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SYLLABLE STRUCTURE AND SYLLABIFICATION IN SINDHI-ENGLISH LOANWORDS

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ABSTRACT

The paper investigates the phonological aspects of syllable structure including the syllable templates, number of consonants at syllable onset, medial, coda, word boundary and the phonotactic constraints in Sindhi. This is the first ever descriptive-cum-synchronic study on the investigation of syllable structure in Northern Sindhi[1]. The key purpose of this paper is to determine the proper mechanism in identifying the rules of syllabification through a word recognition algorithm, syllable inventory, epenthesis phenomenon in consonant clusters of indigenous and loanwords at syllable onset word-initially.

Keyword: Sindhi, Syllabification, Syllable Structure, Phonotactic Constraints, Epenthesis and Algorithm.

1. **INTRODUCTION**

"Sindhi is an Indo-Aryan language with its roots in the Lower Indus River Valley. Sindhi is spoken in the province of Sindh, Pakistan, where it is recognized by the government as the official language of the province" (Cole, 2006). Sindhi is spoken by 18.5 million speakers in Pakistan and 2.8 million in the states of India i.e. Gujarat; Rajasthan and Uttar Pradesh etc. (1997) (From Ethnologue, 15th edition, 2001© Summer Institute of Linguistics; URL[2]: http[3]: (www.ethnologue.com/show_language.asp?code=snd). The modern Sindhi uses the Arabic Nask[h] Script (prominent in the Muslim Sindhi speaker)[4] and Devanagri Script (prominent in the Hindu Sindhi speaker area) (Keerio, 2010). Sindhi has six dialects i.e. *Vicholi, Tharli, Kachchi* (Spoken in India), *Lari, Lasi* and *Utradi* (*Northern)* (Gierison, cited in Allana 1998).

2. **SOUND SYSTEM IN SINDHI**

The Sindhi vocalic system contains five long vowels /a:, i:, u:, e, o, /[5] and three short vowels /a, ɪ, u/ and has the same number of their nasalized counterpart. Sindhi also has two diphthongs /ai, au/ argued by Allana (2009) and Bughio (2001). The presence of eight diphthongs [ɪi:, əʊ, eɪ, əe, əo, ʊu, ʊu:, əi:] in Sindhi were cited by the Jatoi 1996) and by Keerio (2010) as follows: [əy, ɪə, oɪ, ɑɪ, əw, uə, ɑʊ, iʊ][6]. Keerio (2010) also illustrates ten vowel sounds

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1 *Northern* Sindhi dialect is spoken in upper Sindh ranging from Jacobabad to Sewan region (Abbasi, 2009).
2 URL: Uniform Source Locator. A Website Address.
3 http: Hyper Text Transfer Protocol: System of code used to send a web page from the web server to a browser.
4 ( ) Indicates something which is optional, that is, can be omitted or ignored.
5 / / Indicates the phonemic representation of a sound.

(mono-thongs) of Sindhi /i/ /ɪ/ /e/ /ɛ/ /ə/ /ɑ/ /ɔ/ /o/ /ʊ/ /u/, whereas, Allana (2009) and Bughio (2001) state only eight mono-thongs coupled with two diphthongs. The consonantal system of Sindhi consists of following sounds: /p, pʰ[7], b, bʰ[8], t, tʰ, d, dʰ , ʈ, ʈʰ, ɖ, ɖʰ, tʃ, tʃʰ, dʒ, dʒʰ, k, kʰ, g, gʰ, ɓ, ɗ, ʄ, ɠ, [ɖr, ɖʰr, ʈr ʈʰr][9], m, mʰ, n, nʰ, ŋ, ŋʰ, ɲ, ŋ, f, v, s, z, ʃ, q, x, ɣ, ħ, h, r, rʰ, ɽ, [ɽʰ], w, j, l, lʰ/(Jatoi, 1996, Allana, 2009).

2.1. SINDHI VOCALIC SYSTEM

Bughio (2001) describes Sindhi vowels as follows:
Sindhi vowels have been divided into long and short vowels: /a/ half open central short, mid front centralized when final, /a:/ nearly back open long, /ɪ/ half close front slightly centralized short, /i:/ nearly close front long, /u/ half close central rounded short, markedly fronted when final, /u:/ nearly close back rounded long, /e/ long mid open front and /o/ long mid open back.

Sindhi is very unique in terms of the same number of nasal counterpart with their vowels. Nihalani (1995) and Allana (2009) illustrate that each Sindhi vowel has a nasalized counterpart and have also given some examples i.e… /*əsi*/ 'eighty', /*əsĩ*/ 'we'; /*adʰi*/ 'half rupee', /*ãdʰi*/ 'storm'; /*dəhi*/ 'yogurt', /*dəhĩ*[10]/ 'tenth', /*pəsu*/ 'see' (for single), /*pəsũ*/ 'see' (for plural), /*to*/ 'you' (single) /*tõ*/ 'you'(single-plural).

Ladefoged (2004) describes the diphthongs involve a change in quality within single vowel; they can be explained as movements from one vowel to another. If the first part of the diphthong is more prominent than the last one; then such vocalic sounds are known as Falling Diphthongs. The last part is so short it becomes difficult to determine its quality and the Rising Diphthongs have the last part longer than the first part. Clark & Yallop, (2007) cite the example of diphthongs in English such as *high*, *how* and *hoe.*

The status of diphthongs remains contentious in Sindhi vocalic inventory. Trump (1872) states that "Sindhi has no diphthongs such as: /ai/ is mostly pronounced as two separate vowels, a-i, and likewise with [au] which is pronounced as [a-u]" (Bughio, 2001). Bughio (2001) argues that "Trummp's belief that diphthongs are an Arabic influence may be counted by Allana's (1967:76-77) findings that diphthongs are, in fact, traceable to indigenous Sindhi and are found in other Indo-Iranian languages are well". Khubchandani (1961:23) explains that the diphthongs which were discussed by Trummp (1872) have been changed into simple vowels (Bughio, 2001). Nihalani (1995) states the vowels /ɛ/ and /ɔ/ tend to be diphthongized, as [ɛə] and [əʊ] and the vowels in an open syllable tend to be longer than those in closed syllables. Jatoi (1996) and Keerio (2010) argue the presence of eight diphthongs [ɪi:, ʊu:, əe, əo, eɪ, əi:, ʊo, i:ɪ] and [əy, ɪə, oɪ, ɑɪ, əw, uə, ɑʊ, iʊ] respectively.

