

Dzongkha Phonetic Set Description

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Abstract

This report describes the Dzongkha phonemic inventory that was defined during the Text Analysis process for Dzongkha Text-to-Speech Synthesis (TTS) prototype developed in collaboration with NECTEC, Thailand. About 56 unique phonemes were discovered covering four different classifications, viz., initial consonants, vowels, diphthongs and consonant clusters. These phonemes were transcribed with equivalent Latin representations. In the phonemic set, two tones were identified: first is the normal tone and the second one is the modification of the normal tone. The modified tone can be identified by a sharp falling tone (high to low). Following the importance of pronunciation of words and its associated rules in TTS systems, some pronunciation rules are also discussed in the report.

1. Introduction

Dzongkha is the official and the national language of Bhutan. It belongs to the Sino-Tibetan family of languages. The script used in writing Dzongkha is identical to the Tibetan script and is known as ‘Uchen’ script [1]. The spoken form of Dzongkha is not only different from Tibetan but also the vocabulary set used are different from each other leaving very few exceptions. It can be rightly said that the relationship between the spelling of the written language and the actual pronunciation in colloquial speech is not straightforward for both the languages [2].

In the phonetic set definition, it was found that spoken Dzongkha could be represented by 30 initial consonants, 5 clusters, 11 vowels and 10 diphthongs. Each of the phonemes are classified and defined along with some examples.

2. Phonemic Inventory Design

Each of the unique phonemes of the language is transcribed using relevant Latin string (Romanization) equivalents, as demonstrated in the following.

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a) Initial consonants

Thirty initial consonants can be accounted for in Dzongkha language. Table 1 below depicts the list of thirty consonants in the traditional Dzongkha alphabetical order.

Table 1: Initial Consonant Inventory

IPA	Dzongkha Alphabets	Transcribed Phoneme Equivalent	Example Script	Romanized	Transcription (based on the pronunciation)
K	ཀ	K	དཀར་	d k r	k a r 0
Kh	ཁ	Kh	མཁར་	m kh r	kh a r 0
G	ག	G	དགའ་	d g hh	g a 0
N	ང	Ng	ངག་ སྒྲོན་	ng g s ng n	ng a g 0 ng e n 1
tS	ཅ	C	བཅག་	b c g	c a g 0
tSH	ཆ	ch	ཚོག་	ch o g	ch o g 0
dZ	ཇ	j	མཇལ་	m j l	j e l 0
Ø	ཉ	ny	ཉལ་ སྒྲོན་	ny l s ny n	ny e l 0 ny e n 1
T	ཏ	t	བཏར་	b t ng	t a ng 0
tH	ཐ	th	ཐབ་	th b	th a b 0
D	ད	d	གདོང་	g d o ng	d o ng 0

N	ན	n	ནོ་ སྐམ་	no r s n m	no r 0 na m 1
P	པ	p	པར་	p r	pa r 0
ph	ཕ	ph	ཕགས་	ph g s	ph a g 0
B	བ	b	བབ་	b b	ba b 0
M	མ	m	མིག་ མྱགས་	mi g r m g p	mi g 0 ma p 1
Ts	ཅ	ts	གཅང་	g ts ng	ts a ng 0
tsH	ཅཱ	tsh	ཅཱ་	tsh l	tsh e l 0
Dz	ཇ	dz	ཇོ་མས་	hh dz o m s	dz o m 0
W	མ	w	མ་ མང་	w w ng	wa 0 wa ng 1
Z	ཞ	zh	གཞུང་	g zh u ng	zh u ng 0
z	ཟ	z	ཟམ་	z m	za m 0
ú	ཨ	hh	ཨོངས་	hh o ng s	hh o ng 0
j	ཡ	y	ཡལ་ གཡོག་	yl g y o g	ye l 0 yo 1

..	ར	r	རིམ་	ril	ri l 0
l	ལ	l	ལེན་	len	le n 0
s	ཤ	sh	ཤིང་	shing	sh i ng 0
s	ས	s	བསངས་	bsngs	sa ng 0
h	ཧ	h	ཧང་	hng	ha ng 0
/	ཨ	@	ཨམ་	@m	@a m 0

Note: '0' indicates normal tone & '1' represents the modified (high) tone. The transcription follows the format 'initial consonant – vowel - final consonant – tone'. The final consonant may not be present in a syllable.

