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An Exploration into Thai Internet Users' Attitude towards Captcha

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AN EXPLORATION INTO THAI INTERNET USERS' ATTITUDE TOWARDS CAPTCHA

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Abstract

CAPTCHA standing for Completely Automated Public Turing test to tell Computers and Humans Apart has received a remarkable amount of attention. Deciphering distorted texts mostly in English is still a human, not a computer task, that could help prevent abuse of online services. The current CAPTCHA requires users to be able to read English alphabets. As such, Thai CAPTCHA may be the choice for Thai Internet users who are not familiar with English. However, no published work has examined the extent to which Thai Internet users are aware of CAPTCHA. This study thus attempts to survey their awareness of, and attitude toward, CAPTCHA.

Based on the 340 number of usable online questionnaire submission, Thai Internet users are aware of CAPTCHA but their understanding needs little fine-tune. 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 in the Thai Internet user context, online service providers could initiate certain plans in response to their attitude and understanding.

Keywords: Thai users, CAPTCHA, Internet, attitude, exploration.

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 [1]. 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 CAPTCHA in Fig. 1, a subscriber will decode eight altered texts and type H5XGEYNA in the box beneath the array of texts to indicate he or she is a human, not automated computer software.

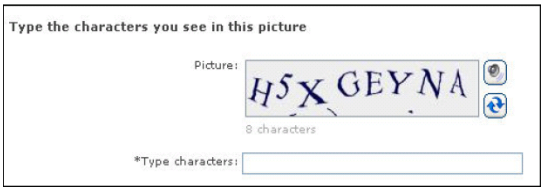

Figure 1: Example of CAPTCHA at hotmail.com

Texts have been acceptable for CAPTCHA implementation [3] [12]. However, other contents have also been experimented. Hoping to help the blinds, Holman and colleagues [2] incorporated audio into textual CAPTCHA. Their preliminary assessment seems promising. This could inspire other scholars to develop sound-based CAPTCHA [6]. Yan and El Ahmad [4] 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 [4].

Security in electronic services has been enhanced because of the application of CAPTCHA. Free e-mail service providers have encountered chronic problems of 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 for electronic services, it also helps presenting knowledge. The best example of this contribution is through the reCAPTCHA project [7]. There has been an attempt to digitize contents in old books using OCR software. However, certain words are not OCR-readable because of classic printing styles with faded ink and yellow pages. von Ahn and coworkers [7] have used those words to display in CATPCHA 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 [8]. Holman and colleagues [2] 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 is much improved [2]. 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 [10] 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 and coworkers [6] 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 and coworkers [6].

Even with normal humans does CAPTCHA still have problems. It is sometimes too difficult for them to understand those distorted texts [3] [5]. 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 [4]. These researchers thus offer tips on how to create more usable CAPTCHA. Gossweiler and coworkers' [6] project that requires humans to orient an image to the upright angle seems to alleviate the difficulty of text-reading.

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 [19]. 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 contents 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 M. H. and Shirali-Shahreza's [12] project in which Persian and Arabic CAPTCHA was developed. However, the main focus of their work was on the technical algorithm and little is on how Persian or Arabic speakers would react to this CAPTCHA in their own language. Moreover, Yan and El Almad [4] confirmed that those with no background in Latin alphabets had more serious problems in decoding CAPTCHA than those with the background. Our extensive literature review also found no development in Thai context, nor an investigation into how Thai people 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 Internet users are aware of CAPTCHA, especially those in Thai language.

Research objectives

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

Methodology

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

Population and samples

Given this research's main concern, the population must be Thai Internet users. According to the 2008 report of National Statistical Office of Thailand [18], the size of this population is 9,320,000. With a 5% error rate, the number of samples is 400 [17].

Initially, we made an effort to use a probability-based sampling technique. However, we were unable to locate a complete list of Thai Internet users and their contact addresses. As a result, we had to adopt a purposive non-probability sampling through an online channel. We 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 Internet users, thereby increasing the study validity [17]. To ensure the reach of only Thai Internet users, the invitation and the instrument were in Thai. Those who do not understand Thai would therefore be excluded from the study.

