Phonological Analysis of Arabic Diphthongs in Defective Verbs

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Abstract
The Arabic diphthongs have two sounds, which are /aɪ/ and /aʊ/, each in its nouns and weak verbs. This study aims to analyse phonological rules related to Arabic diphthongs and syllable segmentation among Arabic diphthongs. Qualitative methods are applied in this research wherein content analysis is conducted using Chomsky and Halle's phonological rules (1968) and Crowley (1987) theory to analyse all data. The data are collected from the Arabic dictionary called *Mu'jam Taşrīf al-`af'āl al-'arabiyyah* and the data are then divided into two categories, namely sound /w/ and /y/. The study observes that the Arabic diphthong sounds are found in in the forms of nouns and defective verbs with suffixes other than /a/, /t/ and /w/. The study finds that in Arabic, diphthong sounds are deleted in defective verbs when the suffix consists of two phonemes, and these sounds transform into long vowel sounds upon the addition of /a/, indicating the third-person singular male in the past tense. The suffixes /t/ and /w/ similarly convert the diphthong to a basic vowel. This study concludes that phonological changes occur more frequently in Arabic defective verbs than in nouns, following certain rules. Additionally, syllable segments change as well when the glide sounds forming diphthongs are deleted.
Keywords: Arabic; diphthongs; phonology; rules; syllable

INTRODUCTION

Diphthongs are sounds that are formed by two vowels in one syllable, i.e., when there is an intentional glide made from one vowel position to another vowel position (Ramelan, 1999). The diphthong sounds are pronounced in many languages, and each language has its own diphthong sounds that are different from each other. For example, there are three diphthongs sounds like cow, /kaʊ/, light, /laɪt/, and boycott /bɔɪ.kɒt/ in English (Yunisrina et al, 2021). The Malay diphthongs are similar to ones in English, like laut /laʊt/ (sea), kait /kaɪt/ (*saw*), and kaloi /kalɔɪ/ (fish). Meanwhile, the Arabic diphthongs have only two sounds, like qawl /qaʊl/ (*word*) and dayf / daɪf/ (guest) without the /ɔɪ/ sound. The vowel sounds in Arabic consist of three main sounds, /a/, /u/, and /i/, and two diphthong sounds, /aɪ/ and /aʊ/ which are a combination between /a/ and /y/, and also /a/ and /w/ (Abdulrazzaq et al, 2023; and Mustafa, 2022).

The Arabic diphthongs show a variety of phonological changes that happen among its nouns and weak verbs in the past tense form (al-Bahansāwī, 2008, & al-Ṣaġīr, 2008). Each change requires specific rules that involve different features. There are many phonological processes applied in certain words, such as deletion, assimilation,

dissimilation, and others. These processes are different based on some factors, like phonemes, segmentations, and others (Hale & Charles, 2008). Previous Arabic diphthong's analyses were based on ancient scholar quotation and did not apply any phonological theories and rules (Norlin, 1985; Abdelgadir, 2021 & Mohammed, 2023)(Mashaqba et al., 2021). Therefore, this study applies some phonological theories and rules to analyse the Arabic diphthongs in defective verbs.

Nasheed (2015) explained the meaning of incomplete verbs and how to remove it. This proves the existence of imperfect verbs in the English language and the importance of imperfect verbs in both Arabic and English. The study also explained about incomplete verbs in Arabic and English, deletion, forward movement, and delay, and showed the similarities and differences between the incomplete verbs of the two languages (Alahdal, 2019). Finally, the study proves that the similarities between the two languages in incomplete verbs outweigh the differences.

Diphthongs in other languages are analysed using some phonological theories and rules to enhance the analysis value. Meanwhile, most of the Arabic diphthong's studies are still discussed based on descriptive methods applied by previous Arabic scholars before (Norlin, 1985; Abdelgadir, 2021 & Mohammed, 2023)(Al-Basri, 2021). Thus, it is critical to understand the phonological processes in the Arabic diphthongs are similar to other languages, and to identify and differentiate between the Arabic diphthongs and the other languages.