The above table shows the transcription of the 30 Dzongkha initial consonants. Their corresponding phonetic representation is the equivalent Latin string counterparts. It is to be noted that while pronouncing the consonants, an inherent vowel sound 'a' is also present. Which follows that when no vowel is used in Dzongkha, the vowel 'a' is appended to the root consonant.

For example, ༀ is pronounced as 'ka' instead of a simple 'k'.

b) Vowels: Spoken Dzongkha has eleven vowels, including five basic vowels, see Table 2 below.

Table 2: Spoken Dzongkha vowel inventory

IPA	Dzongkha Vowel	Transcribed Phoneme Equivalent	Example Script	Romanized	Transcription (based on pronunciation)
a	'inherent vowel'	a	ཨམ་	@m	@a m 0
i	ི	i	ཡིན་	@in	@in 0

u	ུ	u	གུ g u g u 0
e	ེ	e	དེ d e d e 0
o	ོ	o	ཨོམ་ @ o m @ o m 0

ue		ue	གཡུལ་ g y u l y u e l 0
oe		oe	ཡོད་ y o d y o e 0
aa		aa	ཨྱ་ a h h @ a a 0
ii		ii	ཡི་ n h h i n i i 0
uu		uu	བསྐྱུ་ b s d u w d u u 0
oo		oo	བོལ་ b o l b o o l 0

Apart from the inherent vowel 'a', the vowels are written (as diacritics) above or below the root letter or the main consonant letter. “**a** is pronounced like 'cut', **i** is pronounced like 'lit', **e** is pronounced like 'pay', **u** is pronounced like 'good' [3].

Some vowels are modified when the root letter is combined with certain suffixes. And only a few

numbers of suffixes and prefixes are allowed in the language. While the prefixes before the root letters are not at all pronounced, certain suffixes are pronounced along with the root letters. And a handful of them modify the vowels associated with the root letter. Detail for vowel modification is given in Table 3 below.

Table 3: Vowel Modification

Vowel	Suffix										
	g	ng	n	b	m	r	L	p	d	s	hh
a			e n				e l		e	e	
i											
u			ue n				ue l		ue	ue	
e											
o			e n				e l		e	e	

*The table above depicts eleven suffixes and the case of vowel modification when some of them are combined with particular vowels.

*Suffixes d, s, & hh are not pronounced when combined with other letters in a syllable while the rest are all pronounced.

A very few 'vowels' can be modified when combined with particular suffixes. Therefore suffixes **n, l, d** and **s**, with the vowels **a, u** and **o**, will modify the vowels in question (as shown in the table above).

For example 'p l' is pronounced as 'p e l' instead of 'p a l' whereby the vowel 'a' is modified to 'e' vowel

c) Diphthongs: A total of about ten diphthongs were identified for spoken Dzongkha as shown in Table 4.

Table 4: Mapping of Dzongkha Diphthongs

IPA	Diphthong	Example Script	Romanized	Transcription (based on pronunciation)
ai	ai	མཚོ་	@ hh i	@ ai 0

au	au	ཨཱུ་	@ hh u	@ au 0
ae	ae	ཨེ་	@ hh e	@ ae 0
ui	ui	ཨུའི་	b u hh i	b ui 0
oi	oi	ཨོའི་	m o hh i	m oi 0
ou	ou	ཨུ་ལྷ་	l t o w	t ou 0
eu	eu	ཨེུ་	r e hh u	r eu 0
ei	ei	ཨེའི་	s d e hh i	d ei 0
eo	eo	ཨེལ་	ch e w	ch eo 0
iu	iu	ཨུའིུ་	tsh i hh u	tsh iu 0

Note: It might be possible to find more diphthongs in the event of 'the growing text corpus' and its subsequent text analysis.

