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# NATIONAL CULTURE AND TECHNOLOGY ACCEPTANCE: THE IMPACT OF UNCERTAINTY AVOIDANCE

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## ABSTRACT

*This study combined the results from 95 TAM articles to examine the impact of uncertainty avoidance on national culture and technology acceptance. This meta-analysis was based on 342 reviewed TAM articles, of which 95 met the selection criteria of both reported statistics and national culture. Each article was coded for national culture based on the rankings from the works of Hofstede and GLOBE. Overall, hypotheses about uncertainly avoidance practices (UAP) were supported for each correlation. High-level UAP confidence intervals were significantly lower than for the medium-level and low-level UAP groups for each of the TAM construct correlations.*

**Keywords:** technology acceptance, cultural dimensions, uncertainty avoidance

## INTRODUCTION

Scholars frequently cite national culture as influential on technology acceptance, yet scant research has directly addressed how or the degree to which national culture impacts technology acceptance [9, 26, 29, 31]. As Hasan and Ditsa stated, "Of all the factors that must be considered in the adoption of information technology, culture is probably the most difficult to isolate, define and measure" (p. 5) [9]. Further, Veiga, Floyd, and Dechant observed that "to date, the extant literature has centered on the technology acceptance model (TAM) because it is one of the most widely cited and influential models for explaining the acceptance of IT. However, this literature has remained relatively silent with respect to the role that differences in national culture might play in IT acceptance as globalization continues" (p. 145) [35]. IT scholars have frequently referenced the cultural dimensions developed by Geert Hofstede [10], the most influential researcher on cross-cultural work values [9, 18, 27]. In particular, a number of IT researchers have identified uncertainty avoidance (UA) as the most influential cultural dimension in determining cross-cultural variation in technology acceptance [5, 10, 26, 29, 31].

Based on the existing literature, identifying the impact of cultural-level uncertainty avoidance on technology acceptance is hindered by two problems. First, there simply have not been empirical studies that examine technology acceptance in a sufficient number of cultures. Hofstede stated that at least 10 to 15 national cultures are necessary in order to make substantiated claims about the impact of cultural dimensions on behavior. No known technology acceptance research that employs national culture as a unit of analysis about the role of UA meets this threshold [10]. The second problem is that the construct of cultural-level UA has been measured across cultures on a large scale using two approaches and thus producing two sets of results. In this study, we sought to address these two problems by conducting a meta-analysis of the TAM literature so that we could compare construct correlations among samples from dozens of countries. At the same time, we sought to compare these TAM-construct correlations.

## LITERATURE REVIEW

### The Technology Acceptance Model (TAM)

The technology acceptance model (TAM) has been widely reported and abundant descriptions of it can be found elsewhere; therefore, we briefly review the core constructs. Perceived usefulness (PU) is the extent to which using a technology is perceived as helpful to job performance. Perceived ease of use (PEOU) is the extent to which a technology is perceived as not requiring much effort. PU and PEOU influence a person's behavioral intention (BI) or intention to use the technology and the actual usage of the technology. Additional constructs were added in subsequent versions of the technology acceptance model (i.e., TAM2, UTAUT) such as social norm (SN) and attitude (ATT) [4, 21, 22, 27, 36].

### Cultural-level Uncertainty Avoidance

Hofstede (2001) developed the cultural dimensions of uncertainty avoidance, power distance, individualism, and masculinity based on over 116,000 survey responses in IBM units in approximately 60 countries between 1967 and 1971. The surveys were designed to measure work-related values. His works are unquestionably the most influential scholarly works on national culture. Hofstede's measure of uncertainty avoidance (UAI) is intended to assess the degree to which members of a society "feel either uncomfortable or comfortable in unstructured situations. Unstructured situations are novel, unknown, surprising, different from usual. The basic problem involved is the degree to which a society tries to control the uncontrollable" [10].