The discussion in this paper aims to analyse phonological rules related to Arabic diphthongs based on Chomsky and Halle (1968), and to analyse syllables among Arabic diphthongs based on Crowley (1987). The results from the analysis can provide different perspectives for Arabic phonology by presenting new phonological findings that similar to other languages.

Al-Huneety et al. (2021) summarised major linguistic features of Al-Issa-Arabic as follows: 1) obligatory *gahawa* syndrome; 2) application of trisyllabic elision; 3) retention of/aw/ and/ay/; 4) unconditioned affrication of ∗k into /č/; 5) the realisation of the palate-alveolar ∗j as/y/ in all word positions; and 6) syllabification phenomena include *gahawa* syndrome. Epenthesis is applied regardless of sonority hierarchy, syncope, and trisyllabic elesion, as well as sound shift of /a/ > [i] in an open syllable. The researchers found that emphasis spreads bidirectionally within the phonological word; leftward emphasis is absolute, but rightward emphasis spreads emphasis within the tautosyllabic segments. This finding is also similar to Miran and Naji (2023) that found a group of linguistic forms, some of which constitute a special phenomenon.

Segundo and Yang (2019) found that there are some vowel combinations that perform better than others. Regardless the curve-fitting technique applied, they concluded that vocalic sequences (VS) with two back vowels (/uo/) or with mid-back (/ao/) and back-mid (/ua/ and /oa/) vowels consistently give a lower Cllr than VS with front + back and close vowels (/eu/ and /iu/, which seem to perform slightly better. Perhaps this is because of the minimal movement in /uo/, /ua/ and /ao/ while in /eu/ and /iu/ there is a chance of being more personal on how the speaker's tongue moves between items through the vowel space. This process is similar to Arabic diphthongs except that vowels are limited for Arabic diphthongs (Al-Jarf, 2022). Although these diphthongs are different compared to the Arabic diphthongs, the similarity between them is that there is a condition where the diphthong sounds remain without any phonological process.

Jacopo and Jairo (2023) observed that hollow or defective verbs are not considered in this discussion because they often take this irregular form of the subject suffix. Conversely, consonant verbs are affected, but with irregular suffixes in a few varieties of Modern Arabic. Vowel-initial suffix pronouns following subject suffixes are also not considered, as this suffix often makes the subject suffix -āt. El-Mutawakkil et al (2021) suggested that imperfective verbs are grammaticalised in Arabic. This means that over time, a complete verb that indicates "process" and "tense" changes to an "imperfect verb" that indicates only "tense". Based on the hypotheses proposed by El-Mutawakkil et al. (2021), they concluded that forms of imperfect verbs exist in their different grammaticalisation stages, and the hypothesis showed that these verbs are used only complete before its grammaticalisation.

Niina (2020) argued that the first verb and the agent-oriented resultative fuse early in Mandarin defectives incorporating verbs, resulting in the first verb moving away from the post-segmental cephalic position. As a result, it becomes difficult for other elements outside the theta domain to reach the verb. Semantically, two types of noun incorporation are distinguished. One is the early limit type, and the other is the early saturation type. The latter type is identified for the first time. Based on these past studies, the researchers extend the study of Arabic verbs since there are some specific sound changes that are different compared to other languages.

Phonological rule was founded by Chomsky and Halle (1968) through generative phonology theory. Generative phonology studies and analyses all phonological phenomena that occur in all lexical categories by suggesting suitable rules to explain the phenomenon based on this rule:

$$A \rightarrow B / X \_\_\_ Y$$

This rule shows that sound A will change to sound B if the sound A is located between the sound X and sound Y, or as a corresponding element of the type B when A appears in the context of X _ Y (Chomsky & Halle, 1968). These informal specifications are analysed more precisely as the rules are discussed. These rules can be expanded by using distinctive features to elaborate the phonological process in more detail (Mohd Rusli et al, 2022).

As for phonological changes, Crowley (1987) suggested several types such as lenition, sound addition, metathesis, fusion, unpacking, vowel braking, assimilation, dissimilation, and abnormal sound change. Among these types, the lenition analyses more on the syllable changes, such as apocope, where the word final segment loss and affects the syllable structure; and syncope where the middle segments loss and affect the syllable number and structure; and haplology where the entire syllable loss and reduce the syllable number.