Table 5: Mapping of Dzongkha Clusters

IPA	Consonant Cluster	Example Script	Romanized	Transcription (based on pronunciation)
d ^h	dr	ཌལ་	d g r	dr a 0
t ^h	tr	ཌེལ་	s k r	tr a 0
tH ^h	thr	ཌེལ་	th r	thr a 0

lh	lhh	ལྷ་	l h	lhh a 0
hr	hr	ལྷ་	h r	hr a 0

*The letters are stacked over each other to form clusters, i.e, the root letter is usually stacked over the second letter.

d) Clusters: Spoken Dzongkha has the following five consonant clusters. They are written with special letter conjuncts.

For example, ལྷ་ 'letter r is stacked under the root letter g'

e) Final Consonants: In Dzongkha there are only eight final consonants, see Table 6. They are the suffix letters that are actually pronounced along with the root consonant or letter.

Table 6: Mapping of final consonants

IPA	Computer	Example Script	Romanized	Transcription (based on pronunciation)
g	g	དག་	d g	d a g 0
ng	ng	ཐུང་	th u ng	th u ng 0
n	n	དོན་	d o n	d e n 0
b	b	སྟབས་	s t b s	t a b 0
m	m	འཆམ་	hh ch m	ch a m 0
R	r	ལྷུར་	hh j u r	j u r 0
l	l	དལ་	ng l	ng e l 0

p	p	གསར་	g s r p	s a p 0
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f) Tones: Two tones were identified for the language, see Table 7 below. The low tone is normal while the high tone (rising) is the modification of the former tone. They are represented by '0' and '1' respectively. The rising tone variation usually depends on the following:

- Combination of certain prefixes with the root letter,
- Combination of head letter with the root letter (superscribed),
- The subjoined letter stacked under the root letter (subscribed).

But only a few number of head letters and a few number of subjoined letters when combined with particular root letters, will modify the tone of a syllable.

Table 7: Tones in Dzongkha Language

Example	Romanized	Transcription (based on pronunciation)
བང་	b ng	b a ng 0
དབང་	d b ng	w a ng 1
ནང་	n ng	n a ng 0
སྐྱང་	s n a ng	n a ng 1
བམ་	b m	b a m 1
ལྷམ་	b l m	l a m 1

Note: Generally, it can be noted that the combination of certain letters with the root letter affect the tone of the whole syllable or word.

3. Elements of Dzongkha Syllable/Word [4, 5]

A syllable is the basic unit of meaning or morpheme in Dzongkha. Syllables are normally delimited by a delimiter named as the 'tsheg' bar or delimited by other punctuation. Because of this syllable delimiter there are no inter-word spaces in Dzongkha. Each syllable contains a root letter (ming-zhi) and may additionally have any/or all of the following parts in the given order: prefix; head letter; sub-fixed letter; vowel sign; suffix and post-suffix, see Figure 1 below.

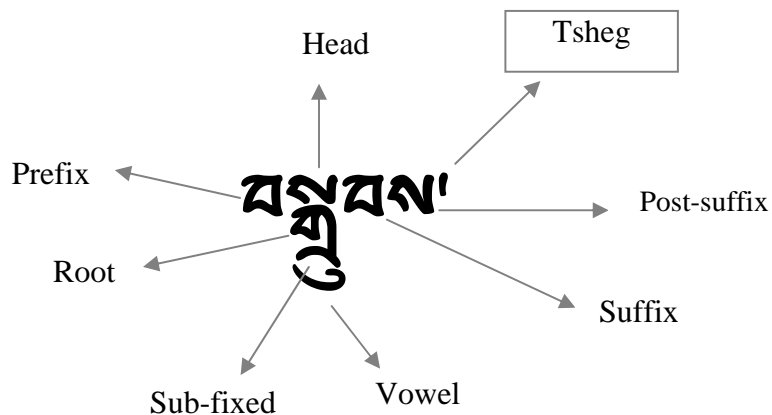


Figure 1: Elements of Dzongkha Syllable

a) Root letter - it is the most vital letter in a syllable since it defines the sound of the syllable. It is the starting point for the sound of the syllable. Hence it is always pronounced first. Therefore identification of this letter is very important.