Beginning in 1993, the GLOBE research team sought to replicate and extend Hofstede's cultural dimensions. Ultimately, 170 social scientists and management scholars from 62 societies engaged in the research, and data was collected from 17,000 managers in 62 countries between 1994 and 1997. Unlike in Hofstede's study of work-related values, the GLOBE team distinguished between practices and values, which are oftentimes negatively correlated. Practices identify the degree to which certain values *are implemented* in society; whereas values identify the degree to which certain values *should be implemented* in society [5, 11, 12, 13].

In terms of uncertainty avoidance, the GLOBE team defines UA in similar but more specific terms than Hofstede: "the extent to which ambiguous situations are threatening to individuals, to which rules and order are preferred, and to which uncertainty is tolerated in society" (p. 602) [5]. GLOBE claims that Hofstede's 3-item measure of UAI lacks face validity since it contains one value item and two items that cannot be classified as value or practice items (an outcome item and a behavioral intention). Furthermore, several items do not seem to adequately profile respondents' responses. For example, one item asks how long an employee intends to continue working for the company. A number of researchers have pointed out that this item is unable to distinguish between employees who have worked for the company for ten years or for one year and both state that they intend to leave the company soon. Another item focuses on a preference for rules. Hofstede assumes that a strong preference for rules assumes that the only reason societies implement rules is to cope with uncertainty. However, in some societies, a preference for rules may be an outgrowth of religious traditions, and stress levels associated with uncertainty may in fact be low. By contrast, the GLOBE measures (UAP and UAV) clearly distinguish values and practices. For example, a typical item on the GLOBE survey to measure UAP is worded as follows: *In this society, societal requirements and instructions are spelled out in detail so citizens know what they are expected to do*. A corresponding item for UAV is worded as follows: *I believe that societal requirements and instructions should be spelled out in detail so citizens know what they are expected to do*.

The Hofstede and GLOBE measures of UA are only moderately correlated, indicating there is a difference in what is being measured. As illustrated in Table 1, UAI and UAV, both of which are intended to measure UA values, are significantly but only moderately correlated ($r$ = .35). UA practices (UAP) are significantly and negatively correlated with values (UAV: $r$ = -.62; UAI; $r$ = -.62)

***Table 1.*** Correlations Between Hofstede and GLOBE Uncertainty Avoidance Measures

| | UAP | UAV | UAI |
|---|---|---|---|
| UAP | - | | |
| UAV | -.62** | - | |
| UAI | -.62** | .35* | - |

Note. UAP = GLOBE measure of UA practices; UAV = GLOBE measure of UA values; UAI measures Hofstede's UA index, which is primarily based on values.
*$p$ < .05; **$p$ < .01

**Impact of National Culture on Technology Adoption and Technology Acceptance**

Hofstede's strongest statements about the role of national culture on technology adoption relate to uncertainty avoidance. He states that technological solutions appeal more to high UA cultures since these solutions are generally more predictable than human solutions. Consequently, high UA cultures are likely to invest more in technology [10]. Like Hofstede, the GLOBE group also identifies UA as the cultural dimension most strongly correlated with technology adoption. They state that "perhaps in no other realm of human endeavor would we expect uncertainty avoidance, defined in terms of formalization and structure, to be more influential than in the conduct and progress of science and technology" (pp. 632-633) [5]. Similar to Hofstede, the GLOBE team recognizes that high UA cultures have a tendency to resist change more often. However, resisting change does not necessarily imply resisting technology. In fact, they support the notion that cultural practices predicated on UA foster technology development: "In formalized and orderly cultures, therefore, one may also find more company-university cooperation, more emphasis on basic science and research, and more interest among youth regarding science and technology issues" (p. 633) [5]. They find that there is a strong correlation ($r$ = .59**) between UAP and a measure of success with basic science.

