Thai Online Practitioners' Attitude Towards CAPTCHA

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Abstract

Completely Automated Public Turing test to tell Computers and Humans Apart or CAPTCHA has received remarkable attention. Deciphering distorted texts is still a human task. The current CAPTCHA mainly requires users to read English alphabets. As such, Thai CAPTCHA may be the choice for Thai online practitioners. However, no published work has examined how Thai online practitioners perceive CAPTCHA. This study thus attempts to fill this void.

Based on the 112 number of usable online questionnaire submission, Thai online practitioners are all aware of CAPTCHA. Also, nine out of ten samples identified correctly the prime benefits of CAPTCHA. Using exploratory factor analysis, their attitude towards CAPTCHA was classified into two dimensions. They perceived (1) drawback of general CAPTCHA and (2) feasibility of Thai CAPTCHA.

In addition to extending our insight into application of CAPTCHA, policy-makers responsible for electronic commerce in Thailand could initiate plans in response to Thai online practitioners' perception.

Keywords : Thai Online Practitioners, CAPTCHA, Internet, Attitude, Exploration

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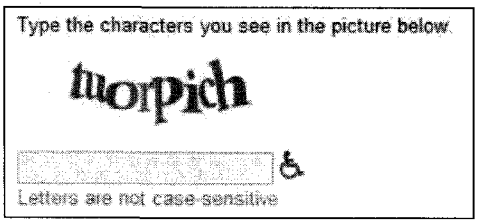
1. Problem Statement

CAPTCHA or Completely Automated Public Turing test to tell Computers and Humans Apart is an automatically created, and publicly available test in which distorted texts are presented to humans so they could decipher the texts but computers could not [von Ahn et al., 2004]. This is how online service providers could prevent hackers from abusing their services since only humans, not computers, could decode the distortion. Typically, users will receive a box on a screen containing texts that had been altered so optical character recognition (OCR) can not read them. The users will then type those decoded texts in the box to confirm they are humans. Without CAPTCHA, spammers may be able to draft automated code that could automatically register for a large number of electronic mail accounts subsequently used in their scam. According to the example of CAP TCHA in <Figure 1>, a subscriber will decode eight altered texts and type *tuorpich* in the box beneath the array of texts to indicate he or she is human, not automated computer software.



〈Figure 1〉 Example of Captcha at gmail.com

Texts have been acceptable for CAPTCHA implementation [Holman et al., 2007; Naone, 2009; Egele et al., 2010]. However, other contents have also been experimented. Based on their experiment, Matthews and Zau [2010] found that an image CAPTCHA requiring a subject to answer about items in the image seems to accurately separate humans from automated software. Hoping to help the blinds, Holman et al. [2007] incorporated audio into textual CAPT CHA. Their preliminary assessment seems promising. This could inspire other scholars to develop sound-based CAPTCHA [Gossweiler et al., 2009]. To deal with spyware, Gao et al. [2009] suggest a new design CAPTCHA. Not only must a user decode the texts, but they have to understand a distorted graphic. Although promising, they lack empirical verification. Yan and El Ahmad [2008] contended that the wide acceptance of text CAPTCHA comes from a fair number of advantages including ease of use and effectiveness in preventing the abuse. Indeed, they have suggested a number of recommendations on how to develop usable CAPTCHA [Yan and El Ahmad, 2008]. Kluever and Zanibbi [2009] offer advice on how to design a video CAPTCHA that balance issues of usability and those of security. Subjects in their experiment admit that they are in much favor of this video CAPTCHA than a typical text CAP TCHA.

Security in electronic services has been enhanced because of the application of CAPTCHA. Free e-mail service providers have encountered chronic serious problems from those who signed up for hundreds of thousands of e-mail accounts. These addresses may then be

used (1) in directing marketing campaigns including those for pornography websites or (2) by those who want to flood their opinions into web boards or public blogs without being traced their identities.