A letter in a syllable is always a root letter if:

- 1) It has a vowel or
e.g,

ཚས་

ch oe s

-pronounced as 'ch oe 0'
-root letter is 'ch' with vowel 'oe'

- 2) It has a head letter (superscribed) or sub-fixed (subscribed) letter or
e.g,

བསྟན་

b s t n

-pronounced as 't e n 0'
-root letter is 't' with head letter 's'

ཞབ་

zh b m o

-pronounced as 'zh a m 0'
-root letter is 'zh' with sub-fixed letter 'b'

3) In a two letter syllable with no explicit vowel, root letter is the first letter or
e.g,

ཤར་	sh r	-pronounced as 'sh a r 0' -root letter is the first letter 'sh'
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4) In a three letter syllable with no explicit vowel, root letter is usually the middle letter unless the last letter is the post-suffix letter. In which case sometimes the root letter is the first letter, or it is the second letter or
e.g,

རངས་	r ng s	-pronounced as 'r a ng 0' -root letter is the first letter 'r'
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མདས་	m d s	-pronounced as 'd e 0' -root letter is the second letter 'd' with post-suffix 's'
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5) In a four letter syllable with no explicit vowel, the second letter is the root letter.
e.g,

གསཔ་	g s r p	-pronounced as 's a p 0' -root letter is 's'
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b) Head-letters: Only three letters can be the head-letters. They are **r, l** and **s**.

1) The Ra-go letters

ཀ་ ཁ་ ཅ་ ཇ་ ཉ་ ཏ་ ཐ་ ག་ མ་ ཙ་ ཟ་ འ་

- 'r' can be allowed as head letter for only twelve letters; k, g,ng, j, ny, t, d, b, m, ts and dz.
- They are all pronounced the same as the root letters.

e.g, ཀོ is pronounced as 'k a'.

2) The La-go letters:

ལྷོ ལྷོ ལྷོ ལྷོ ལྷོ ལྷོ ལྷོ ལྷོ ལྷོ ལྷོ

-'l' can be allowed as a head letter for only ten letters; k, g, ng, c, j, t, p, b & h

-All except one are pronounced the same as the root letters. That is, ལྷོ is pronounced as 'l hh a'.

3) The Sa-go letters:

སྷོ སྷོ སྷོ སྷོ སྷོ སྷོ སྷོ སྷོ སྷོ སྷོ སྷོ

-'s' can be allowed as the head letter for only eleven letters; k, g, ng, ny, t, n, p, b, m and ts

-Also pronounced the same as the root letters.

c) Sub-fixed (subscribed) letters: Four letters; y, r, l and t are sub-fixed with few root letters as follows:

i) The Ya-ta letters: here the letter 'y' is the subscribed letter, see Table 8 below.

Table 8: Ya-ta letters

Example	Romanized	Transcription (based on pronunciation)
ཀྷོ	k y	c a 0
ཁྷོ	kh y	ch a 0
གྷོ	g y	j a 0
པྷོ	p y	c a 0
ཕྷོ	ph y	ch a 0
བྷོ	b y	j a 0

ᄃᆫ	m y	y a 1
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ii) The Ra-ta letters: Here the letter 'r' is the subscribed letter, see Table 9 below

Table 9: Ra-ta letters

Example	Romanized	Transcription (based on pronunciation)
ᄃᆫ	k r	tr a 0
ᄃᆫ	kh r	thr a 0
ᄃᆫ	g r	dr a 0
ᄃᆫ	t r	tr a 0
ᄃᆫ	th r	thr a 0
ᄃᆫ	d r	dr a 0
ᄃᆫ	n r	nr a 0
ᄃᆫ	p r	tr a 0
ᄃᆫ	ph r	thr a 0
ᄃᆫ	b r	dr a 0
ᄃᆫ	m r	mr a 0
ᄃᆫ	sh r	shr a 0
ᄃᆫ	s r	s a 0
ᄃᆫ	h r	hr a 0

Note: The ra-ta letters usually form clusters.