Distinctive features are the most fundamental component of phonological structure that separates one sound from another within a language. Phonemes are composed of various characteristics that distinguish them from other phonemes (Oden, 2022). These features are very distinct as they indicate differences between phonemes. A distinguishing feature arises from the distinction between one phoneme and another (Mielke, 2008). The distinctive features are based on the principle that phonemes should not be viewed as independent, indivisible entities, but as combinations of different features (Roach, 2000). By using binary notation, the symbol `+` means that a phoneme does possess that feature and '-' means that it does not (Okafor, 2021). As for the Arabic diphthongs, they are formed by these three phonemes: /a/, /w/, and /y/; and their distinctive features are as follows:

Table 1. Distinctive Features For Non-Consonantal Sounds

	/a/	/w/	/y/
High	-	+	+
Low	+	-	-
Back	-	+	-

Table 1 shows that vowel /a/ produces low sound compared to /w/ and /y/ that produce high sound due to the similarity between /w/ and /u/ sounds, as well as the similarity between /y/ and /i/ sounds in Arabic. As the foundation of the sound system, segmental phonology studies speech that can be broken down into discrete pieces, or segments, along with the many phonetic features and processes that connect and distinguish these segments (Crystal, 1981). The number of phonemes, or distinctive and significant sounds, and the variations in sounds can be seen as the result of the phonological environment in which the sounds of such a language occur. This problem of variation is sometimes simplified to mean where a particular sound occurs in a word: word-initial, word-medial, or word-final. All the above can be identified as the segmental phonology of a certain language (Eka et al., 2020). Therefore, it specifies the sound patterns of a particular language. These segments are formed into syllables.

Every spoken language in the world has a syllable, and most people understand what a syllable is, intuitively. Each language has its own restrictions on the kind of syllables that are acceptable and unacceptable (Alsoudi, 2023), but the fundamental structure is the same throughout the world languages. The syllable is a phonological unit consisting of one or more sounds. The main function of syllables is to analyse the internal structure of the segment and indicate the number of rhythmic units present within the syllable. Different languages use different sequences of consonants (C) and vowels (V) (Vaux & Bridget, 2015).

Mturm (2018) found that Czech is characterised by lexical stress fixed to the first syllable of polysyllabic words (including prefixed words, compare /ˈmazat/ “to grease [imperfective]” and /ˈnamazat/ “to grease [perfective]”), by distinctive vowel length (compare /ˈɦrabjɛ/ “earl” and /ˈɦraːbjɛ/ “rake”) and by a complex syllabic structure, allowing four-consonant word-initial onsets and three-consonant word-final codas and, moreover, allowing tautosyllabic S-O clusters word-initially (e.g. /ˈlʒɪt͡ʃka/ “teaspoon”). These structures reflect Arabic structure with the three-consonant word along with the stress at the final syllable with the glide sound.

According to Campos et al (2022), most words have a CV combination, either when it forms a syllable, such in the word *ba.nho* [bath - CVCCV] or when it is just a group of letters rather than a syllable, as in the word *bal.de* [bucket – CVC.CV]. They found that the syllable effect was retained only for the target words and was more pronounced for words with CV structure on the first syllable. This may reflect the downward activation sent from lexical to syllable items, both those that share the same syllable as the target word. The findings of the research show that structures can be affected by their numbers, just like the Arabic structure that decreases from trisyllabic to bisyllabic.

There are two syllable structure types: CV and V in one of Nigerian dialects, which is Ikhin language that operates in an open syllable structure. According to Oladimeji (2022), three syllable structure processes were discussed as follows: 1) vowel elision; 2) vowel insertion; and 3) glide formation, and presented via optimality theory that show the language did not have palatalisation but only glide. As for the German, the

most typical monosyllable in northern German dialects is CVC, while the dialects in southern Germany tend towards more complex monosyllables, with obstruent clusters. The final demisyllables in southern German tend to be made up of segments more closely arranged on the sonority scale. Initial demisyllables in middle German are often comprised of segments that are far apart on the sonority scale (Lameli, 2022).

