UA), Masculinity/Femininity (M/F). This became the basis for characterization of culture for each country . The fifth element Confucian Dynamism or Long/Short term orientation was introduced after a subsequent study in an attempted to capture the uncertainty of Asian culture. The indulgence/Restraint originally proposed by [12], was later introduced by Hofstede increasing the number of dimensions element to six. The following provides a brief outline of the six dimension of national culture according to Hofsede.

**Power Distance:** This explains the societal desire for hierarchy and acceptance of distribution of power among individuals and institutions within that culture. A culture that ranks high in power distance tolerates much inequality whereas cultures of low power distance do not support inequality but however support independence of members to express their opinion. It is therefore reasonable to expect less use of Information in high power distance culture and less need for protection against cyber attacks

**Uncertainty Avoidance:** This dimension addresses the societys tolerance of ambiguity and uncertainty. A society with low tolerance of uncertainty will have a high index on uncertainty avoidance and is characterized with intolerance, risk evasiveness and emotional need for extensive legislations even when they may not be obeyed [7]. This dimension is therefore relevant as policies , standards and control are major factor in cybersecurity development

**Individual versus collectivism:** According to [7], this dimension expresses the degree with which a society reinforces individual or collective achievement and interpersonal relationship. The individualism culture is concern with right of privacy and prefers the use of electronic communication as they more technology minded than collectivist culture that prefers face to face communication in view of their preference to tightly knit social framework in which individual expects their group to look after them in exchange for unquestioning loyalty.

**Masculinity versus femininity:** According to [7], masculinity stands for preference in society for achievement, assertiveness and material success while femininity expresses the preference for relationship, modesty and caring for the weak. It is an outcome oriented culture that deals more on facts than with feelings. The use of technology therefore guarantees delivery of results which is one of the concerns of a masculine culture

**Long term versus short term orientation:** This dimension expresses the extent which a culture orientates its members to accept a future focused long term goals as against respect for tradition and short term orientations which emphasizes on the past and the present. Such culture sets long term goals and strategies which is one of the significant index of cybersecurity.

**Indulgence versus restraint:** According to [13], indulgence dimension is defined as the extent to which people try to control their appetite (their desire and impulses).

## II. Research Questions and Hypothesis

Our primary research questions is; is there a correlation between national culture and cybersecurity development.

Based on our literature review we have developed five hypothesis in other to understand the impact of national culture (giving consideration only to five cultural dimension of Hofstede) on cybersecurity development.

H1: Countries with small power distance tend to have a high level cybersecurity development.

H2: Countries with high individualism tend to have a high

level of cybersecurity development.
H3 Countries with low uncertainty avoidance tend to have a high level of cybersecurity development.
H4 Countries with high masculinity tend to have a high level of cybersecurity development.
H5 Countries with long term orientation culture tends to have a high level of cybersecurity development.

The development of the hypothesis is summarised in the proposed research model 1 and testing them is to guide us in providing answers to the our main research question and to gain understanding as to what extent national culture impacts on the development of cybersecurity and cyber-wellness profile so as to develop specific target approaches in addressing country specific cybersecurity development challenges

## III. Dependent variables

**The ITU Global Cybersecurity (Cyber-wellness profile)Index (GCI)**
The GCI was an outcome of research conducted by the International Telecommunication Union (ITU) to drive the issue of cybersecurity to the top national discourse. The 2015 published survey used instruments focusing on how government of member states are committed in five main areas namely; legal measures, technical measures, organizational measures, capacity building and international cooperation measure.

The index as based on ITU survey of member state which was conducted in 2015. It rates the cyber-wellness profile using multi criteria analysis to establish preference between options by reference to explicit set of identified objectives for which there are established measurable criteria. The maximum possible value is one and the minimum (worst readiness) possible value is zero.

**Legal Measure** The ITU team assessed the legal environment based on the existence of a number of legal institutions and frameworks dealing with cybersecurity and cybercrime using criteria such as the existence of criminal legislation and regulations for cybercrime and compliance to the regulations.

**Technical measures** This index reflects the measure of the existence of technical institutions and frameworks such as the establishment of Computer Emergency Response Teams (CERT), government approved frameworks for the implementation of globally recognized standards, certifications and accreditations of public agencies by globally recognized cybersecurity standards.

**Organisational measures:** This index is measured by the existence of number of institutions and strategies organizing cybersecurity development at national level. The indicator for this measure includes the existence of specific sector strategy or policy for cybersecurity, governance road map incorporating the various stakeholders.

**Capacity building measures:** Capacity building is necessary to enhance knowledge and promote the development of competent cybersecurity professionals. The indicator for this measure is the existence of at the national level globally recognized standards, the presence of accessible training and awareness programs.