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 [13] [14]. The final section gathered the samples' demographic details including screening questions to ensure the subject's eligibility (i.e., Thai Internet users) 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.

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 process took about 30 days to achieve 340 usable responses.

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 [8] [13] [14], all items were carefully crafted so that 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 were 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.

Data analysis framework

The framework has two folds. First, we employed descriptive statistics to report (1) the extent to which samples of Thai Internet users 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.

Results

Respondents' demographics

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

- Each gender holds about half of the respondents. 6 in 10 of them are 26-30 years old. The largest portion (95%) hold at least college degree and about a quarter have a computer-related major.
- The majority (85%) of respondents live in Bangkok. Note that 3% of them reside abroad. About the same portion (85%) have at least six years of experience with the Internet. When asked if having subscribed to any online services, 99% of the samples admitted it.

Table 1: Respondents' demographic (N=340)

Demographics	Respondents N (%)

Gender	
Male	163 (52)
Female	177 (48)
Age	
< 26 yrs	74 (22)
26-30	206 (61)
31-40	51 (15)
41-50	9 (2)
Highest education	
Less than college	18 (5)
College degree	195 (57)
Master degree or higher	127 (38)
Whether educational major is computer-related	
Yes	86 (25)
No	254 (75)
Current residency	
In Bangkok metropolitan	289 (85)
In provincial area	39 (12)
Residing abroad	12 (3)
Experience with Internet (years)	
< 3 yrs	3 (2)
3-5	47 (14)
6-9	149 (44)
10+	141(41)
Online service subscription	
Yes	337 (99)
No	3 (1)

Thai Internet users' awareness and understanding of CAPTCHA

According to Table 2, nearly all (99%) respondents had seen CAPTCHA. 88% contend that they had 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 (60%) and e-mail (53%) services. The three locations where the smallest portions of the respondents admitted their encounters with CAPTCHA are (1) community or portal websites, (2) game and (3) news services. While the first accounts for 16%, the final two choices account for 14% and 8%, respectively.

We also attempted to learn the extent to which the respondents know about the proper title of CAPTCHA. While 59% of them admitted they had no idea of the title, 41% claim they were aware of it. Yet, only 9% of those who claimed they knew it were able to identify the correct title of CAPTCHA. This means, besides 59% who reported they did not know the title, there are still the other 32% 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 PASSWORD, CHECK, and ENCRYPT.

Table 2: Respondents' awareness and understanding of CAPTCHA

Demographics	Respondents N (%)
Whether they had seen CAPTCHA (N=338)	
Yes	335 (99)
No	3 (1)
On which websites or services CAPTCHA was seen (N=340=100%)	
Clip image or file sharing	298 (88)
Webboards	205 (60)
E mail	181 (53)
Online transaction services	94 (28)
Blogs, or online diaries	87 (26)
Social network	84 (25)
Music offer	60 (18)
Community or portal webs	54 (16)
Game services	48 (14)
News services	28 (8)
Title in which CAPTCHA is known (N=335)	
CODE	36 (11)
CAPTCHA	31 (9)
PASSWORD	15 (5)
CHECK	15 (5)
ENCRYPT	14 (4)
IMAGE	9 (3)
SUBMIT	6 (2)
BLIND	5 (1)
GOTCHA	2 (.6)
VISION	1 (.3)
ERROR	1 (.3)
I don't know	199 (59)

Although less than 10% were aware of CAPTCHA's correct title, 61% of the respondents knew its principal benefit: to tell computers and humans apart (see Table 3). 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 16% of the respondents had no idea of what CAPTCHA could offer.

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 [20]. The three most favorable attitude scales are (1) there may be other better ways to do what CAPTCHA does, (2) Thai CAPTCHA could support the services only for those knowing Thai, and (3) CAPTCHA is effective. Their arithmetic means are 3.67, 3.66 and 2.96, respectively. Based on these three items, it seems that the respondents agree to the large extent on CAPTCHA's positive attributes (i.e., effectiveness, good support for Thai people), although they perceive CAPTCHA may not be the best to distinguish between a man and machine (i.e., better tools than CAPTCHA may exist).