There was a great need for acoustic analysis of controversial diphthongs because above all observations were based on phonological, articulatory-phonetic, diachronic and orthographical study, except the recent acoustic study by Keerio (2010). In his recent acoustic study through voice samples of 75 Sindhi native speakers across Sindh (province of Pakistan), Keerio (2010) conducted acoustic-phonetic[11] analysis of Sindhi diphthongs to clarify the current status of such sounds as being classified as vowels by some phoneticians and diphthongs by others and he found the presence of eight diphthongs in Sindhi.

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6 [ ] Indicates the phonetic realization.
7 [ʰ] Superscript diacritic for voiceless aspiration.
8 [ʰ] Superscript diacritic for voiced aspiration.
9 [ɖr, ɖʰr, ʈr ʈʰr] they are allophonic sounds pronounced instead of /ɖ, ɖʰ, ʈ, ʈʰ/ in Northern dialect also noted by Prem (1995)
10 [ĩ] Superscript diacritic for nasalized sound
11 Acoustic-Phonetics: Acoustic-Phonetics describes the speech sounds themselves and how they are formed acoustically. The scientific study of speech sounds is a part of general field of speech science; which focuses especially on the sound patterns that function in language (Pickett, 1999).

2.2. CONSONANTAL SYSTEM

Allana (2009) describes that the sound system of Sindhi consists of 52 distinctive consonantal sounds. Cole (2001) argues the most prominent feature of Sindhi is its implosives[12], and the consonants have aspirated or breathy voiced counterparts. Sindhi has also the full series of stop consonants of any of the Indo-Aryan language, displaying contrasts voicing, aspiration, and plosives/implosive articulations. The consonantal sound system displays five places of articulation i.e. Labial, dental, retroflex, palatal and velar. Allana, (2009) states that the implosives are indigenously found in Sindhi and some of the implosives are also found in Indo-Aryan languages i.e. Siraiki and Marwari. Allana (2009) states that the five Arabic consonants /s, x, q, ɣ, h/ have been included in Sindhi alphabet and there are seven indigenous Sindhi sounds /ɓ, ʄ, ɗ, ɠ, ŋ, ɲ, ɳ/ in the Sindhi sound system.

In addition, five Sindhi sounds which have not been made the part of Sindhi alphabet yet, includes: (i) flapped [ɽʰ], ڙ ه (ii) lateral [lʰ], لھ (iii) aspirated nasal [nʰ], نھ (iv) aspirated nasal [mʰ], مھ and (v) aspirated nasal [ɳʰ][13], ڻھ (Allana, 2009). While Keerio (2010) states 48 consonant sounds; including nine language redundant sounds on account of the same acoustic properties produced by Sindhi native speakers (SNS)[14] for the sounds as follows: (i) س (fricative [s]), with **ث, ص,** ; (ii) ز (fricative [z]) with **ظ , ض ,ذ,**; (iii) ت (stop [t]) with [ط]; (iv) ك (stop [k]) with [ق]; (v) ه(fricative [h]) with [ح]; and (vi) ع glottal [?]) With [ء]. And six sounds that are not yet part of the language alphabet as follows: ه ڙ[ɽʰ] (ii) ره [rʰ] (iii) لھ [lʰ] (iv) نھ [nʰ] (v) مھ [mʰ] and (vi) ڻھ [ɳʰ]. Cole (2001) argues that "the aspirated sonorants, [mʰ, nʰ, ŋʰ, lʰ, ɽʰ, vʰ, (wʰ)], occur inter-vocalically, but since they do not contrast with a sonorant+/ h / cluster, no strong claim can be made for their phonemic status. Native speakers feel them to be unitary sounds, and are reluctant to separate them in syllable-by-syllable pronunciation, even though the / h / component is written as a separate letter in the orthography system" (Cole, 2001, cited in Malik, 2009). Chatterji (1942) describes compounded sounds as follows:

> The aspirated stops- kh, gh, ch, jh, th, dh, ph, and bh, were felt by the ancient Indian phoneticians as compounded sounds, made of the stops elements accompanied by emission of breath (usman prana), hence they were called mahaprana, i.e. 'Great breath' or 'much breath' sounds. In adopting the Persio-Arabic Script for Hindi in India, the aspirates were indicated by the letters for the stops plus ه-h (Chatterji, 1942).

The compounded and individual sounds with minimal pairs as also noted by Jatoi (1996) and Keerio (2009) are not the part of Sindhi alphabet yet, as illustrated in Table 1, but have phonemic status in Sindhi.

Table 1. Sindhi Minimal Pairs

SN	Sindhi Phonemes		Sindhi Words	Meaning	Minimal Pair	Meaning
1	/ɽʰ/	ڙ ه	pəɽʰ	Read	pəɽʊ	Cloth
2	/lʰ/	لھ	kəlʰə	Knowledge	kələ	Yesterday
3	/mʰ/	مھ	sʊ mʰe	Sleep	sʊmə	Foot of horse
4	/ ɳʰ/	ڻھ	ma. ɳʰe	Mother	ma.ɳe	Achieve
5	/nʰ/	نھ	sən. nʰo	Thin	səna	Praise

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12 The implosives in Sindhi are ingressive as argued by Nihalani, (1972) 'Sindhi has ingressive airflow; plosive are egressive and implosives are ingressive, and duration of voicing of the Sindhi implosives ranges from 52 % to 81 % of the corresponding plosives' (Nihalani, 1972). 'Sindhi implosives involve the suction of air from outside, in contrast to the observation by Ladefoged' (cited in Nihalani, 1974). Some observations lead Ladefoged to the conclusion that 'the difference between implosives and plosives is one of degree rather than of kind…. an implosive is simply a sound in which this downward movement is comparatively large and rapid' (Ladefoged, 1971, pp.27, cited in Nihalani, 1974). In contrast to Ladefoged, the traditional characterization of implosives is that they are glottalic ingressive sounds, produced by lowering the vibrating glottis (Catford, 1939; Pike, 1943, cited in Nihalani, 1974).