**International Cooperation measures:** The sharing of best practices and threat information is captured in this index. The indicator for the measure is the presence of officially recognized program and partnership for sharing and partnership for sharing cybersecurity assets between countries and between agencies

## IV. methodology

In our statistical analysis, Hofstede cultural dimension scores from different countries were used as earlier described in our literature review. We used the five dimension index score of Power distance index (PDI), Uncertainty Avoidance index (AU), Individual-collectivism index (IDV), Masculinity Femininity (MAS) and Long Term-Short Term Orientation (LTO). The current index score are available for 89 countries for PDI and IDV, 88 for MAS and UAI and 78 for LTO according to Values Survey Module (VSM) 2013

In order to answer the research question, we utilised the 2013 value survey module (VSM) of Hofstede cultural dimension index and the Global Cybersecurity Index of 89 countries generated by a research conducted by International Telecommunication Union (ITU 2015). We also used the statistical method of correlation and hierarchical regression to analyse the two sets of global data, we further examined whether cultural dimensions are significantly correlated with the cybersecurity development and contribute to the differential in the cybersecurity development across various countries. We used IBM SPSS 23 to carry out the statistical analysis. The basic statistics about the variables analysed is presented in I. Since the primary focus of the study is to empirically examine how national culture impacts on cybersecurity development using the Global Cybersecurity Index (GCI), we conducted hierarchical regression analysis by first entering IDV based on our theoretical understanding and because of the results of our correlation indicates that IDV has a stronger correlation with Global Cybersecurity Index [14], [3]. The result of our correlation is shown in II

## V. Results

The scores of several variables in relation to cybersecurity development published in ITU report 2015 and Hofstede Cultural dimension index available at the Value Survey Module 2013 were analysed using Pearson correlation coefficient. The result is presented in II. From the result, global cybersecurity index is significantly correlated with all the variables except masculinity (MAS) and uncertainty avoidance (AUI). The strong positive correlation between cybersecurity developments (GCI) and Organisation (ORG).876, capacity building (CAB) .877, legal (LEG) .693 and International Corporation (COR) .779 was expected as they are composite scores. ORG and CAB are strongly correlated with GCI while COR is less correlated with GCI. These findings suggest that the cybersecurity strategies and capacity building are very key

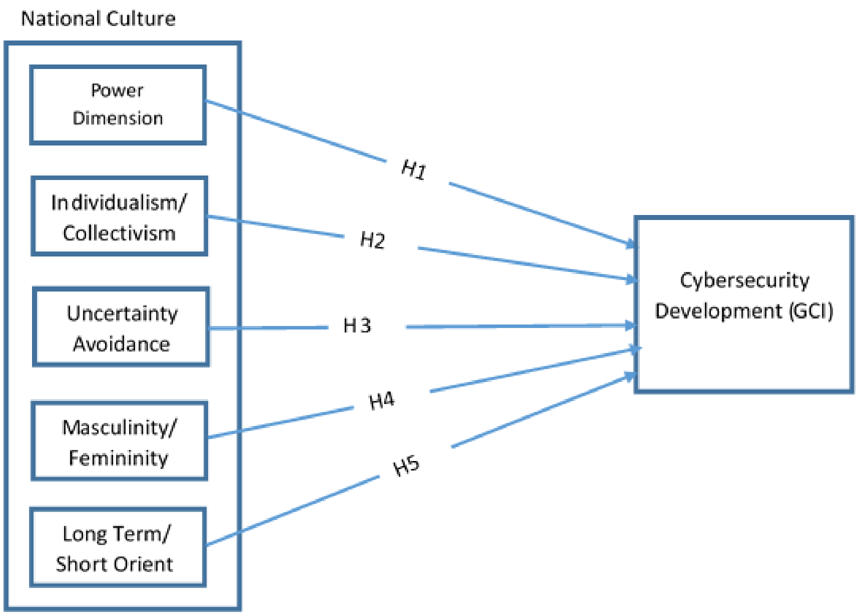


Fig. 1. Proposed Research Model

TABLE I
DESCRIPTIVE STATISTICS

| Statistics | PDI | IDV | MAS | UAI | LTO | CAB | COR | GCI | LEG | TECH | ORG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 61.8202 | 41.6404 | 48.8295 | 64.5341 | 43.8077 | .4157 | .3469 | .4495 | .6567 | .5019 | .4719 |
| Standard Deviation | .63156 | 22.631567 | 19.11924 | 21.74140 | 22.92113 | .25891 | .18536 | .20238 | .31017 | .533 | .29721 |
| N | 89 | 89 | 88 | 88 | 78 | 89 | 89 | 89 | 89 | 89 | 89 |

important factor in the development of cybersecurity. The statistics also shows the strong correlation CAB has with LEG and ORG. This further underscore the importance of capacity building and organisation (Strategy) in the entire cybersecurity ecosystem