Not only does CAPTCHA help preventing abuse, it also helps presenting knowledge. The best example of this contribution is through the reCAPTCHA project [von Ahn et al., 2008]. There has been an attempt to digitize contents in old books using OCR software. However, certain words are not OCR-readable because of the old books' classic printing styles with faded ink and yellow pages. von Ahn et al. [2008] have used those words to display in CAPTCHA so that humans could help deciphering the words. This reCAPTCHA has improved the performance of digitizing old printed contents and makes that knowledge more accessible to the public.

CAPTCHA does have drawback. Since it requires humans to read distorted characters, it may impose particular problems on visually-impaired people, the blinds or the illiterates. Such concern results in a few projects that have tried to use other details to tell computers and humans apart. Yahoo has allowed the blinds to register for their services by providing their numbers which will later be used to verify their blindness [Garfield, 2003]. Holman et al. [2007] offered both visual and audio CAPTCHA and found that the blinds have no problems working with the audio version. Also, they contended that the use of audio-based CAPTCHA would gain higher acceptance only when the speech recognition software is much improved [Holman et al., 2007]. Instead of making an attempt to decode fuzzy texts, ones should be more comfortable working with images of cats or dogs These animals have been known as humans' best friends. Golle [2008] thus adopted this concept to implement pictorial CAPTCHA and his results, although not through the comparison, have ascertained the high accuracy of this type of CAPTCHA. Based on this similar pictorial CAPTCHA, Gossweiler et al. [2009] at Google used an experiment to verify their image-orienting CAPTCHA. According to their experiment, humans simply need to orient an actor in the image to the upright position using a variety of hardware tools. Computers, on the other hand, should not as yet figure out this task. Orienting an image may require a higher skill than just typing texts. This could then be the major concern in the work of Gossweiler et al. [2009]. Given a quick improvement of OCR which could be serious threat to CAPTCHA acceptance, Mitra et al. [2009] suggest that a 3-D image be adopted in lieu of the text CAPTCHA. This remark does clearly point out to this evolving area of interest.

Even with normal humans does CAPTCHA still have problems. It is sometimes too difficult for them to understand those distorted texts [Margulius, 2006; Naone, 2009]. Given the fuzzy design background plus the heavily distorted characters, ones may constantly ask to change many sets of CAPTCHA before they could figure out correctly the twisted texts [Yan and El Ahmad, 2008]. These researchers thus offer tips on how to create more usable CAPTCHA. Gossweiler et al. [2009] project that requires

humans to orient an image to the upright angle seems to alleviate the difficulty of text-reading. Instead of demanding users to decode texts, Matthews and Zou [2010] require that the users must (1) look at an image CAPTCHA and (2) respond to a question, of which the answer comes from their understanding of items on the image. Although difficult to implement, Matthews and Zou [2010]'s experiment had proved this style of CAPTCHA is sufficiently difficult to prevent the abuse but sufficiently easy for humans to work with.

The final drawback has to do with CAPTCHA's context dependency. The original and specific context is that (1) a human with certain English reading skill (2) must understand an array of distorted characters blended in an obscured background and then (3) use a psychomotor skill interacting with certain hardware in order to type the decoded texts into the box before submitting them to verify that he or she is not an automated computer program. While the second and the third specific requirements have been addressed in previous paragraphs, the first or language dependency is particularly of our interest.

