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Research paper



Designing Cham Font Unicode Standard and Cham Keyboard

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Abstract

The main purpose of this research is to design and develop the Cham font for Unicode standard and Cham keyboard application. Research sample is divided into two groups and research instrument distributed into three forms of survey. The Cham font Unicode standard and the Cham keyboard (Chamkey) was developed using ADDIE model. This survey, the acceptance of Cham font, and Cham keyboard view by fifty-four respondents and the results showed that 100% respondents either agreed or strongly agreed with every statement. In order to evaluate Cham font typeface, we choose fifty-four participants include academics, experts and students to evaluate the typefaces of Cham font using two forms. All of them totally agreed that the typeface of Cham fonts were designed exactly for all alphanumeric Cham letters with the result for EFEO Cam Times is 99.12% and EFEO Cam Arial is 99.64%. Viewed by sixteen experts using Fuzzy Delphi for Cham keyboard application the results show that percentage of all items are 100%, more than what required (75%), the value of d for total construct is 0.08 (required $d \leq 0.2$). Thus, it can be concluded that all sixteen experts have come to a consensus that the Cham keyboard is acceptable. In order to preserve and promote the cultural heritage as well as the language and Cham scripts of the United Nations Charter on Indigenous Peoples, we offer a solution for applying information technology in the issue of preserving the native language of the Cham in Vietnam. Hence, using technologies to design and develop for Cham fonts for Unicode standard and Cham keyboards application is not only theoretically significant but also practically significant.

Keywords: *Cham font; Cham script; Chamkey; Cham keyboard; Cham font conversion*

1. Introduction

The Cham people have used Cham scripts, derived from the Sanskrit alphabet (Devanagari) in India since the 2nd century on the Vo Canh stone stele (1). In the early period, Cham people mainly used ancient Cham script to inscribe Sanskrit. By the 4th century on Dong Yen Chau stone stele in the 4th century (2, 3) appears the ancient Cham script written in Sanskrit and written in Cham language. Akhar Thrah (traditional Cham script) is the most popular script and became the official writing of the Champa kingdom from the 17th century, in addition to engraving on the tower of Po Rome (1627-1651) on the seventeenth (2), this script is also handwritten and widely used in all fields from international diplomacy, administration, religion, history, Cham literature, etc. Due to many social and historical reasons, the Cham script is considered an endangered language in Vietnam. The crucial problem is that the Cham Textbook Compiling Committee (CTCC) has not yet supported to preserve the traditional Cham script (TCS) (4). This has become an emergent phenomenon and the cause of the biggest conflict in the Cham community. Most Cham elders, students, intellectuals, experts and Cham people strongly desire to conserve the TCS (3, 5), because it's not only the heritage value from the ancient sources but also TCS as the main key to understand Cham Royal documents which are written in TCS.

Using Cham font and Cham keyboard to typing Cham scrip on the computer is needed. Thus, we offer solutions to design Cham font for Unicode standard and Cham keyboard application which include four options: Cham Thrah, Cham Latin, English and Vietnamese. This is very useful in using the Cham font to learn and teach Cham language as well as preserve the heritage of Cham language and script.

2. Literature Review

Using fonts to type text on a computer is very necessary. For the use of Cham font, first the Cham-Pandarang and Cam - Tanran font was created for Macintosh and used for the Champa research by l'École française d'Extrême - Orient (EFEO). However, this font still has some defects and technical errors. Subsequently, another Cham font was used in Cham - Vietnamese dictionary (6) . Based on the EFEO Cham font and the Cham-Vietnamese font in the dictionary, a number of research centres and Cham scholars have created different Cham font types. The Cham Thrah font created by Sang (2002, 2012) and Bingu di tanran font created by Cham Unessco (2012) were developed from Cham - Tanran (EFEO), rebuilt, redesigned on the Windows keyboard. However these Cham fonts are not consistent in the value of the code page, and this causes many difficulties in the exchange of information.
EFEO Panrang, EFEO Parik, and EFEO Udong font were created by (7). These three fonts are designed to be assigned directly to

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Windows and Macintosh keyboards platform and do not require accompanying application software. However, these three fonts were not used for Unicode standard range AA00 - AA5F. With the approval of Unicode Standard range AA00 - AA5F for Cham font, we continue to design and develop the EFEO Panrang, EFEO Parik, and EFEO Udong fonts based on the Unicode standard. Furthermore, for using the Cham font for this standard, researcher also need to design and additional the Cham keyboard application.