13 [ʰ] Superscript diacritic for voiced aspiration

14 SNS Sindhi Native Speakers

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3. **SYLLABLE STRUCTURE AND SYLLABLE TEMPLATES**

Kenstowicz (1994) explains that the syllable structure carries an obligatory nucleus preceded and followed by an optional consonantal onset and consonantal coda respectively. The nucleus plus coda than onset plus nucleus make the tight bond. The rhyme an additional sub-constituent is juxtaposed with nucleus and coda. Figure 1 shows syllable structure in general and Figure 2 shows CVC in a syllable structure.
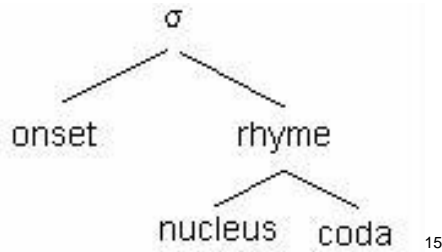

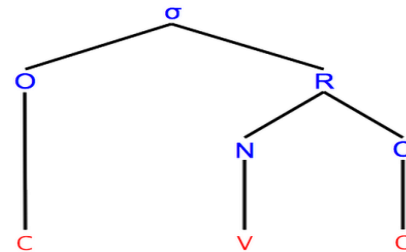**Fig 1**. *Syllable Structure*   **Fig 2.** *Syllable Structure*

Ashby and Maidment (2008) argue that the syllable is the "shortest stretch of speech" and is not the individual sound, but rather the syllable. A syllable is like a "one pulse of speech". It carries one prominent part and may optionally have consonant preceded and followed by the vowel. Yule (2004) describes the syllable structure as follows:

A syllable must contain a vowel (or vowel like) sound. The most common type of syllable in language also has a consonant before the vowel, represented as a CV. The syllable like *me*, *to* or *no* have an onset and a nucleus, but no coda. They are known as 'open' syllables. When a coda is present, as in the syllables *up*, *cup*, *at* or *hat*, they are called 'closed' syllables. The basic structure of the kind of syllable found in English words like *green* (CCVC), *eggs* (VCC), *and* (VCC), *ham* (CVC)[16], *I* (V), *do* (CV), *not* (CVC), *like* (CVC), *them* (CVC), *SAM* (CVC), *I* (V), *am* (VC).

Kenstowicz (1994) explains the syllable is a very important concept for understanding the phonological structure. Catford (1988) describes that "the syllable is a minimal pulse of initiatory activity bounded by a momentary retardation of the initiator, either self-imposed, or, more usually, imposed by a consonant type of articulatory stricture". Napoli, (1996) argues the syllable is counted as a beat or tapping the finger while stressed or unstressed beat is produced. Roach (2004) describes "the syllables are often explained as occupying the center that has little or no obstruction to airflow and which phones relatively aloud; before and after the center and there would be greater resistance to airflow". Cole (2001) argues the Sindhi syllable as follows:

Syllable structure in Sindhi is maximally CCVC in word-medial position and CCV word-finally. The onset consonant is optional, words may begin in vowel hiatus within words is frequently resolved through glide insertion or glide formation. Word-medial -CC- clusters may consist of any combination of obstruent and/or sonorant consonants. In -CC- clusters with an initial obstruent, there is typically an alternative pronunciation with a vowel inserted between the two consonants i.e. The word *hikɽo* 'one' and *jʰupɽi* 'shack' can be alternatively pronounced as *hikəɽo* and *jʰupɪɽi* by inserting intrusive short vowels /ə /, and /ɪ / respectively.

Sindhi syllables in most of the cases end with vowels or semi-vowels and consonant clusters can occur at initial, medial and final position of words (Jatoi, 1983). Different languages have different number of syllable inventory at word level. Sindhi has one minimum and six maximum syllables in a word as argued by Jatoi (1996) in a word as illustrated in Table 2.

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[15][σ] Sigma is shorthand for syllable
[16] [CVC] Consonant vowel consonant

Table 2. Sindhi Minimum & Maximum Syllables

Syllable	Sindhi Words in IPA	Meaning	Syllable	Sindhi Words in IPA	Meaning
One	a:.[17]	Come	Four	s ə. ɗa:. i:. do	Call
Two	tʃəm.ko	Light	Five	nə. ve. kə. la:. i:	Loneliness
Three	pa:.ləɳ.ha:.r	Allah Almighty	Six	tʃəv.ra:.i:.do.sã:.sə	Send words

Jatoi (1996) explains that there are eight templates as illustrated in Table 3 and there are CCVC and CVCC templates exist in Sindhi, for example *prem* and *hərdʒ* in Sindhi words as follows:

Table 3. Sindhi Syllable Inventory

SN	Sindhi words	Sindhi Templates	Meaning
1	a:	VV[18]	Come
2	nə	C[19]V	No
3	mã:	CVV	I
4	hu:ə	CVVV	She
5	sãn	CVVC	With
6	kya	CCVV	Did
7	kyas	CCVVC	Forgive
8	hərdʒ	CVCC	Problem

Sindhi syllable templates occur at three environments of a word: word-initially, word-medial, word-finally. Sindhi has CCV syllable templates word-initially, word-medially and CCV word finally. Jatoi (1996) argues word-initially CCV consonant clusters occur when a consonant is followed by glide or rolled/trill or flapped /j, r, or ɽ/ consonants; for example, /kya/ 'did', /pri:təm/, 'love', /pɽi:/ 'sale ground for cattle'. While Cole (2006) states that word-initial consonant clusters carrying the consonant+ glide (y, w), as do CC of retroflex stop + ɽ (flapped).