English has been one of the most frequently used languages on the computer screen [Nelson and Loranger, 2006]. It has however exhibited serious threat to copyrighted contents in other languages or to those who are unfamiliar with English alphabets. That is, if Thai innovators have drafted an online content and they hope these will be sharable among Thai people, it would imply a serious need to develop a language-sensitive CAPTCHA. It would thus be able to tell computers and, say, Thai people apart. This need is evident in Shirali-Shahreza and Shirali-Shahreza's [2006] and Chen's [2009] projects. However, the main focus of these projects was on the technical algorithm and little is on how Persian or Arabic [Shirali-Shahreza and Shirali-Shahreza, 2006] or Chinese [Chen, 2009] native speakers would react to this CAPTCHA in their own languages. Moreover, Yan and El Almad [2008] confirmed that those with no background in Latin alphabets had more serious problems in decoding CAPTCHA than those with the background. Also, Egele et al. [2010] surveyed users of their CAPTCHA improvement and discovered they had favorable attitude toward CAPTCHA. This would emphasize the need to examine one's attitude toward CAPTCHA. Our extensive literature review, however, found no development in Thai context, nor an investigation into how Thai practitioners perceive CAPTCHA in general or Thai-CAPTCHA in specific. The development of Thai CAPTCHA would be useless if Thai people hold negative thought towards general or Thai CAPTCHA. Consequently, we attempt to examine the extent to which Thai online practitioners are aware of CAPTCHA, especially those in Thai language.

2. Research Objectives

Based on the study's problem statement, we pursued the following objectives : (1) survey Thai online practitioners' awareness and understanding of CAPTCHA, and (2) describe their attitude towards CAPTCHA.

3. Methodology

This section will discuss five methodological topics : population and samples; instrument; data collection execution; validity and reliability issues; and data analysis framework.

3.1 Population and Samples

Given this research's main concern, the population must be Thai online practitioners. Initially, we made an effort to use a probability-based sampling technique. However, we were unable to locate a complete list of Thai online practitioners or their contact addresses. As a result, we had to adopt the purposive non-probability sampling through an online channel. We further believe that the online questionnaire should be the most feasible means to access to such samples. Once the instrument was ready (detail of its development is in the next section), we posted an invitation to participate in our project on a fair number of web boards to which a variety of our target samples had contributed. Although this may pose certain limitation to the findings, it helps access to the distinct group of Thai online practitioners, thereby increasing the study validity [Babbie, 2010]. To ensure the reach of only Thai online practitioners, the invitation and the instrument were in Thai. Those who do not understand Thai would therefore be excluded from the study.

3.2 Instrument

Given the online survey approach, our questionnaire consisted of three sections. The first one captured a sample's awareness and understanding of CAPTCHA. In this section were three main questions asking them (1) whether they had seen CAPTCHA, (2) in which websites they had encountered CAPTCHA, and (3) what the title and the main benefits of this CAPTCHA are. In the second section were 16 scales measuring their attitude towards CAPTCHA. The scales were adopted and adjusted based on previous studies examining attitude towards similar concepts [Portera and Donthub, 2006; Seo et al., 2007]. The final section gathered the samples' demographic details including screening questions to ensure the subject's eligibility (i.e., Thai online practitioners) to this current project.

The questionnaire was drafted in paper, reviewed by two experts in information technology and pretested by peers in software development companies. Once finalizing the content, we converted it into the online version using an open source survey management program named LimeSurvey. We configured the online questionnaire following the program instruction and pilot-tested it with a different set of peers in order to maximize the instrument usability.

3.3 Data Collection Execution

As explained in previous sections, we had to adopt the purposive non-probability sampling. We thus approached samples using announcements posted in various web boards. In the announcement was invitation to participate in the study, followed by a link to the website containing the questionnaire. When a sample completed the response, all data were recorded

in MySQL database. The data collection took about 30 days to achieve 112 usable responses. The number of samples is justified, given this study's exploratory nature [Babbie, 2010].

3.4 Validity and Reliability Issues

To respond to this study's objectives, we strive to ensure the finding's reliability and validity. Such effort includes the followings.

The questionnaire development received our high priority. Based on previous work [Garfield, 2003; Portera and Donthub, 2006; Seo et al., 2007], all items were carefully crafted so samples would understand them properly. Several rounds of pretests and pilot tests were carried to improve the quality. Finally, each questionnaire was accompanied by an e-mail message detailing the researchers and their affiliations via which samples could contact in case of questioning.