3. Methodology

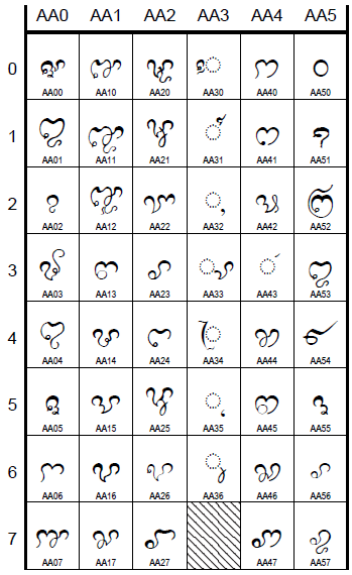
This research was implemented using a quantitative approach and the application was developed using ADDIE model. Parts of the research are presented in details as below:

3.1. Cham Font Unicode Standards

In order to design *Cham* font for Unicode, first we based on the Unicode standard version 9.0, ranges AA00 - AA5F. Second, to design the typeface for new Cham font, we based on font Times New Roman and Arial. The Unicode Cham font will bring many advantages in exchanging information, creating and storing *Cham* documents on a computer widespread in domestic and foreign.

3.1.1. Cham Font Analysis

The total numbers of code point in range AA00 - AA5F of Unicode standard for Cham font are 83 letters (8), within this range, the remaining 13 code points have no character assigned. However, the code point addresses AA41 provided by Unicode standard in range AA00 - AA5F is not in alphabet of traditional Cham script. Meanwhile, the Cham final letter "*wa matai*" in the traditional Cham alphabet is missing. See the Unicode standard range AA00-AA5F for Cham script as Figure 1.



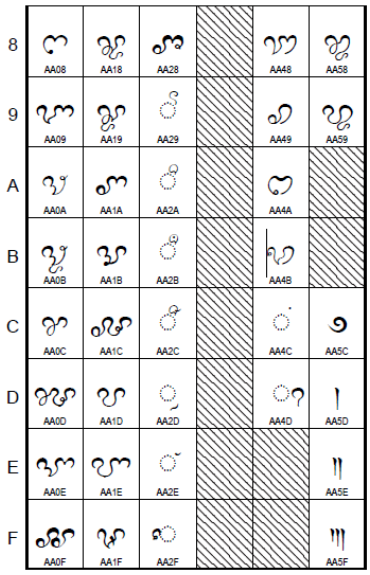


Fig.1: Unicode standard range AA00 - AA5F version 9.0

3.1.2. Cham Font Design

Unicode standard for Cham font in range AA00-AA5F has a total of 83 letters. As has explained in Cham font analysis, the code point AA41 for "gak matai" needs to replace by "*wa matai"* the Cham final letter. However, for convenience of typing Cham script, we design and add more 7 letters to the free space in range AA00-AA5F, as shown in Figure 2.

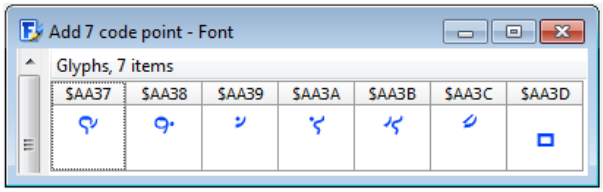


Fig.2: Number of code point add in range AA00-AA5F

Hence, the total letters of Cham font in range AA00 - AA5F needs to design is 90 letters as shown in Figure 3.

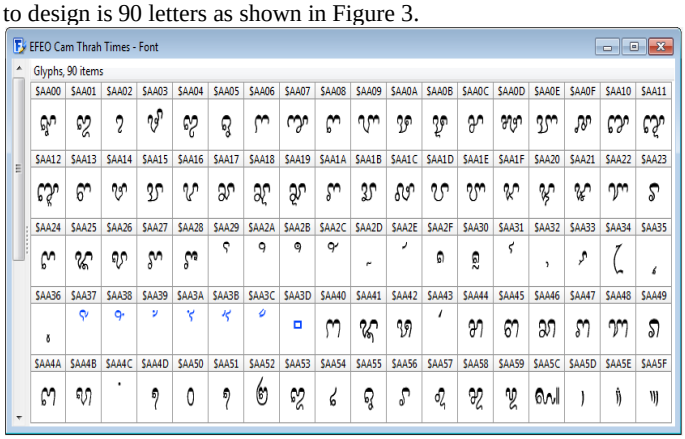


Fig.3: Total code point for Cham font in range AA00-AA5F

3.2. Cham Keyboard (Chamkey)

In order to design the Chamkey, first we designed the keyboard to type Cham letters accordingly. Second, design application includes four functions: Cham Thrah, Cham Latin, English and Vietnamese.