Table 3: Perceived benefits of CAPTCHA (N=340 =100%)

Benefits	Percentage
To tell computers and humans apart	61%
To authenticate service subscribers	27%
To protect against computer virus	9%
To prevent typographical error	8%
To indicate age-restricted websites	3%
No idea of what possible benefits are	16%

At the other end, the respondents rated three scales of attitude as least favorable: (1) Thai CAPTCHA is easier than typical CAPTCHA, (2) the respondents try to avoid working with CAPTCHA-enabled websites and (3) website designers find it difficult to incorporate CAPTCHA into their design. Their arithmetic means are 2.01, 2.19 and 2.26 respectively. Least favorable attitude may indicate a certain degree of disagreement. As such, interpretation of the three least favorable items could be that the respondents believe Thai CAPTCHA is somewhat difficult but still willing to use the websites equipped with carefully-designed CAPTCHA.

Such interpretation regarding Thai Internet users' attitude towards CAPTCHA was made based solely on the three most and 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 [15]. 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 43% of the variance among the attitude items. According to Table 5, Factor I accounted for 23.2% of the variance. Highest loadings of the five attitude items on the first factor reflect Thai Internet users' perceived drawback of general CAPTCHA. Factor II accounted for 19.7% of the variance. Three items loaded highest on this factor indicating their perceived feasibility of Thai CAPTCHA. Four attitude items 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 0.779, the value of which Kaiser [16, p. 35] considered "meritorious." Also, the statistics of Bartlette's (996.686, df=66, p<.000) contends that the two factors parsimoniously and properly underscore Thai Internet users' attitude towards CAPTCHA.

Table 4: Attitude towards CAPTCHA: Descriptive statistics

Statements	Mean	Standard deviation	Skewness	Kurtosis
There may be other better ways to do what CAPTCHA does	3.67	1.049	.474	-.319
Thai CAPTCHA could support services for those knowing Thai language	3.66	1.327	-.644	-.780
CAPTCHA is effective*	2.96	.878	-.089	-.156
CAPTCHA enhances website creditability*	2.95	.952	-.257	-.432
I have confidence in CAPTCHA*	2.80	.949	-.106	-.48
Decoding CAPTCHA is difficult	2.69	1.242	-.213	-.947
I am more comfortable working with a website if it contains Thai texts	2.65	1.284	.283	-.942
I don't like those unreadable texts	2.52	1.345	-.433	-.989

Thai websites have capable CAPTCHA*	2.46	.896	.396	.322
Websites are more secured with Thai CAPTCHA	2.44	1.280	.479	-.885
Thai CAPTCHA may support proper use of copyrighted content	2.38	1.129	.401	-.636
Thai websites should use Thai texts in CAPTCHA	2.34	1.276	.630	-.643
CAPTCHA is unnecessary	2.27	1.060	-.601	-.184
Web designers find it difficult to incorporate CAPTCHA into the design	2.26	1.091	-.616	-.230
I try to avoid working with CAPTCHA-enabled websites	2.19	1.091	-.665	-.296
Thai CAPTCHA is easier than typical CAPTCHA	2.01	1.092	1.003	.397

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	**.79**	.11	
Decoding CAPTCHA is difficult	**.76**	.01	
I don't like those unreadable texts	**.75**	-.03	
Web designers find it difficult to incorporate CAPTCHA into the design	**.74**	.17	
CAPTCHA is unnecessary	**.57**	.26	
Factor II: Feasibility of Thai CAPTCHA			
Thai websites should use Thai texts in CAPTCHA	.10	**.82**	
I am more comfortable working with a website if it contains Thai texts	.00	**.73**	
Thai CAPTCHA is easier than typical CAPTCHA	.16	**.82**	
Percent of Variance Explained	**23.2%**	**19.7%**	**= 42.9%**
Not assigned			
There may be other better ways to do what CAPTCHA does	.17	.13	
Websites are more secured with Thai CAPTCHA	.16	.48	
Thai CAPTCHA could support services for those knowing Thai language	-.02	-.04	
Thai CAPTCHA may support proper use of copyrighted content	.26	.36	

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 five items and that for the Feasibility factor's three items are 0.78 and 0.74, respectively. Since a threadhold of 0.70 or higher will indicate acceptable reliability [21], it is reasonable to claim the reliable quality of the two factors' components.