Several groups of researchers have examined the role of uncertainty avoidance, using Hofstede's scores, on technology adoption. Ironically, these researchers have tended to approach the notion of uncertainty avoidance from a different perspective than Hofstede or the GLOBE team. Whereas Hofstede and the GLOBE team suggest that high UA are more likely to embrace technology as a means to reduce uncertainty, these researchers have tended to hypothesize that a fear of uncertainty results in a resistance to adopting the technology in the first place. Png, Tan, and Wee examined the degree to which UA and power distance affected corporate adoption of frame relay technology. Based on responses from 153 businesses in 24 countries, they found that high UA cultures (according to UAI measure) were significantly less likely to adopt the technology; however, power distance had no affect on technology adoption [26]. Sundqvist, Frank, and Puumalainen examined the impact of Hofstede's cultural dimensions on the adoption timing of wireless communications from 1981 to 2000. Controlling for national wealth, they hypothesized that Hofstede's dimensions would have the following impacts: (a) countries with higher UAI adopt innovations by imitation; (b) countries with high individualism would have faster diffusion of wireless communications; (c) countries with higher power distance would have slower diffusion of wireless communications; and (d) countries with higher masculinity would have faster diffusion of wireless communications. All of these hypotheses failed with the exception of their hypothesis about UA. Thus, they concluded that high UA cultures do indeed wait longer to adopt technology and rely more on observing the experiences of early adopters [31]. Garfield and Watson also found that high UA slowed the development of technology infrastructure [8]. Various other researchers have also concluded that high UA cultures adopt technology later [7, 8, 9, 19, 35].

A number of IT researchers have described the role of each of Hofstede's cultural dimensions on TAM [1, 2, 3, 9, 16, 17, 25, 28, 32, 33, 35]. Uncertainty avoidance is singled out much more frequently than the other cultural dimensions (power distance, individualism, and masculinity); therefore, we focused our study on UA. The first researchers to examine TAM outside of North American culture were Straub, Keil, and Brenner in 1997. They examined email use in the United States, Switzerland, and Japan. They primarily focused on the potential impact of UA on technology acceptance and expected high UA cultures to use computer-mediated communication less. They concluded that TAM did not work well with the Japanese sample.

The most ambitious effort to identify the role of national culture on TAM was McCoy's 2002 study. He hypothesized that the PEOU-PU, PU-BI, and PEOU-BI correlations would be higher for high UA cultures. Since the more useful a technology or system is and the easier it is to use, the more it reduces uncertainty. He collected surveys from 3,904 (2,506 U.S.; 1,329 non-U.S.) university students. Samples from most countries were extremely small, with the exception of the following countries with more than 50 respondents: Australia (206), Singapore (190), Hong Kong (156), Puerto Rico (101), Canada (100), South Africa (69), and China (68). He employed individual-level scores of Hofstede's cultural dimensions. All UA hypotheses were supported in his study. Most of the hypotheses he made about other cultural dimensions were not supported [24]. It is important to note, however, that McCoy compared individual-level scores for UA with individual-level TAM scores. Hofstede strongly opposes such practice and states that cross-natural variations can only be accurately detected by comparing national-level scores [10].

**Prior Meta-Analyses of TAM**

We identified three prior meta-analyses of TAM studies: Ma and Liu's 2004 study [22], King and He's 2006 study [20], and Schepers and Wetzels' 2007 study [27]. Ma and Liu and Schepers and Wetzels employed comparable methods of selecting articles. They identified empirical TAM articles that reported sample size and correlation coefficients, consistent with classical meta-analysis guidelines [14]. Ma and Liu identified 26 studies and Schepers and Wetzels identified 63 studies.

Since most studies do not report correlation matrices and many researchers are more interested in structural relationships among TAM constructs, King and He meta-analyzed 88 studies and took two approaches to obtaining beta scores: converting correlation scores into beta scores and coding path coefficients in linear-regression-based analyses [20]. This method, however, is more controversial, and some prominent meta-analysis methodologists recommend against this method [14].