3.2.1. Cham Keyboard Analysis

In order to design the appropriate keyboard, we continue to develop the keyboard designed for Windows and Macintosh (7), some case use lower case letter, shift key with lower case key, and some letters typed twice on the keyboard. See Figure 4.

Final letter (akhar matai), typing the lower case letter twice on the keyboard such as: AA40 (kk), AA41 (ww), AA42 (qq), AA44 (cc), AA45 (tt), AA46 (nn), AA47 (pp), AA48 (yy), AA49 (rr), AA4A (ll), AA4B (xx).
Code point for starting the document AA5C (`), closing the document AA5F (shift `), comma AA5D (,), and full stop is AA5E (.). The code point AA41 provided by Unicode standard in range AA00 - AA5F is not in alphabet of traditional Cham script. Hence, we replace this final letter for "wa matai" with code point AA41 (ww).
To determine the position for dependent vowel signs and consonant signs, we have designed a sign for code point AA3D (shift <) and the list for this sign such as: <AA3D>< AA29>; <AA3D>< AA2A>; <AA3D><AA2B>; <AA3D>< AA2C>; <AA3D><AA2D>; <AA3D>< AA2E>; <AA2F><AA3D>; <AA30><AA3D>; <AA3D>< AA31>; <AA3D>< AA32>; <AA3D><AA33>; <AA34><AA3D>; <AA3D><AA35>; <AA3D><AA36>; <AA3D><AA37>; <AA3D><AA38>; <AA3D><AA39>; <AA3D><AA3A>; <AA3D><AA3B>; <AA3D><AA3C>.

3.2.2. Cham Keyboard Design

For typing Cham script more convenient, we designed the keyboard and used the EFEO Cham Lain for typing in the system. The assignment is presented as below:
(i). Vowel group: vowel of Cham akhar Thrah are include 6 letters AA00 (a), AA01 (i), AA02 (u), AA03 (e), AA04 (ai, A), AA05 (o)
(ii). Consonant group: consonant of Cham akhar Tharh are include 35 consonants letter.
AA06 (k), AA07 (K, kh), AA08 (g), AA09 (G, gh), AA0A (q, ng), AA0B (Q, Ng, NG)
AA0C (c), AA0D (C, ch), AA0E (j), AA0F (J, jh), AA10 (z, ny), AA11 (Z, Ny, NY), AA12 (zz, nj)
AA13 (t), AA14 (T, th), AA15 (d), AA16 (D, dh), AA17 (n), AA18 (N), AA19 (nd)
AA1A (p), AA1B (P), AA1C (f, ph), AA1D (b), AA1E (B, bh), AA1F (m), AA20 (M), AA21 (mm, mb)
AA22 (y), AA23 (r), AA24 (l), AA25 (w, v), AA26 (x), AA27 (s), AA28 (h)
(iii). Final consonant: Final consonant or *akhar Matai* in Cham akhar Thrah use for the final position of a word, to end of a word. Final consonant of Cham akhar Thrah has 14 letters.
AA40 (kk), AA41 (ww, vv), AA42 (qq, ng + tab), AA43 (-), AA44 (cc), AA45 (tt), AA46 (nn), AA47 (pp), AA48 (yy), AA49 (rr), AA4A (ll), AA4B (xx), AA4C (.), AA4D (H),
(iv). Numeral group
AA50 (0), AA51 (1), AA52 (2), AA53 (3), AA54 (4), AA55 (5), AA56 (6), AA57 (7), AA58 (8),
AA59 (9),
AA29 (shift 1), AA37 (shift 2), AA2A (shift 3), AA2B (shift 4), AA38 (shift 5), AA2C (shift 6), AA2E (shift 7), AA39 (shift 8)
(v). Extra signs
AA5C (`), AA31 (=), AA43 (- ), AA3B (shift -), AA3A (shift =), AA5F (shift `).
For ease of use in typing Cham script, we designed the Cham letters directly on keyboard as shown in Figure 4.