In examining the relationship between the five cultural dimensions with other variables, we observe that UAI and MAS has no correlation with any of the variables, however while PDI has a negative significant correlation with GCI, IDV has a significant positive correlation with all the variables with exception of technical (TECH). The relationships between technical and capacity building are not well defined hence the significant positive correlation between IDV and CAB could account for the absence of correlation with TECH. The overall result of the correlation analysis suggest that three of the cultural dimensions cultural dimension (PDI, IDV, LTO) are significantly correlated with GCI as shown in 2

III also shows the result of hierarchical regression in order to determine extent of influence of our predictor constant (IDV). We also examined the variance influence factor (VIF) in order to address the problem of multi-collinearity and found that none of the factors exceeds 10.0 thus indicating that multicollinearity is a non-issue in the analysis. A variance inflation factor less than 5 indicates acceptable shared variance [18] The result also shows that the five cultural dimension collectively accounts for 34.3 percent (0.343) of variation in cybersecurity development (GCI) pattern in model 2, however considering the R-square change in model 1 and 2 we observe that IDV explains about 30 percent of the variation in cybersecurity development pattern leaving 3.9 percent variation to be explained by the other four dimensions collectively.

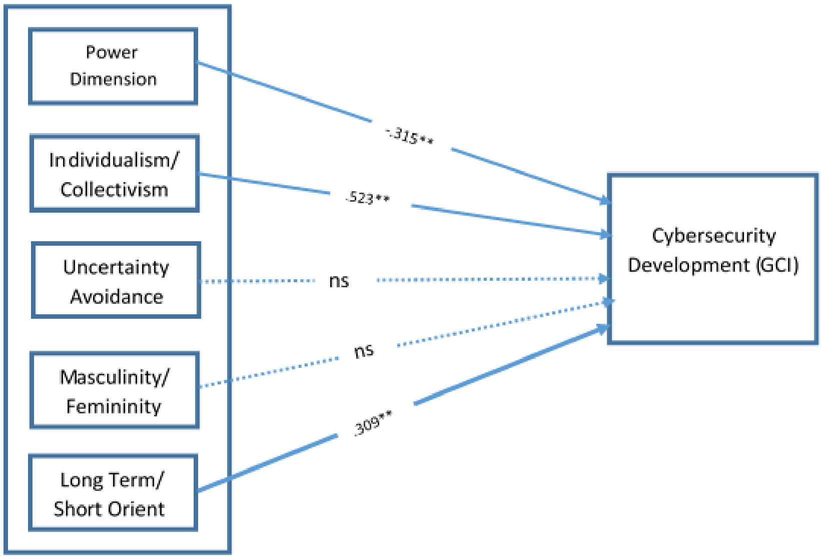
At step 1 of the model, IDV beta score is 0.551 at a p value of 0.000, which is highly significant, however when we introduced all the cultural dimension in step 2 IDV received the highest in number in beta value 0.45 for cybersecurity development at a significant level of 0.001 in III which is consistent with the result of our correlation analysis.

We also observe in from III from the result of the hierarchical regression, LTO receive the second highest score number in beta 0.191 but fails to pass the significant test (P>0.005). PDI has a negative value in beta -.061 which shows a negative correlation with GCI which is also consistent with our correlation analysis and suggests that high PDI leads

TABLE II
PEARSON CORRELATION

| Variables | PDI | IDV | MAS | UAI | LTO | LEG | TECH | ORG | CAB | COR | GCI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PDI | 1 | -.609** | .040 | .191 | -.098 | -.229* | .003 | -.271* | -.266* | -.287** | -.315** |
| IDV | -.609** | 1 | .011 | -.198 | .253* | .403** | .068 | .442** | .437** | .433** | .523** |
| MAS | .040 | .011 | 1 | -.017 | .030 | -.031 | .073 | -.011 | .079 | -.071 | .002 |
| UAI | .191 | -.198 | -.017 | 1 | .011 | .053 | -.164 | -.032 | -.058 | -.081 | -.047 |
| LTO | -.098 | .253* | .030 | .011 | 1 | .404** | .297** | .203 | .143 | .367** | .309** |
| LEG | -.229* | .403** | -.031 | .053 | .404** | 1 | .222* | .524** | .501** | .501** | .693** |
| TECH | .003 | .068 | .073 | -.164 | .297** | .222* | 1 | .205 | .301** | .237* | .332** |
| ORG | -.271* | .442** | -.011 | -.032 | .203 | .524** | .205 | 1 | .608** | .627** | .876** |
| CAB | -.266* | .437** | .079 | -.058 | .143 | .501** | .301** | .608** | 1 | .605** | .847** |
| COR | -.287** | .433** | -.071 | -.081 | .367** | .501** | .237* | .627** | .605** | 1 | .779** |
| GCI | -.315** | .523** | .002 | -.047 | .309** | .693** | .332** | .876** | .847** | .779** | 1 |

[1] **Strong at 0.01 p value
[2] *Weak at 0.01 p value



Notes: ns indicates statistically non-significant at p<0.01

Fig. 2. Outcome of Research Model

to lower GCI. However the result fails the significant test (P>0.005) . Just like the result of our correlation, MAS and UAI fails to pass the significant test.