3.1 SYLLABIFICATION

The syllabication of the word is a natural process which is carried out by the native speaker of a particular language. Most of the speakers agree on the syllabification of a word in their language. The agreement of the syllables in a word mostly is triggered by the intuition of the native speakers, which guides them to syllabify the words in a natural way of speech. Giegerich, (1998) describes there are few English words, that may have variable pronunciation. For example, including (i) *Bottling*, can be pronounced with two or three syllables, (ii) *Realistic* with three or four etc. In the same way, one polysyllabic Sindhi word /nə.ve.kə.la:.i:/ 'loneliness' may be syllabified with five syllables and the same with four syllables /nə.vek.la:.i:/ 'loneliness'. There is, of course, the intuition of the speaker of the language, which may disagree to the syllabification carried out by the other native speaker of the same language. However, this happens in rare cases, where the speaker disagrees on the number of syllables of a particular word. Hence, native speakers may make disagreement on the number of syllables in a word of their language.

3.2 THE PRINCIPLES OF SYLLABIFICATION

Many of the languages tend to follow two recognized principles of syllabification, for example, includes (i) Sonority Sequence Principle (SSP) and (ii) Maximal Onset Principle (MOP). There are several languages which do not follow MOP, but most of the languages follow SSP.

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[17] [.] Syllable boundary is marked with dot
[18] [VV] Long Vowel
[19] [V] Short Vowel

3.3. SONORITY SEQUENCE PRINCIPLE (SSP)

The sequence of consonants in a syllable follows the phonotactic constraints of a language. The consonants following the sonority sequence make the syllable and do not break the phonotactic rules of language. The phonotactic rules of a language tell us what (and what not) consonant occurs on onset, on rime coupled with nucleus plus coda. There may be some consonants which occur at onset in one language but are not allowed in another language in the same environment. The phonotactics of a language follows the sonority principle. Kenstowicz, (1994) explains the Sonority can generally be described as a measurement of openness of sounds. The SSP requires the onset to rise in sonority towards the nucleus and codas to fall in sonority from the nucleus. Carr (2008) argues the sequence of consonants on onset increases according to the sonority hierarchy, as one leads towards the nucleus, which is granted for the most sonorous sound in the syllable and sequence of consonants in the coda decreases in sonority as one heads away from the nucleus of the syllable. Clark, et al (2007) explains sonority as follows:

The sonority refers to energy relative to effort, or more informally to the 'carrying power' of a sound. A sonorous sound is one with high output relative to the articulatory effort required to produce it, and sounds can therefore be ranked according to their degree of sonority. The vowel of *hawk* is more sonorous than the vowel of *hook.* We can say in general that the points of greatest sonority in an utterance will be interpreted as syllable peaks.

Goldsmith (1990) argues that the SSP may not be a universal principle; languages may violate the sonority sequence principle. Hawkins (1984) cites that a hierarchy of sonority can thus be established as illustrated in Figure 3.
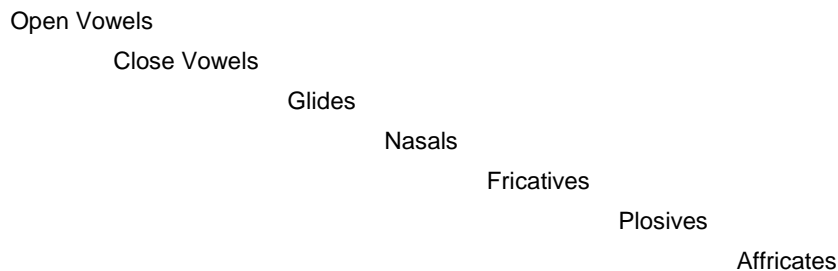
Open Vowels
    Close Vowels
        Glides
           Nasals
              Fricatives
                Plosives
                    Affricates

Fig 3. *Hierarchy of Sonority*

3.4. MAXIMUM ONSET PRINCIPLE (MOP)

The MOP prefers consonants on the onset and thus allowing no coda consonants except for the word final position. Gussenhoven & Jacob (2003) explain that the onset is made as long as it can be, and then a legitimate coda is formed. This means, the principle gives priority that a floating consonant i.e. a consonant which may occupy either coda or onset, may go to the onset position. Carr (2008) states that MOP principal describes that; according to the phonotactic restrictions of the language, a consonant may be syllabified as an onset, if a consonant can constitute a well-formed coda consonant in a word or a well-formed onset. For instance, in English word *appraise*, the syllabification *əp.reiz* satisfies the phototactic constraints of English because a coda carrying only a /p/ is legitimate, as in *cup*, an onset carrying only /r/ is also legitimate, as in *run* and /pr/ CC is also legitimate, as in *pray,* so, the syllabification *ə. preiz* is legitimate as well.

5. *NORTHERN* DIALECTAL ASPECTS

Prem (1995) cites the dialectal features in *Northern* dialect: these sounds [tr, ʈʰ, ɖr, ɖʰr] as a stop-rhotic cluster also noted by Cole, have allophonic significance but are not pronounced with /r/ in central dialect and another dialectal aspect is the elision of /h/ sound in some words as follows: /*man(h)jo, tun(h)jo and kan(h)jo*/.

5.1. EPENTHESIS PHENOMENA

The epenthesis is a phonological phenomenon which occurs in many languages, especially; when the consonant cluster is broken by inserting a vowel and sometimes a vowel does not break but comes initially on syllable onset. Crystal (1997) defines that epenthesis a type of intrusion, where an extra sound is inserted in a word; often classified into prothesis[20] and anaptyxis[21].

Fleischhacker (2000) explains the epenthesis pattern as follows:

> A similar pattern is seen in the pronunciation of English words by the native Hindi speakers described by Bharati (1994). For these speakers, initial /sm/ clusters, like ST clusters, are resolved through prothesis: e.g. [ismaail] 'smile'; however, for initial /sn/ and /sl/ clusters, prothesis and anaptyxis are in free variation: [sinek] ~[22] [isnek] 'snake', [silo] ~ [islo] 'slow'.

Gouskova (2002) cites that a vowel is inserted in rising sonority clusters between the two consonants at the onset. And the vowel is inserted before the cluster, noticeably s-obstruent clusters in falling sonority clusters, as illustrated as follows:

i. Rising sonority	internal epenthesis	gloss/source
Hindi	fɪrut	fruit
Central Pahari	sɪlet	slate

ii. Falling or flat sonority	edge epenthesis	gloss/source
Hindi	ɪskul	school

Singh (1985) Broselow (1992) illustrate for Hindi speakers of English as follows:
"a.[ɪspeliŋ] 'spelling', [ɪskul] 'school', [ɪsteʃən] 'station'
b. [pɪlɪz] 'please', [fɪrut] 'fruit', [sɪlɪpʌr] 'slipper'
c. [ɪskru] 'screw.'"