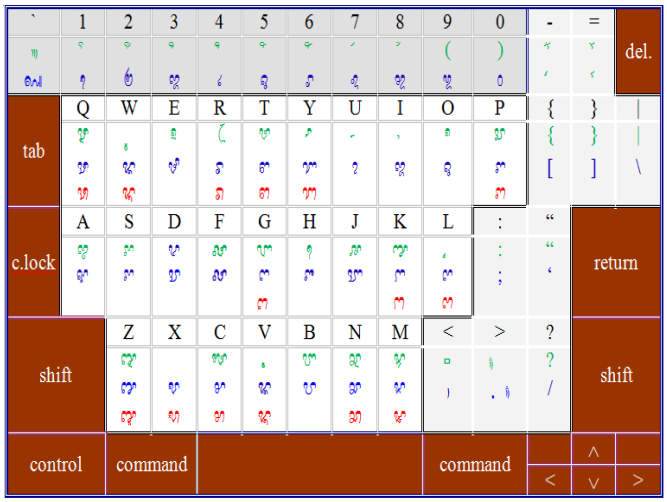


Fig.4: Cham keyboard layout

3.2.3 Cham Keyboard Application

To develop the Cham keyboard, we designed include four functions: Cham Thrah, Cham Latin, English and Vietnamese. In order to type Vietnamese and English, Chamkey supports the Telex and VNI for typing as UniKey (9). To type Cham Latin, we embed the EFEO Cham Latin to Cham script conversion application (10, 11). In order to use the Chamkey convenient, we designed the Chamkey application includes four options. For typing Cham script need to shift the application to C or press (Alt + C), typing Cham Latin (Convert EFEO Cham Latin to Cham Thrah) shift the application to L or press (Alt + L), typing Vietnamese shift the application to V or press (Alt + V), and typing English shift the application to E or press (Alt + E). To switch this mode, click on the icon of Chamkey on the taskbar or use the shift key as shown in Figure 5.

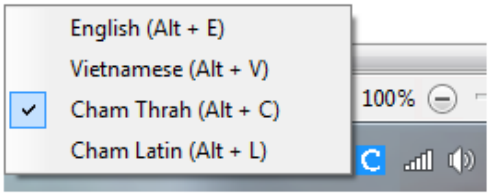


Fig.5: Chamkey interface on taskbar

4. Results and Findings

4.1. Acceptant Level of Cham Font

This section will address the acceptance level for the Cham font. Each question was answered on a scale from 1 to 5 to measure respondents' acceptance of the Cham font. The survey results for each question are presented in Table 1.

Table1: The level acceptance of Cham Font

No.	Item	Agree	Strongly Agree	Total
1	These Cham fonts display text clearly on Internet Explorer	35 (64.81%)	19 (35.19%)	54 (100%)
2	These Cham font display text clearly on Mozilla Firefox	35 (64.81%)	19 (35.19%)	54 (100%)
3	These Cham font display text clearly on Google Chrome	34 (62.96%)	20 (37.04%)	54 (100%)
4	Cham font letter position run perfectly on application	19 (35.19%)	35 (64.81%)	54 (100%)
5	Cham font letter position on keyboard are easy to	23 (42.59%)	31 (57.41%)	54 (100%)

	use			
6	The Cham font size is similar with the Times New Roman	18 (33.33%)	36 (66.67%)	54 (100%)

Based on Table 1, for all questions, the results showed that all 54 respondents (100%) either agreed or strongly agreed with every statement. This indicates that the respondents had a good level of acceptance towards the Cham fonts. No respondent disagreed with any of the statements. Specifically, from the six items asked, item 6 showed the highest number of respondents choosing the answer 'strongly agree', at 36 (66.67%). These results tell us that the respondents agreed that the font size is similar to Times New Roman. Items 1 and 3 had the lowest proportion of 'strongly agree' responses, at 19 (35.19%) and 20 (37.04%) respectively. This implies that among the six items, respondents had the lowest perceptions towards the text display online. However, these items are still considered as high value.

To analysis the level of Cham font, we compute the score of six items for each respondent. The result is displayed as in Table 2.

Table 2: Number of respondents and total score for Cham font

Number of respondents	Total score
10	30
4	29
5	28
18	27
1	26
4	25
12	24

In order to make decision, we decided to categorize the score to two categories as follow:

Table3: Categories of total score for Cham Font

Categories	Total score
Not Accepted	6 -18
Accepted	19 - 30

Based on Table 2 and Table 3, it can be concluded that all respondent 54 (100%) accept the Cham font.

4.2. Acceptant Level of Cham Keyboard

This section will address the level of acceptance of the Cham keyboard application. We select a total of fifty four university students and working people to evaluate four items. Each question was answered on a scale from 1 to 5. The results for each question are presented in Table 4.

Table4: The level acceptance of Cham keyboard application

No.	Item	Agree	Strongly Agree	Total
1.	Chamkey use typing Cham Thrah is very convenient	12 (22.22%)	42 (77.78%)	54 (100%)
2.	Chamkey use typing Vietnamese is very convenient and stable	8 (14.81%)	46 (85.19%)	54 (100%)
3.	Chamkey convert EFEO Cham Latin to Cham Thrah is very accurately	16 (29.63%)	38 (70.37%)	54 (100%)
4.	Chamkey is easy to use	7 (12.96%)	47 (87.04%)	54 (100%)

Based on Table 4, for all questions, the results showed that all 54 respondents either agreed or strongly agreed. Specifically, item 4 showed the highest value with 47 respondents (87.04%) strongly agree and 7 respondents (12.96%) agree. This result tells us that the respondents had a good level of acceptance towards the Cham keyboard application.