Based on our analysis using Pearson correlation analysis, our hypothesis 1, 2 and 5 are accepted;
Countries with smaller power distance tend to have high level of cybersecurity development (GCI): H1
Countries with high individualism tend to have high level of cybersecurity development (GCI): (H2)
Countries with long term orientation tends to have high level of cybersecurity development (GCI): (H5)
Based on our analysis using hierarchical regression analysis; Hypothesis 2 is accepted
Countries with high individualism tend to have high level of

TABLE III
HIERARCHICAL REGRESSION

| | | B | Beta Value | Sig. Level | VIF |
|---|---|---|---|---|---|
| Model1 | IDV | 0.004 | 0.55 | .000 | 1.000 |
| Model2 | IDV | 0.005 | .450 | .001 | 1.878 |
| | PDI | -0.001 | -.061 | .636 | 1.792 |
| | MAS | 0.000 | 0.42 | .667 | 1.028 |
| | UAI | -.001- | .067 | .497 | 1.052 |
| | LTO | .002 | .191 | .060 | 1.080 |

TABLE IV
HIERARCHICAL REGRESSION

| Model | R | R Sq. | Adj.R Sq | Std. err. | R Sq Change |
|---|---|---|---|---|---|
| 1 | 0.551* | .303 | .294 | .16287 | .303 |
| 2 | .585 | .343 | .296 | .16258 | .039 |

cybersecurity development (GCI): (H2)

Our hypothesis 3 and 4 are rejected by either of the statistical analysis

Countries with low uncertainty avoidance tend to have a high level of cybersecurity development (GCI): H3

Countries with high masculinity tend to have a high level of cybersecurity development (GCI): H4

The result of the Pearson correlation analysis is summarised in Fig 2

## VI. DISCUSSUION

National culture influences cybersecurity development and explains for the variation between countries (R-square =.343) Table IV. This can be seen from the result of our regression analysis. The result also shows that countries from national cultures that expresses individualism tend to perform better in cybersecurity development (high GCI index). This is evident as high individualism culture is associated with countries from the west with cultural index score in individualism as follows (USA ,91 , UK 89, Canada 80, Netherland 80) which also have very high GCI.

LTO could not pass the test of significant in the regression analysis but how ever was significantly correlated with GCI in the Pearson correlation analysis. Our explanation for this is that cybersecurity is an emerging phenomena which hovers in between both long and short tern approach hence the difference in the results of the two analysis. However the significant correlation it has with GCI is an indication of long term strategic planning associated cybersecurity development.

We also see that PDI which could not also pass the significant test at the regression analysis though it has a negative correlation with GCI suggesting that cultures with lower power distance have tend to have high cybersecurity development (GCI). Countries such Canada New Zealand, Norway UK and Estonia all have low PDI culture but with high cybersecurity development. We observe some inconsistency which suggest that factors such as the countrys political system which was not incorporated in our analysis could also be responsible for the out result outcome as PDI failed test of significance at the regression analysis.

Our result further shows that UAI and MAS has a minimal and statistically insignificant effect on cybersecurity development. This however contradicts the assumption that low Uncertainty Avoidance (UAI) embrace technology and hence the need for cybersecurity development

## VII. CONCLUSION AND FUTURE WORKS

Our study was on impact of national culture on cybersecurity development. The study contributes to a better understanding of how culture effect cybersecurity development and account for the variations in the level of cybersecurity development amongst nations.

Cybersecurity is an emerging phenomena and various countries are taking its advantage to explore avenues of economic development. Developing the sector has therefore become highly imperative as businesses and political activities now depend on the cyberspace to achieve economy of scale and coverage. Our conclusion therefore is that culture affects the nations approach to cybersecurity development, each country should depend on their cultural strength to accelerate the development of cybersecurity. The study further provides empirical guidance for government and policy makers in the design of an effective cybersecurity strategy.

Given the limitations of our study which include the criticism of Hofstede cultural dimension index as not covering all the countries, inspite of inclusion of the most recent up to date index score as obtained value scale module, only index score of 89 countries was available, more so the fact that culture is not static and changes over time [15].

It is important that the study is conducted using a different cultural framework. Future work may consider incorporating other factors such as the governance model and other qualitative factors that contribute to cybersecurity development.

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