Broselow (1992) argues that the difference between s-obstruent cluster and rising sonority clusters is in the structure because s-obstruent clusters are "complex segments" which cannot be broken up by the epenthesis phenomena. Gouskova (2002) cites that there may not be any particular structure concerned with s-obstruent clusters that may explain the restriction to epenthesis at the onset.

The vocalic variation is a phonological phenomenon in languages. Some speakers of the same language drop and some add vocalic sounds to the words and sometimes insert vowel sound between consonant clusters. This phenomenon occurs in Sindhi language also where speakers drop and add the word-ending vocalic sound and insert vowel between consonant clusters in free variation. This happens because of different social background of the person i.e. Educated, uneducated, rural and Muslim (religious background) as also noted by Bughio (2001) and Cole (2006). Cole (2006) argues on word-final vowel deletion as follows:

> Old and new varieties of Sindhi are also distinguishable by the frequent deletion or total loss of the word-final short vowels in the new varieties… the gender class marking are expressed through a combination of stem alteration and final vowel suffix.

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[20] Prosthesis is a type of epenthesis (an intrusion), where an extra sound is inserted initially in a word. The phenomenon is common both in historical change and in connected speech. (e.g. Latin spiritus- French esprit) (Crystal, 1997).

[21] Anaptyxis is a type of epenthesis (an intrusion), where an extra sound is inserted into two consonants (Crystal, 1997).

[22] [~] A swung dash indicates a relation between alternative forms of the same word or pattern: boy ~ boys (Leech, 2007).

Bughio (2001) explains the trend or tendency of vocalic sound particularly on the word-ending position is noticeably observed and the habit of dropping vocalic sound or not pronouncing is relatively not as common in *Lasi* as in *Kachchi* or *Lari* (dialects of Sindhi). Bughio (2001) argues the impact of Urdu-English on Sindhi with particular reference to vowel variable occurrences, as illustrated in the following list of English words pronounced by SNS.

Table 4. List of Sindhi-English Loanwords

Sindhi	English
"isku: lu	school
ka:leju	college
kampyu:taru	computer
isteS[23]ani	station
filetu	flat
injekSani	injection
jajhu	judge
ma:jistretu	magistrate
seni:ma	cinema
filimu	film
telifoni	telephone
kaisiti	cassette"

6. MOTIVATION FOR THE CURRENT STUDY

The phonological aspects of Sindhi syllable structure coupled with phonotactic restrictions on consonant clusters occurring syllable onset word-initially, medially and finally and an essential query of epenthesis in indigenous and English loanwords at onset word-initially were the main motivations for the study.

7. SAMPLINGS AND EXPERIMENTATION

The experimental study was designed to do two experiments: *Subjects*: The population of the study is 10 adults (five male and five female) with no speech impairment. They were randomly selected from *the Northern dialect* of Sindhi spoken in Upper Sindh, (province of Pakistan). The subjects were Sindhi native speakers (SNS) (literate in Sindhi) and their age ranged from 17 to 40. Before experimenting and marking the syllable boundaries, the subjects were briefed about the syllables. *Experiment*: (i) to elicit syllables from native speakers of Sindhi the *Northern* dialect, in order to investigate their intuition of syllable structure and *Experiment*: (ii) to determine native speakers' syllabifications of words with respect to the three methods of syllabification. *Material*: Participating subjects were provided with the list of Sindhi words to syllabify by repeating the same word three times at an audible voice frequency and mark the syllable boundaries in their natural order of speech as illustrated in Appendix-A. The stimuli contained 100 high frequency words from New Comprehensive Sindhi Dictionary, volume **I** to **III** by Baloch (2005) including monosyllabic, disyllabic and polysyllabic words. No Sindhi dictionary is available that marks the syllable boundaries of the words. The syllabification was noted by the author and since no any study is available on the high frequency of Sindhi words the study relied on the intuition of the author who is also a native speaker of Sindhi (*Northern* dialect).

8. DATA ANALYSIS

8.1 MONOSYLLABIC WORDS

There were 30 mono-syllabic words given to the subjects, and asked to repeat them three times each. Out of 900 repetitions, 665 were uttered as mono-syllabic words and 235 repetitions were uttered as bi-syllabic words, as shown in Figure 4. Mono-syllabic words including *train*, *drain*, *prĩ, pɽi, prem, kya* and *thya* were syllabified mono-syllabic as well as bi-syllabic *trainə, drainə pɪ.rĩ, pɪ.ɽi, pɪrem, kɪya* and *thɪya.*

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[2]3 S   Capital 's' stands for /ʃ/ sound of English and Sindhi

8.2 BI-SYLLABIC WORDS

There were 30 bi-syllabic words given to the subjects, and asked to repeat them three times each. Out of 900 repetitions, 671 were uttered as bi-syllabic words and 229 repetitions were uttered as tri-syllabic words, as shown in Figure 4. Bi-syllabic words including *xə.siːs*, *ɪs.kul, priː.təm, ky.as, suː.kʰɽi* and *juː.pɽi* were syllabified tri-syllabic words *xə.siː.sə, ɪs.ku.lə, pɪ.riː.təm, kɪ.ya.sə, suːkʰɪ.ɽi* and *juː.pɪ.ɽi* etc.

8.3 TRI-SYLLABIC WORDS

There were 20 tri-syllabic words given to the subjects, and asked to repeat them three times each. Out of 600 repetitions, 386 were uttered as tri-syllabic words and 229 repetitions were uttered as quartet-syllabic words, as shown in Figure 4. Tri-syllabic words including /*ɪs.te.ʃən, sʊ.lətʃ.ŋo*/ etc were syllabified quartet-syllabic /*ɪs.te.ʃə.nə,. sʊ. lə. tʃə. ŋo*/ etc.