Secondly, we select a total of sixteen experts to evaluate four items (from Table 4) of the Cham keyboard application by Fuzzy Delphi. Each item of question was rated on a scale from 1 to 5. The level of acceptance from experts is presented in Table 5.

Table 5: Threshold Value and Percentage Consensus by Experts

Experts	Items			
	I1	I2	I3	I4
1	0.03	0.01	0.04	0.03
2	0.03	0.01	0.04	0.03
3	0.03	0.01	0.04	0.03
4	0.03	0.01	0.04	0.03
5	0.03	0.01	0.04	0.03
6	0.18	0.01	0.04	0.03
7	0.03	0.01	0.04	0.03
8	0.03	0.01	0.04	0.03
9	0.03	0.01	0.04	0.03
10	0.03	0.01	0.04	0.03
11	0.03	0.01	0.04	0.03
12	0.18	0.01	0.04	0.18
13	0.03	0.01	0.04	0.03
14	0.03	0.01	0.16	0.03
15	0.03	0.19	0.04	0.18
16	0.03	0.01	0.04	0.03
Frequency $d \leq 2$	16.00	16.00	16.00	16.00
Percentage item $d \leq 2$	100%	100%	100%	100%
d value for total construct			0.08	

From Table 5, the threshold (dm, n) for each item based on the expertise and the experts' percentage consensus ($d \leq 0.2$) for all six items was 100%, more than the required value of 75%. The value of d for the total construct is 0.08 (required $d \leq 0.2$). Thus, it can be concluded that all sixteen experts have come to a consensus that the Cham keyboard is acceptable.

4.3. Evaluate Cham font typeface

In order to evaluate Cham font typeface, we choose fifty four participants include academics, experts and students to evaluate the typefaces of Cham font using two forms. All of them totally agreed that the typeface of Cham fonts were designed exactly for all alphanumeric Cham letters (traditional Cham script), especially the two Cham fonts typeface named EFEO Cam Times and EFEO Cam Arial designed based on Times New Roman and Arial. The result is shown in Table 6.

Table 6: Typeface of Cham font

Evaluate	EFEO Cam Times	EFEO Cam Arial
Not Accepted	0%	0%
Almost	0.88%	0.36%
Accepted	99.12%	99.64%

Based on Table 6, the two Cham fonts get high evaluation from respondents with the achieved results as following: EFEO Cam Times (99.12%), EFEO Cam Arial (99.64%).

The font size of EFEO Cam Times, EFEO Cam Arial is similar with the Times New Roman in the same document, the result as shown in Figure 6.

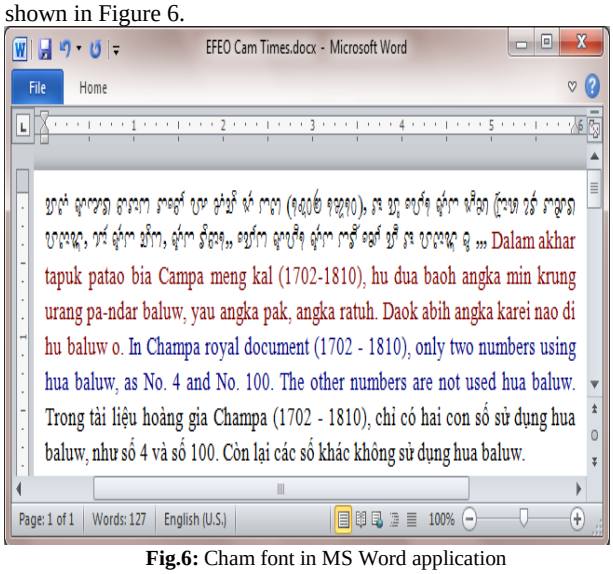


Fig.6: Cham font in MS Word application

5. Conclusion

We have presented a new approach in analysis, design and development for Cham font in Unicode standard range AA00-AA5F and Cham keyboard application with four options as Cham Thrah, Cham Latin, English and Vietnamese. The products were developed using the ADDIE model. In evaluation the acceptant level of Cham font and Cham keyboard, the result shows that all respondents are accepted. Typeface of EFEO Cam Times and EFEO Cam Arial was designed exactly for all alphanumeric Cham letters and get high evaluation from respondents. In addition, Cham keyboard application was evaluated using Fuzzy Delphi get high consensus by experts.

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