Once transformed into the online version, the questionnaire was assessed, especially on how a sample would be able to fill in the questionnaire. Such assessment was to ensure (1) robustness of this online version, (2) the smooth flow of answering, and (3) the complete development and conversion of data file for further statistical analysis.

3.5 Data analysis framework

The framework has two folds. First, we employed descriptive statistics to report (1) the extent to which samples of Thai online practitioners become aware and understanding of CAPTCHA and (2) their demographics. Second, we adopt an exploratory factor analysis (EFA) with principal component extraction and varimax rotation in order to examine broader constructs underlying their attitude towards CAPTCHA.

Given the exploratory nature of this research, it would be premature to test any hypotheses. However, our work should inspire following scholars to develop or even test any hypotheses in their own studies.

4. Results

4.1 Respondents' Demographics

<Table 1> presents important characteristics of survey respondents, the highlight of which are as follows :

- Male samples account for almost 60% of the respondents. About 7 in 10 of them are 26~30 years old. The largest portion (97%) holds at least college degree and almost 70% have a computer-related major.
- The majority (78%) of respondents live in Bangkok. Note that 12% of them reside abroad. 9 in 10 respondents have at least six years of experience with the Internet. The largest portion (56%) claim to be web developers. About 36% are online business owners while the other 10% are online marketers.

4.2 Thai online practitioners' awareness and understanding of CAPTCHA

According to <Table 2>, all respondents had seen CAPTCHA and contended that they had

〈Table 1〉 RESPONDENTS' DEMOGRAPHIC (N = 112)

Demographics	Respondents N (%)
Gender	
Male	66 (58)
Female	46 (42)
Age	
< 26 yrs	23 (21)
26~30	74 (66)
31~40	15 (13)
Highest education	
Less than college	4 (3)
College degree	58 (52)
Master degree or higher	50 (45)
Whether educational major is computer-related	
Yes	76 (68)
No	36 (32)
Current residency	
In Bangkok metropolitan	87 (78)
In provincial area	11 (10)
Residing abroad	14 (12)
Experience with Internet (years)	
< 3 yrs	2 (2)
3~5	9 (8)
6~9	27 (24)
10+	74 (66)
Responsibility (multiple answers are allowed)	
Web developer	63 (56)
Entrepreneur/owner	40 (36)
System administrator	35 (31)
Graphic designer	33 (30)
Online marketer	10 (9)
Engineer/programmer	6 (5)

〈Table 2〉 Respondents' Awareness and Understanding of Captcha

Demographics	Respondents N (%)
On which websites or services CAPTCHA was seen (N = 112 = 100%)	
Clip image or file sharing	112 (100)
Webboards	99 (88)
E mail	61 (54)
Blogs, or online diaries	56 (50)
Online transaction services	54 (48)
Social network	47 (42)
Community or portal webs	35 (31)
News services	31 (28)
Game services	30 (27)
Music offer	27 (24)
Title in which CAPTCHA is known (N = 111)	
CAPTCHA	42 (38)
CODE	13 (12)
IMAGE	5 (5)
PASSWORD	3 (3)
CHECK	3 (3)
ENCRYPT	2 (2)
BLIND	2 (2)
GOTCHA	2 (2)
I don't know	37 (33)

experienced CAPTCHA when they were engaged in clip, image or file sharing services. Indeed, the other two of the top three websites (or services) on which the respondents had seen CAPTCHA are webboards (88%) and e-mail (54%) services. The three locations where the smallest portions of the respondents admitted their encounters with CAPTCHA are (1) news, (2) game and (3) music offer services. While the first accounts for 28%, the final two choices account for 27% and 24%, respectively.

We also attempted to learn about the extent to which the respondents know about the proper title of CAPTCHA. While 33% of them admitted they had no idea of the title, 67% claimed they were aware of it. In addition, 38%

of those who claimed they knew it were able to identify the correct title of CAPTCHA. This means, besides the 33% who reported they did not know the title, there are still the other 29% who thought they had known it but what they knew was wrong. Among the incorrect names, CODE seems most common among these respondents, followed by IMAGE, PASSWORD and CHECK.