𑂔 (nr a 0), 𑂕 (mr a 0), 𑂖 (shr a 0) are excluded from the list of clusters because they are extremely rare.

iii) The La-ta letters: Here the letter 'l' is the subscribed letter, see Table 10

Table 10: La-ta letters

Example	Romanized	Transcription (based on pronunciation)
ལྷ།	kl	l a 1
ལྷ།	gl	l a 1
ལྷ།	bl	l a 1
ལྷ།	rl	l a 1
ལྷ།	sl	l a 1
ལྷ།	zl	d a 0

iv) Fifteen Wa-zur letters: Here the letter 'b' is the subscribed letter.

ཀྱ་ ལྷ་ ལྷ་ ལྷ་ ལྷ་ ལྷ་ ལྷ་ ལྷ་ ལྷ་ ལྷ་ ལྷ་ ལྷ་ ལྷ་ ལྷ་ ལྷ་ ལྷ་

-All are pronounced the same as the root letters.

d) Prefixes: These are unpronounced letters in the beginning of a syllable before the root letter. Though they are never pronounced, some of them modify the pronunciation of some root letters. There are five prefixes; g, d, b, m and hh.

ག་ ད་ བ་ མ་ འ་

e.g,

མཚོ

m tsh o

-pronounced as '**ts o 0**'

-m is silent (this is because the root letter here is **tsh**)

དབང

d b ng

-pronounced as '**w a ng 1**'

-Here the root letter **b**'s pronunciation is modified to that of **w**'s and also the tone of the whole syllable is modified.

- d) Suffixes: These are the letters written after the root letters. Suffixes 'hh' and 's' are never pronounced. Pronunciation of the remaining suffixes depends on the combining root letters. That is, depending on the combining root letters those suffixes may or may not add their own sounds. There are ten suffixes; g, ng, d, n, b, m, hh, r, l and s.

ག་ ང་ ད་ ར་ བ་ མ་ འ་ ར་ ལ་ ས་

e.g,

འཇིག་

hh j i g

-pronounced as '**j i g 0**'

-suffix **g** is pronounced along with root letter **j**

བཀག་

b k g

-pronounced as '**k a 0**'

-here suffix **g** is not at all pronounced

Note: As seen earlier, some suffixes are capable of modifying the vowel sound in a syllable. And all suffixes can combine with all thirty initial consonants (root consonants) to produce a word or a syllable.

f) Secondary-suffixes: These are letters that come after the suffix letters. They can also be called as post-suffixes. The letters 's' & 'd' are the post-suffixes for the language. They are not pronounced at all in a syllable.

e.g,

ལྷགས་

l c g s

- pronounced as 'c a g 0'

-the post-suffix 's' is not pronounced in the syllable

Note: Post-suffix 'd' is seldom used. When used it can combine with suffixes 'n', 'r', & 'l' only, while the frequently used post-suffix 's' can have combinations with only four suffixes, 'g', 'ng', 'p' and 'm' in a syllable.

4. Result

Phonemic inventory have been researched and clearly defined. This phoneme set definition has been used for design and development of Dzongkha TTS prototype [6].

5. Conclusion

This paper presented the definition of phonetic inventory for Dzongkha language. The sound system for the language is guided by certain pronunciation rules. It can be concluded that arrangement of letters in a word greatly influences the pronunciation of that particular word. More insight to the language can be achieved with further research on the language.

6. References

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