Among the three research groups to conduct meta-analyses, only Schepers and Wetzels addressed whether culture was a moderating variable in the

TAM model. They coded cultures as Western or non-Western—46 studies were Western and 17 were non-Western. The Western societies included US, Canada, Norway, Netherlands, Australia, New Zealand, and Finland. The non-Western societies included Hong Kong, Taiwan, Saudi Arabia, Nigeria, China, UAE, Korea, and Singapore. They found that culture was a significant moderating variable, but an overall pattern was hard to distinguish. While PU was more important in Western societies, PEOU was more important in non-Western societies. The weakness of their study, however, was that their method of coding for culture was not based on cultural dimensions but rather West versus non-West countries. This distinction is primarily a geographic distinction with little description about the rationale for cultural variation. This distinction is particularly tenuous given the wide range in cultural-level uncertainty avoidance among countries within each of the two groups.

## RESEARCH METHODOLOGY

Based on our literature review, we made the following hypotheses:

$H_1$: Higher UA values (UAI, UAP) are associated with higher PEOU-PU correlations; Higher UA practices (UAP) are associated with lower PEOU-PU correlations.

$H_2$: Higher UA values (UAI, UAP) are associated with higher PEOU-BI correlations; Higher UA practices (UAP) are associated with lower PEOU-BI correlations.

$H_3$: Higher UA values (UAI, UAP) are associated with higher PU-BI correlations; Higher UA practices (UAP) are associated with lower PEOU-PU correlations.

We selected empirical TAM articles based on the following criteria: (a) included a description of the sample; (c) provided effect sizes, either as Pearson Product Moment Correlations (*r*) or other statistics that could be converted into a correlation coefficient (*r*). We coded each research sample separately. In some cases a single article contained more than one sample. For example, Straub, Keil, and Brenner sampled groups from Japan, Switzerland, and the United States. We also coded for national culture so that we could use corresponding rankings from the works of Hofstede and GLOBE.

Altogether, we reviewed 342 TAM articles. We identified 95 studies among these articles that met our criteria. As illustrated in Table 2, the United States was the country most frequently sampled. Altogether, the articles included samples from 25,011 respondents in 19 countries. Table 2 also provides scores (low, medium, high) for UAI, UAP, and UAV, to illustrate the broad range of cultural tendencies among these samples.

We chose to conduct our meta-analysis consistent with techniques applied to several previous meta-analyses, particularly that of Ma and Liu [22] and

***Table 2***. Country Samples Represented in Meta-Analysis

| Country | Studies | *N* | UAI | UAP | UAV |
|---|---|---|---|---|---|
| USA | 39 | 7,106 | L | M | M |
| China | 8 | 1,870 | L | H | H |
| Canada | 8 | 1,164 | L | M | L |
| Taiwan | 8 | 2,584 | M | M | H |
| UK | 5 | 1,338 | L | M | M |
| Hong Kong | 4 | 3,146 | L | M | H |
| Korea | 4 | 1,412 | H | L | H |
| Singapore | 4 | 1,900 | L | H | H |
| NZ | 3 | 670 | L | H | M |
| Finland | 2 | 900 | M | H | M |
| Australia | 2 | 500 | L | M | M |
| Jordan | 1 | 812 | M | L | H |
| Kuwait | 1 | 387 | M | M | H |
| Nigeria | 1 | 143 | - | M | H |
| Netherlands | 1 | 212 | M | M | L |
| Denmark | 1 | 38 | L | H | L |
| Israel | 1 | 90 | M | L | M |
| Norway | 1 | 459 | L | H | M |
| Turkey | 1 | 280 | H | L | H |
| Totals | 95 | 25,011 | | | |

*Note*. H = High; M = Medium; L = Low

guidelines from Hunter and Schmidt [14]. We first calculated the mean correlation with a sample size adjusted mean:

$$\bar{r} = \frac{\sum[N_i r_i]}{\sum N_i}$$

Then, we calculated the sample variance with the frequency-weighted average squared error:

$$s_r^2 = \frac{\sum[N_i(r_i - \bar{r})^2]}{\sum N}$$

We calculated the number of studies, total sample size, mean correlation and sample variance for each correlation (PEOU-PU, PEOU-BI, PU-BI) and level (low, medium, high) of UA (UAI, UAP, UAV).