8.4 QUARTET-SYLLABIC WORDS

There were 15 quartets-syllabic words given to the subjects, and asked to repeat them three times each. Out of 450 repetitions, 288 were quartet-syllabic words and 163 repetitions were uttered as five-syllabic words, as shown in Figure 4. Quartet-syllabic words including /*tʃəv.raː.iː.do, səd.ra.i:do*/ were syllabified five-syllabic /*tʃə.və.raː.iː.do, sə.da.ra.iː.do*/ etc.

8.5 FIVE-SYLLABIC WORDS

There were 5 five-syllabic words given to the subjects, and asked to repeat them three times each. Out of 150 repetitions, 89 were uttered as five-syllabic words and 61 repetitions were uttered as six-syllabic words, as shown in Figure 4. Five-syllabic words including /*tʃəv.raː.iː.do.ãːs, səd.ra.iː.do.sãs, ro.kə.ra.i.do, nə.ve.kə.la.i*/ were syllabified six-syllabic /*tʃəv.raː.iː.do.sãː.sə, səd.ra.i:do.sã.sə*/ etc.

The results were also analyzed in SPSS displaying means and standard deviation and graph in the table no : 4 and figure no 4. as follows:

Table 5. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
monosyllabic1	10	60.00	71.00	66.5000	3.34166
bisyllabic1	10	19.00	30.00	23.5000	3.34166
bisyllabic2	10	61.00	73.00	67.1000	4.04008
trisyllabic2	10	17.00	29.00	22.9000	4.04008
trisyllable3	10	35.00	43.00	38.6000	2.31900
quartetsyllabic3	10	17.00	41.00	23.4000	6.60303
quartetsyllabic4	10	23.00	34.00	28.8000	3.52136
fivesyllabic4	10	11.00	22.00	16.3000	3.40098
fivesyllabic5	10	7.00	11.00	8.9000	1.52388
sixsyllabic5	10	4.00	8.00	6.1000	1.52388
Valid N (listwise)	10				

A Graph of Means Across Speakers
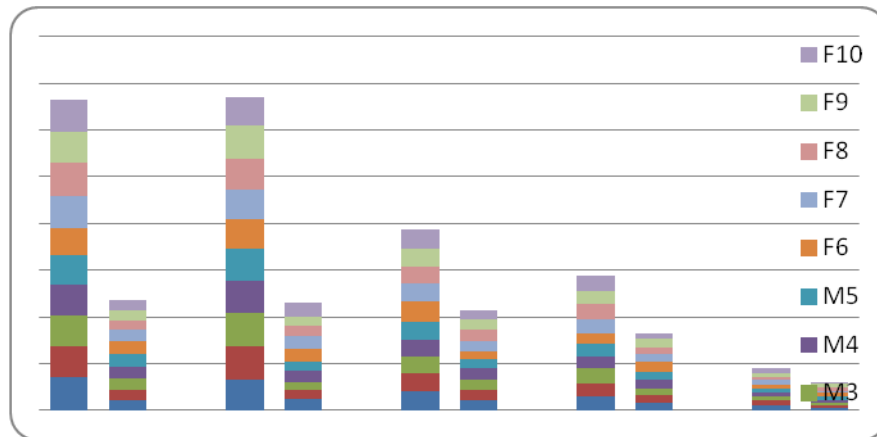

Fig 4. *Various Syllabic utterances in words were produced by SNS*

8.1 EPENTHESIS IN INDIGENOUS AND LOANWORDS OF SINDHI

Broselow (1999) states when the loanwords with complex onsets are received into CVC languages, the obstruent clusters are mostly considered differently from others. Since in s-obstruent clusters, vocalic sound are inserted at the edge: English 'school' Hindi [ɪskul], whereas, in rising sonority clusters, the vocalic sound is inserted into the cluster, English 'fruit' Hindi [fɪrut].

As illustrated in the data and Appendix-A that the elision of final vocalic sound occurs (subject to variation in the language) as noted in this study, is relatively high in the utterances of SNS of *Northern* dialect as compared to the study carried out by Bughio (2001). Further the study noted that the word-ending vowels as cited in loanwords of Sindhi by Bughio (2001) were as follows: / u, i, a/ but the study noted that in most of their utterances of SNSND (Sindhi native speakers of *Northern* dialect) pronounced schwa vowel in free variation instead. The SNSND speakers break -CC- (consonant cluster)[24] of the Sindhi loanwords on onset syllable word-initial (s-obstruent) because Sindhi follows the sonority sequence principle even at word edges and such consonant clusters do not exist in Sindhi. Consonant cluster like /tr, ɖr/ are the dialectal aspects of *Northern* dialect in terms of the pronunciation of the stops i. e. /t, ɖ/ as cited in the literature review. That is why stop-rhotic cluster /tr, dr/ were not broken by native speakers through insertion of vocalic sound. Consonant cluster i.e. /st, sp, sk/ is resolved through prothesis while anaplyxis is in free variation in clusters i.e. /pr, pɽ, ky, kʰɽ, kɽ/ whereas anaplyxis occurs in clusters i.e. /sl, sm, pl, gl/ but not in free variation, however, a vowel is attached or elided at word-ending environment subject to speech variation as also noted by Bughio (2001) and as the following list of Sindhi indigenous and loanwords cited in this study as follows in the table no: 5

Table 6. List of Sindhi-English Loanwords

(I) Rising sorority	internal/edge epenthesis		alternative in Sindhi	meaning/gloss
English	dreɪn	drenə	dren	drain
English	treɪn	treɪnə	treɪn	train
Hindi	prem	pɪremə	prem	love
Hindi	pri:təm	pɪri:təmə	pri:təm	love
English	slæt	sɪletə	sɪlet	slat
English	smaɪl	sɪmaɪlə	sɪmaɪl	smile

English	pli:z	pɪli:zə	pɪli:z	please
English	fɪlm	fɪlɪmə	fɪlɪm	film
English	glɑ:s	gɪlasə	gɪlas	glass
Sindhi	su:kʰɽi	su:kʰɪɽi	su:kʰɽi	gift
Sindhi	ju: pɽi	ju:pɪɽi	ju:pɽi	Cottage
Sindhi	kʰopɽi	kʰopɪɽi	kʰopɽi	Skull
Sindhi	sekɽo	sekɪɽo	sekɽo	Percentage
Sindhi	hekɽo	hekɪɽo	hekɽo	One
Sindhi	əŋgrez	əŋgɪrezə	əŋgɪrez	Englishman