While 4 in 10 samples know CAPTCHA's correct title, 88% of the respondents knew its principal benefit : to tell computers and humans apart (see <Table 3>). Almost 3 out of 10 samples misunderstood that CAPTCHA was mainly to authenticate service subscribers. Less than 10% improperly perceived the advantages. These incorrectly perceived advantages included protecting users from computer virus, preventing typographical error and signaling age-restricted websites. Readers must note from <Table 3> that only 3% of the respondents had no idea of what CAPTCHA could offer.

〈Table 3〉 Perceived Benefits of CAPTCHA (N =112 = 100%)

Benefits	Percentage
To tell computers and humans apart	88%
To authenticate service subscribers	27%
To protect against computer virus	8%
To prevent typographical error	7%
To indicate age-restricted websites	3%
No idea of what possible benefits are	3%

4.3 Attitude Towards CAPTCHA

We asked the samples 16 scales to measure their attitude towards CAPTCHA. They would rate one if they found the scale least favorable or five if most favorable. Descriptive statistics of these 16 scales are in <Table 4>. Skewness and kurtosis statistics are included to indicate that the distributions of these variables are almost normally distributed [Muylle et al., 2004]. The three most favorable attitude scales are (1) Thai CAPTCHA could support the services only for those knowing Thai, (2) CAPTCHA is unnecessary and (3) the respondents try to avoid working with CAPTCHA-enabled websites. Their arithmetic means are 3.91, 3.84 and 3.69, respectively. Based on these three items, it seems that the respondents agree to the large extent on CAPTCHA's unconstructive attributes (i.e., unnecessary to have it or refraining from working with CAPTCHA), although they still perceive that it could support services exclusively for those knowing Thai.

At the other end, the respondents rated three scales of attitude as least favorable : (1) the respondents are more comfortable working with websites containing Thai texts, (2) Thai websites should use Thai CAPTCHA and (3) Thai CAPTCHA may support proper use of copyrighted content. Their arithmetic means are 2.05, 2.29 and 2.29 respectively. Least favorable attitude may indicate a certain extent of disagreement. As such, interpretation of the three least favorable items could be that Thai online practitioners want little to do with (1) Thai CAPT CHA, (2) its application to protect copyrighted content or (3) a website containing Thai texts. Although these are the three least favorable items, their magnitudes are still moderate suggesting their somewhat favorable viewpoint toward CAPTCHA.

Such interpretation about Thai online practitioners' attitude towards CAPTCHA was made based solely on the three most and the three least favorable attitude items. While it is useful to some extent, this understanding may present only fraction of small pictures of their attitude. Consequently, we performed an exploratory factor analysis on these attitude items in order to explore broader constructs underlying their perceptions. Prior to that, however, the scales with marginal variances (i.e., their standard deviations are less than one) were excluded from this analysis since they would not serve to differentiate among emerging factors [Harman, 1976]. The excluded items are detailed in <Table 4>.

<Table 5> presents results of factor analysis that include the factor pattern matrix in which loadings of the attitude items on the two emerging factors are also included. The two factors together explained about 45% of the variance among the attitude items. According to <Table 5>, Factor I accounted for 25.8% of the variance. Highest loadings of the four attitude items on the first factor reflect Thai online practitioners' negative perception toward general CAPTCHA. Factor II accounted for additional 19.0% of the variance. Three items loaded highest on this factor indicating their perceived feasibility of Thai CAPTCHA. Five other attitude items, however, were not assigned to any of these two factors since they did not load cleanly on either of the two factors.