Conclusion and Discussion

Based on the 340 usable questionnaire returns, our respondents are equally men and women, mainly (76%) in between 26-40 years of age and largely (95%) college graduates. Also, 9 out of 10 respondents have at least six years of experience using the Internet and virtually all of them have subscribed to online services. Comparing this profile to those Thai Internet users in [18], it is reasonable to assume the representativeness of our samples.

Thai Internet users are highly aware of CAPTCHA. The evidence of this overwhelming awareness comes from 99% of the samples could recall their encounters with CAPTCHA. Moreover, 88% confirmed its appearance in content-sharing websites. Although they are aware of CAPTCHA, their understanding seems partial. That is, less than a half of our respondents claimed they knew the proper term of CAPTCHA. Among those who made such claim, only 6% were able to identify CAPTCHA's proper title. Had we asked what CAPTCHA stands for, it would have been embarrassing for the respondents. Furthermore, about a quarter (16%) of them admitted having no ideas of what benefit CAPTCHA could offer. About 73% of those who claimed knowing it were able to present CAPTCHA's correct main benefit: To tell computers and humans apart.

Results of Thai Internet users' assessment of 16 attitude items indicated they were in favor of CAPTCHA's effectiveness and support for Thai practitioners, if implemented in Thai. However, they doubt if there could be other ways offering better services than CAPTCHA. If individuals' least favorable attitude indicates their agreement in the opposite of an attitude statement, the following conclusion should be valid. That is, Thai Internet users would agree that Thai CAPTCHA is as complicated as other CAPTCHA but they would have no objection working with websites containing thoughtfully-designed CAPTCHA.

A factor analysis on the 16 attitude items has shed new light on broader constructs underlying Thai Internet users' perception towards CAPTCHA. Indeed, they perceive drawback of general CAPTCHA and feasibility of Thai CAPTCHA. Two conclusions are from these findings. First, Thai Internet users view general CAPTCHA as it still has certain limitations including the difficulty in decoding unreadable and heavily distorted texts. The second conclusion comes from the finding in which Thai Internet users perceive possible feasibility of Thai CAPTCHA. Such feasibility includes Thai Internet users' preference to work with Thai CAPTCHA-enabled websites and Thai CAPTCHA's ease of use.

The conclusion of these findings leads to the study's contribution. Theoretically, it extends insight into application of CAPTCHA to the context of Thai Internet users. This non-English implementation has received more recognition [12]. Practically, we could offer two recommendations for practitioners. First, Thai Internet users are well aware of CAPTCHA but still hold incomplete understanding towards it. To prevent abuse of online services, responsible agents must therefore convey to the public correct messages on the concepts of CAPTCHA. Once they are clear about CAPTCHA, more adoptions of CAPTCHA in Thai online business environment could be on its way. Second, it is unfortunate that Thai Internet users denote drawback of general CAPTCHA, although perceiving a bright side of it in Thai alphabets. It thus points out to the challenge in which a program is needed to remove these negative attitude. Such program includes a website supplying definitions and details about CAPTCHA or an exclusive online resource taking more active role to spread out proper knowledge on this topic. Once Thai Internet users adjust their views, working with CAPTCHA would become more successful.

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 Internet users, it may pose the second limitation on generalizability of our findings. While the findings have shed light on the users, we have little to offer on Thai online practitioners. Fellow researchers may want to examine the practitioners' reactions to both Thai and general CAPTCHA. The results once available would present a more complete picture of CAPTCHA adoption in Thai online business environment.

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