## RESULTS

Results for number of studies, total sample size, mean correlation, sample variance, and confidence interval are provided for each UA level in Table 3. Since so many studies were conducted in the U.S., we were worried that American samples could exert a disproportional effect on the results. Therefore, whenever the U.S. was part of a UA level, we report results for the entire group as well as the non-U.S. portion and U.S.-only portion of the group.

Overall, hypotheses about UA practices (UAP) were supported for each correlation. High-level UAP confidence intervals were significantly lower than for the medium-level and low-level UAP groups for each of the TAM construct correlations.

Hypotheses about UA values (UAI and UAV) are mixed. Hofstede's measure of UA values (UAI) was not significantly different between low-, medium-, and high-levels for the PU-PEOU and PU-BI relationships. For the PEOU-BI relationship, high-level UAI correlations were significantly higher than medium-level UAI correlations, which is consistent with our hypothesis; however, low-level UAI correlations are essentially the same as high-level UAI correlations, which is contrary to our hypothesis. High-level UAV correlations are higher than medium-level UAV PEOU-PU correlations, consistent with our hypothesis; however, high-level UAV correlations are the same as low-level UAV PEOU-PU correlations, inconsistent with our hypothesis. High-level UAV correlations are significantly higher than medium-level non-U.S. and low-level UAV PEOU-BI correlations consistent with our hypothesis. Finally, higher-level UAV PU-BI correlations were not higher; in fact, low-level UAV produced significantly higher PU-BI correlations, contrary to the expected direction of this relationship.

## CONCLUSIONS

This study provides some insight into the role of cultural-level UA and technology acceptance. UA was associated with significant differences in some of the TAM-construct correlations. In particular, UA practices were shown to significantly impact technology acceptance. In cultures where UA is in practice—in other words, where there are institutionalized rules and procedures already in place to deal with uncertainty—correlations between the TAM constructs (PEOU-PU, PEOU-BI, PU-BI) are lower. This likely follows the logic of the GLOBE team and Hofstede. Technological solutions appeal to these cultures in order to reduce the inevitable uncertainty associated with people-based solutions. Furthermore, these societies, with their attention to orderliness and structure, institutionalize the learning of science and technology. Thus, cultural members generally have a higher level of science and technology expertise. Perceived ease of use is less consequential because cultural members trust that they have sufficient skills to learn new technologies and there are formal mechanisms established in society to help people learn new technologies when necessary.

Both measures of UA values (UAI and UAV) were poor predictors of traditional propositions about the impact of UA on technology acceptance, although UAV outperformed UAI. All prior cross-cultural IT research has focused on values (values that *should be* implemented in society) as opposed to practices (practices *that are* implemented in society). Since UA practices outperformed UA values in described cross-variation in technology acceptance, we recommend that future cross-cultural IT research employ a measure of practices in addition to or in place of values.

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***Table 3***. Sample Size Adjusted Means and Variance for High, Medium, and Low Uncertainty Avoidance Cultures