We inspected the quality of these factor analysis results using Kaiser-Meyer-Olkin (KMO) index and Bartlette's test of Sphericity. The KMO index is 0.687, the value of which Kaiser [Kaiser, 1974, p. 35] considered "middling." Also, Bartlette's statistics (363.195, df = 66, $p < .000$) contends that the two factors parsimoniously and properly underscore Thai online practitioners' attitude towards CAPTCHA.

In addition, we used Cronbach's alpha to examine the extent to which items that have highest loadings on each of the two emerging factors are reliable. The Cronbach's alpha for the Drawback factor's four items and that for the Feasibility factor's three items are 0.756 and 0.759, respectively. Since a threadhold of 0.70 or higher will indicate acceptable reliability [Nunnally, 1978], it is reasonable to claim the reliable quality of the two factors' components.

5. Conclusion and Discussion

Based on 112 respondents, the profiles of Thai online practitioners are mostly male, in between 26~30 years of age with computer-related major. 78% of the sampling practitioners live in Bangkok while 12% reside abroad and the rest stay in provincial area. 9 in 10 have at least 6 years of experience with the Internet. The practitioners hold multiple professional responsibilities including technical and managerial positions. Such technical titles are web developers or graphic designers whereas the managerial names are business directors or online marketers. Given that a profile of Thai online practitioners was not documented, we were unable to compare our findings against those in previous studies. Consequently, we would like to challenge fellow researchers to explore more of this

〈Table 4〉 Attitude Towards CAPTCHA : Descriptive Statistics

Statements	Mean	Standard deviation	Skewness	Kurtosis
Thai CAPTCHA could support services for those knowing Thai language	3.91	1.366	-.937	-.469
CAPTCHA is unnecessary	3.84	1.111	-.935	.372
I try to avoid working with CAPTCHA-enabled websites	3.69	1.170	-.566	-.483
Web designers find it difficult to incorporate CAPTCHA into the design	3.68	1.042	-.634	.146
CAPTCHA enhances website creditability*	3.26	.984	-.370	-.375
I don't like those unreadable texts	3.22	1.285	-.195	-1.014
CAPTCHA is effective*	3.17	.939	-.813	.174
Decoding CAPTCHA is difficult	3.07	1.168	-.072	-.840
I have confidence in CAPTCHA*	2.96	.934	-.181	-.118
Thai CAPTCHA is easier than typical CAPTCHA	2.61	1.181	.174	-.895
There may be other better ways to do what CAPTCHA does	2.46	1.065	.118	-.677
Websites are more secured with Thai CAPTCHA	2.39	1.351	.544	-.917
Thai websites have capable CAPTCHA*	2.35	.856	-.041	-.715
Thai CAPTCHA may support proper use of copyrighted content	2.29	1.235	.587	-.646
Thai websites should use Thai CAPTCHA	2.29	1.220	.717	-.283
I am more comfortable working with a website if it contains Thai texts	2.05	1.073	.784	.228

Note) * Items with a standard deviation less than 1.00 are removed from factor analysis.

〈Table 5〉 Factor Analysis Result for Attitude Towards CAPTCHA

Attitude	Factors I	Factors II
Factor I : Drawback of general CAPTCHA		
I try to avoid working with CAPTCHA-enabled websites	.76	-.11
Decoding CAPTCHA is difficult	.72	.00
I don't like those unreadable texts	.72	.06
CAPTCHA is unnecessary	.68	-.16
Factor II : Feasibility of Thai CAPTCHA		
Thai CAPTCHA is easier than typical CAPTCHA	-.09	.84
Thai websites should use Thai texts in CAPTCHA	.11	.77
I am more comfortable working with a website if it contains Thai texts	-.08	.68
Percent of Variance Explained	25.8%	19.0% = 44.8%
Not assigned		
There may be other better ways to do what CAPTCHA does	.54	.12
Web designers find it difficult to incorporate CAPTCHA into the design	.52	-.43
Websites are more secured with Thai CAPTCHA	-.06	.57
Thai CAPTCHA may support proper use of copyrighted content	-.03	.57
Thai CAPTCHA could support services for those knowing Thai language	.08	-.06

profile in order to portrait a more complete picture of these online practitioners.