(ii) Falling or flat sonority	edge epenthesis	alternative in Sindhi	gloss
English skul	ɪskulə	ɪskul	school
English spɪrɪt	ɪspɪrɪtə	ɪsprɪt	spirit
English steɪʃn	ɪsteʃənə	ɪsteʃən	station

9. DISCUSSION

9.1 SYLLABLE STRUCTURE AND SYLLABLE TEMPLATES IN SINDHI

9.1.1 ONSET

Sindhi possesses indigenous words with two consonant clusters at the onset i.e. /*kya, thyas, pyar, byai* and *prĩ,/* they are simultaneously pronounced with broken clusters by inserting vocalic sound through epenthesis by the layman. In case of some English and Hindi loanwords in Sindhi which are pronounced by educated class people, without breaking the consonant clusters, confirm that the Sindhi follows Maximum Onset Principle since Sindhi loanwords allows maximum two consonant cluster on syllable onset word-initially, medially and word-finally. The syllabification of Sindhi loanword /*pri:təm/* satisfies phonotactic constraints of a language since onset /pr/ is a legitimate consonant cluster (as in /*prĩ/* Sindhi indigenous word). A /p/ consonant is followed by /r/ as it satisfies the phonotactic constraints of Sindhi as well as MOP. The CC /pr**/** in Sindhi satisfies MOP in a way that /p/ plosive consonant ranks second last in the Hierarchy of Sonority as illustrated in Figure 3 and /r/ liquid ranks third one sonorous sound in the Hierarchy of Sonority. Hence, /p/ stop is less sonorous than the /r/ liquid. In this way the CC /pr/ and /pɽ/ word initially in Sindhi satisfy the Maximal Onset Principle. In addition, Jatoi (1996) argues that the consonant cluster can occur on onset syllable, in case a consonant is followed by gliding /j/, rolled /r/ and flapped /ɽ/ in the language and the phonotactic constraints of Sindhi are subject to occurrences of certain sounds for example, Sindhi words do not begin with the consonants i.e. Flapped sound /ɽ/ aspirated flapped /ɽʰ/ and three nasal sounds /ŋ, ɲ, ŋ/. In addition, an epenthesis phenomenon is common in languages where free variation occurs in loanwords as cited by Broselow (1999) and noted by the current study in Sindhi. Another vowel elision phenomenon also occurs in pronunciation of Sindhi words as illustrated by Bughio (2001) and as cited in the data of this study. Sindhi language flexibility is noticed in its free variation aspect as follows: /prem/ and /pro.li/ is also pronounced alternatively /pɪrem/ and /pɪroli/ by inserting intrusive short vowel sounds. However, the study had no prior knowledge of the status of compounded sounds occurring on onset word-medially like /po.ɽho, mə.lh, sən.nho and /mã.ŋhũ/ before carrying out the research, the research found at a later stage of the study. They were pronounced without insertion of vocalic sound, since they are compounded individual phonemes and have not been made the part of Sindhi alphabet, as also illustrated by Allana & Keerio (2009, 2010) respectively. The same was noted in current research that no any subject inserted vowel between the compounded sounds /[ɽh], lh, nh, ŋh, mh/ as illustrated in the literature review.

9.1.2 CODA

One or maximum two consonants can occupy coda at word-final position optionally, otherwise vowel occupies the coda in Sindhi. On account of dialectical features the speakers of *Northern* dialect add third consonant in pronunciation of a particular sound, whereas, it is neither the part of the orthography nor the speakers of other dialects pronounce them. The words like these have three consonants at the coda for example /dʒənɖ[ɾ] and kʰənɖ[ɾ]/ in pronunciation and all they occur on word boundary position. Hussain (2010) argues that Urdu has two consonants

at the coda position, and has specified the constraints that the first and second must be voiceless fricative coupled with a stop in Urdu respectively. The coda constraints in Urdu as argued by Hussain (2010), does not occur in Sindhi words. In Sindhi coda consonants also follow the SSP principle, as has been investigated in the current study that mostly the sequence of consonants at coda word-finally followed by a vowel or ϕ[25] vowel as illustrated i.e. fricative+stop, nasal+plosive, liquid+affricate, liquid+stop and nasal+affricate and in pronunciation (spoken) nasal+stop+liquid in *Northern* dialect for example: /*səxt or səxtə, kəndʰ, kəndʰə,   rəndʒ, rəndʒə* and *kʰənd[r], kʰənd[r]ə/.*

9.1.3 RIME

The rime consists of a nucleus and coda. A syllable carries vowel as a nucleus while consonants do not make syllables in Sindhi. Sindhi consonants can be preceded or followed by short or long vowel, while Hussain (2010) argues that the Urdu word does not end with short vowels. However, this study finds that the SNSND elide vowel at word-boundaries of Sindhi indigenous and loanwords at relatively high rates. This ultimately denotes that there is a clear impact of Urdu-English on the speech of SNSs as also noted by Bughio (2001). Sindhi follows both SSP and MOP since two consonant clusters occur at syllable-onset in Sindhi loanwords. Sindhi follows SSP in a way that onset sonority raises from the onset towards the nucleus and codas to fall in sonority from the nucleus. An example of Sindhi two syllable word is /*kə.kər/* 'clouds'. The first consonant in the syllable onset is /k/, which is stop, the lowest on the sonority scale as shown above in sequence. The next is schwa /ə/ in IPA, the sonority peak. In second syllable onset is again /k/ which is plosive the lowest in the sonority hierarchy coupled with schwa /ə / the sonority peak. The next is liquid at the coda of the second syllable which is more sonorous but less than short vowel. Hence Sindhi follows the Sonority Sequence Principle (SSP).