| ***PU-PEOU*** | # of Studies | Total *N* | Sample Size Adjusted Mean | Sample Variance | Confidence Interval Lower | Confidence Interval Upper |
|---|---|---|---|---|---|---|
| High UAI | 5 | 1692 | .607 | .045 | .518 | .696 |
| Medium UAI | 13 | 4278 | .510 | .008 | .494 | .525 |
| Low UAI | 75 | 15142 | .492 | .031 | .431 | .553 |
| Low UAI (non-U.S.) | 36 | 8753 | .425 | .072 | .283 | .566 |
| Low UAI (U.S. only) | 39 | 6389 | .583 | .064 | .458 | .709 |
| High UAP | 19 | 4191 | .398 | .015 | .369 | .427 |
| Medium UAP | 69 | 14857 | .520 | .027 | .467 | .574 |
| Medium UAP (non-U.S.) | 30 | 8468 | .473 | .023 | .428 | .518 |
| Medium UAP (U.S. only) | 39 | 6389 | .583 | .026 | .532 | .634 |
| Low UAP | 7 | 2594 | .543 | .040 | .464 | .622 |
| High UAV | 32 | 11365 | .439 | .023 | .394 | .483 |
| Medium UAV | 53 | 9075 | .582 | .027 | .530 | .635 |
| Medium UAV (non-U.S.) | 14 | 2686 | .580 | .029 | .524 | .637 |
| Medium UAV (U.S. only) | 39 | 6389 | .583 | .026 | .532 | .634 |
| Low UAV | 10 | 1202 | .443 | .013 | .417 | .470 |
| ***PEOU-BI*** | | | | | | |
| High UAI | 5 | 567 | .454 | .036 | .383 | .524 |
| Medium UAI | 13 | 1978 | .536 | .005 | .526 | .546 |
| Low UAI | 75 | 9826 | .416 | .019 | .378 | .453 |
| Low UAI (non-U.S.) | 36 | 5924 | .381 | .015 | .353 | .410 |
| Low UAI (U.S. only) | 39 | 3902 | .469 | .021 | .427 | .510 |
| High UAP | 19 | 1018 | .351 | .017 | .317 | .385 |
| Medium UAP | 69 | 11173 | .437 | .019 | .400 | .474 |
| Medium UAP (non-U.S.) | 30 | 7271 | .420 | .017 | .387 | .453 |
| Medium UAP (U.S. only) | 39 | 3902 | .469 | .021 | .427 | .510 |
| Low UAP | 7 | 567 | .454 | .036 | .383 | .524 |
| High UAV | 32 | 6845 | .439 | .020 | .400 | .478 |
| Medium UAV | 53 | 4859 | .443 | .021 | .403 | .483 |
| Medium UAV (non-U.S.) | 14 | 957 | .338 | .004 | .330 | .347 |
| Medium UAV (U.S. only) | 39 | 3902 | .469 | .021 | .427 | .510 |
| Low UAV | 10 | 1054 | .320 | .005 | .311 | .330 |
| ***PU-BI*** | | | | | | |
| High UAI | 5 | 567 | .577 | .038 | .503 | .650 |
| Medium UAI | 13 | 2086 | .614 | .023 | .570 | .659 |
| Low UAI | 75 | 11252 | .500 | .019 | .462 | .538 |
| Low UAI (non-U.S.) | 36 | 6826 | .466 | .017 | .433 | .499 |
| Low UAI (U.S. only) | 39 | 4426 | .553 | .019 | .516 | .590 |
| High UAP | 19 | 1920 | .343 | .024 | .297 | .390 |
| Medium UAP | 69 | 11805 | .537 | .016 | .506 | .567 |
| Medium UAP (non-U.S.) | 30 | 7379 | .527 | .013 | .501 | .554 |
| Medium UAP (U.S. only) | 39 | 4426 | .553 | .019 | .516 | .590 |
| Low UAP | 7 | 567 | .577 | .038 | .503 | .650 |
| High UAV | 32 | 7920 | .486 | .024 | .438 | .533 |
| Medium UAV | 53 | 5318 | .530 | .018 | .494 | .567 |
| Medium UAV (non-U.S.) | 14 | 892 | .419 | .019 | .382 | .457 |
| Medium UAV (U.S. only) | 39 | 4426 | .553 | .019 | .516 | .590 |
| Low UAV | 10 | 1054 | .623 | .004 | .616 | .631 |