The online practitioners are fully aware of CAPTCHA since all of them correctly confirm seeing it in clip, image, or file sharing services. More than 50% also report their experience with it in web boards, email sign-ups or blog and online diary services. Although the majority is aware of CAPTCHA, 33% admitted they did not know its proper title and 29% identified it incorrectly leaving 38% to be able to get it right. When asked about CAPTCHA's benefits, 88% accurately know them.

The top three highest scores of 16 attitude items indicate that Thai online practitioners are not so in favor of CAPTCHA but still agree that Thai CAPTCHA could provide exclusive support to Thai native speakers. This is in the opposite of Egale et al. [2010] work in which English native_speakers were in favor of a typical CAPTCHA. An interpretation of attitude items receiving least favorable scores may suggest hazy topics in which Thai online practitioners need clarification. Such topics include CAPTCHA-enabling protection of copyrighted content and a need for Thai websites to incorporate Thai CAPTCHA in a more pleasant working style.

A factor analysis on the 16 attitude items has shed new light on broader constructs underlying Thai online practitioners' perception towards CAPTCHA. Indeed, they perceive drawback of general CAPTCHA and feasibility of Thai CAPTCHA. Two conclusions are from these findings. First, Thai online practitioners view general CAPTCHA as optional and having certain limitations including the difficulty in decoding unreadable texts. The second conclusion comes from the finding in which Thai online practitioners perceive possible applicability of Thai CAPTCHA. Such feasibility includes Thai online practitioners' preference to work with Thai CAPTCHA-empowered websites, their recommendation to use Thai CAP TCHA and its ease of use.

6. Contribution

The study's findings lead to contribution. Theoretically, it extends critical insight into application of CAPTCHA to the context of Thai online practitioners. This CAPTCHA's non-English implementation has received increasing recognition [Shirali-Shahreza and Shirali-Shahreza, 2006; Chen, 2009].

Practically, we could offer two recommendations. First, Thai online practitioners are well aware of CAPTCHA but still hold fraction of its complete picture. Policy makers may thus put effort to enhance the practitioners' understanding toward CAPTCHA. It could be through proper communication channels. Once they are clear about CAPTCHA, more adoptions of CAP TCHA in Thai online business environment could be on its way. Second, it is unfortunate that Thai online practitioners denote drawback of general CAPTCHA. It thus points out to the challenge in which a program is needed to adjust these few negative attitudes. Such program may be one session, in technical training to which these practitioners may attend, offering accurate detail of CAPTCHA. This could per-

suade them to change their view toward CAPTCHA in general and Thai CAPTCHA in specific. Once Thai online practitioners adjust their views, working with CAPTCHA would become more successful. In addition, web developers who maintain online storefronts for these practitioners may locate technical applications so the display of Thai texts or Thai CAPTCHA on an electronic commerce website would lead to a more pleasant working condition.

The application of this study's results would have been more visible, should there not have been two limitations. First, the Internet environment is immensely dynamic. Our data collection is thus a snapshot of this fast moving context. Replication of similar research effort is encouraged to monitor the evolution of CAPTCHA adoption. Since our focus is on Thai online practitioners, it may pose the second limitation on generalizability of our findings. While the findings have shed new light, we have little to offer on other types of online practitioners. Fellow researchers may want to examine the other set of practitioners' reactions to CAPTCHA. The results once available would present a more complete picture of CAPTCHA adoption in digital business environment.

7. Remark

The first version of this paper was presented at the 2009 ITAM in Korea. Feedback from Reviewers and audiences has helped enhance the quality of this current version. It must be gratefully appreciated.

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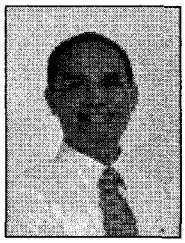
Author Profile



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