9.2. SYLLABIFICATION IN SINDHI

Syllabification determines as to how many syllables are in a word; which ultimately depends on the phonological patterns of a language. This determines the rules of syllables occurring independently at word initially, medially, and at coda final position. The syllable templates generally vary from language to language and even within the dialects of the same language. Weerasinghe et al. (n.d) state that the syllabification algorithms are proposed for various languages including English, German, Spanish and Hindi etc. Syllabification algorithms are mostly applied to the text-to-speech (TTS) systems in the production of natural sounding speech, and in speech recognizers for finding words.

The researchers may differ with the number of syllables templates. For example, Hussain (2010) states 12 syllabic templates, Akram (2002) argues 11 syllabic templates and Bokhari (2002) eight syllabic templates whereas Nayyar (n.d) reports 15 syllabic templates in Urdu. Jatoi (1996) reports eight syllable templates in Sindhi as shown in Table 3 whereas the current study found 5 Sindhi syllable templates as illustrated in Table 6:   whereas V stands for short or long vowel and C stands for consonant as follows:

Table 6. Possible Sindhi Syllable Templates

SN	Sindhi words	Sindhi Templates	Meaning
1	ə.tʃʊ	V.CV	Come
2	ɪl.hamə	VC.CVCV	Message
3	sa.rə	CV	Remember
4	kəm.zor	CVC	Weak
5	pəndʰ	CVCC	Walk

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[25]ϕ stands for zero value

To determine the syllabification mechanism for Sindhi, the template matching based technique is applied in order to syllabify Sindhi word. Syllabication can be done by matching C0,1[26], VC*[27] templates from the beginning of the word towards its end. The template matching starts from the beginning of the word. Sindhi dictionary shows two forms of suffixes in words one is written and other is vocalized. The current study is only concerned with the phonetic aspect of the word rather than the orthographic aspect. For example, 'topiyoun', 'caps' the suffix 'youn' is pronounced and written as well; while /məttə/ 'jar' -(CV)(CV)- suffix /ə/ is only vocalized but not written. Hussain (2005) argues that the syllabification is done by either projecting nuclei through applying SSP and MOP in order to integrate some other phonological aspects or by applying syllable CV templates and to fit them from either left to right or right to left direction. The following algorithm has been devised after template matching techniques on 1000 words in the study. Syllabification can be done with the help of the algorithm in Sindhi as follows:

9.3 NUCLEUS PROJECTION METHOD

9.3.1 ALGORITHM FOR THE SYLLABIFICATION IN SINDHI

DIRECTION FROM LEFT TO RIGHT

1. Project the syllable from each vowel, then
2. attach onset consonant to each vowel, and
3. if there are two consonants on the onset, then attach second one to each vowel and then
4. apply SSP then
5. apply MOP if there is some ambiguity for the syllabification, then
6. apply phonotactic constraints with consonant cluster as follows:
   i. word-initial position: if the first onset consonant follows /ɽ, y or r/consonants; and
   ii. word-medial position: if the first onset consonant follows /ɽ or y/, then
   iii. the first onset consonant must also be attached with the same vowel.
   iv else it must be detached and attached to the coda of the previous syllable.
7. finally attach the remaining coda consonants to the vowels concerned.

10. CONCLUSION

Sindhi is an open-syllable language. The Sindhi syllable structure consists of onset, nucleus and coda. Sindhi syllable carries vowel as a nucleus while consonants do not make syllables. Vowel alone can stand as a syllable, while consonants can optionally have an onset. The phonotactic constraints in Sindhi are i.e. the consonant cluster can occur on onset syllable at three environments of a word, in case a consonant is followed by gliding /j/, rolled /r/ and flapped /ɽ/ in the language. The syllables may begin with consonant clusters, like /kya/ 'did', /pɽi/ 'sale area of cattle' and /kyas/ 'forgive'. Whereas, the consonants i.e. flapped sound /ɽ/ aspirated flapped /ɽʰ/ and three nasal sounds /ŋ, ɲ, ɳ/ are restricted to occur syllable onset word-initially as also noted by Jatoi (1996). Sindhi syllable contains one minimum and two maximum consonants optionally at the syllable onset word-initially, medially and finally. Sindhi has one minimum and six maximum syllables in a word. In addition, the research found 5 syllable templates as illustrated in Table 4 while Jatoi (1996) argued eight syllable templates as cited in Table 3.

The study also developed an algorithm consisting of seven parameters in words that can help recognize the words in Sindhi. Sindhi is a flexible language with reference to epenthesis in free variation coupled with vowel elision at word-boundaries subject to variation in the language as illustrated in data analysis. Since the language allows two -CC- at the onset, coda, word-medial and word final positions, Sindhi follows both Universal theories i.e. Sonority Sequence Principle and Maximum Onset Principle theories.

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[26] C0, 1 stands for single consonant or more than one
[27] C* stands for single consonant or more

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Table 7. Appendix-A

Table 7: The Result of Total Repetitions for Syllabification of Sindhi Words											
Subjects	W/RP	M1	M2	M3	M4	M5	F6	F7	F8	F9	F10	T RP
Mono-Syllabic Words	30	70	68	65	65	63	60	67	71	67	69	665
Bi-Syllabic		20	22	25	25	27	30	23	19	23	21	235
Repetitions	90	90	90	90	90	90	90	90	90	90	90	900
Bi-Syllabic Words	30	65	71	73	67	69	63	64	66	72	61	671
Tri-Syllabic		25	19	17	23	21	27	26	24	18	29	229
Repetitions	90	90	90	90	90	90	90	90	90	90	90	900
Tri-Syllabic Words	20	40	38	37	35	40	43	38	36	39	40	386
Quartet-Syllabic		20	22	23	25	20	17	22	24	21	20	214
Repetitions	60	60	60	60	60	60	60	60	60	60	60	600
Quartet-Syllabic Words	15	30	28	32	25	27	23	29	33	27	34	288
Five-Syllabic Words		15	17	13	20	18	22	16	13	18	11	163
Repetitions	45	45	45	45	45	45	45	45	45	45	45	450
Five-Syllabic Words	5	11	9	10	8	7	8	11	8	7	10	89
Six-Syllabic		4	6	5	7	8	7	4	7	8	5	61
Repetitions	15	15	15	15	15	15	15	15	15	15	15	150
W- Words, RP-Repetitions, T-Total, F-Female, M-Male											

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