As for the Arabic syllable, there are five types of segments (ʿAkāmaï, 2007) which are as follows:

Table 2. Types of Arabic Syllables

Types	Syllable	Symbol	Example
Short Open	Consonant + one vowel	C V	/bi/
Long Open	Consonant + two vowels	C V V	/m a a / → /mā/
Short Close	Consonant + one vowel + consonant	C V C	/q u l/
Long Close	Consonant + two vowels + consonant	C V V C	/n a a l/→ /n ā l/
Closed	Consonant + one vowel + two consonants	C V C C	/k a s b/

Table 2 shows five types of syllables that form Arabic lexical or words. The first type consists of consonant and a vowel and considered as a short open type, such as /bi/ that has a consonant and a vowel. The long open type is formed by a consonant and two same vowels, like /mā/. As for the short close type, it starts with a consonant, a vowel, and ends with a consonant. The long close type consists of a consonant, two same vowels, and ends with a consonant. The closed type is different than the third type because it ends with two consonants (al-Bahansāwī, 2008).

Arabic nouns are divided into two types, feminine nouns, such as /madrasah/ and masculine nouns, such as /qalam/. Arabic nouns fall into three categories: singular, such as /dirāsah/, dual /dirāsatān/, and plural /dirāsāt/. The diphthong sounds in Arabic may be formed in one syllable, such as mawt /maʊt/ (*death*) and sayf /saɪf/ (sword), or in two syllables which are located within the first syllable, such as maytah /maɪtah/ (corpse), or located within the second syllable, such as Suhayl /Suhaɪl/ (star) (Sa'ad, 2005). As for the Arabic verbs, they are divided into two types, consonantal verbs and weak verbs. Arabic consonantal verbs have two types: triple consonants, /kataba/ (write), and quadruple consonants, /dahraja/ in their original form. As for the Arabic weak verbs, they are formed by two weak sounds, which are /w/ and /y/, or named as diphthongs and have four types of weak verbs, namely: 1) hollow verbs (middle is the weak sound), such as /qawala/ → /qāla/ and /sayara/ → /sāra/; 2) paradigm verbs (a verb starting with the weak sounds), such as /waṣala/ and /ya'isa/, 3) defective verbs (a verb ending with the weak sounds), such as /ramaya/ → /ramā/ and /daʕawa/ → /daʕā/; and 4) enfolding verbs (defined as verbs that contain two weak sounds in their root form), such as /waqaya/ → /waqā/ and /nawaya/ → /nawā/ (al-Rajhī, 2018).

As for the Arabic syllables for diphthongs, there are also some phonological processes involved that change the syllabic structure in its nouns and verbs. These phonological processes require further analysis to determine the processes applied.

METHOD

The methodology of this study is qualitative, where content analysis method is applied by the researchers. According to Vincent et al (2007), content analysis has several advantages for any studies that are related to grounded theories. Zaidman (2014) defined content analysis as a systematic, replicable approach, which aims to analyze as many words as possible in any sample into more limited content categories according to clear coding rules (O'Connor & Joffe, 2020).

The samples of this study are extracted from an Arabic dictionary called *Mu'jam Taṣrīf al-`af'āl al-'arabiyyah*. The dictionary is considered as one of the latest Arabic dictionaries that was written by the Arabic Language Association in 2004. Additionally, al-Ma`ani website is also referred to check the vowels that were stated in the dictionary are same. The al-Ma`ani website is chosen among many Arabic online dictionaries because it provides the morphological changes of each searched word.

Data are collected by choosing and filtering targeted words (Cheong et al, 2023) that consisted of Arabic diphthong sounds /aw/ and /ai/ from nouns and verbs categories from *Mu'jam Taṣrīf al-`af'āl al-'arabiyyah*. The researcher categorises the data into two types, nouns and verbs; then the verbs are only analysed in terms of the past tense form to focus on specific syllables as discussed earlier. Data are selected from the defective verbs because more various phonological processes are applied, which involve more rules than the other categories among the weak verbs.

Before the verbs are analysed, the researchers show the filtered verbs to two experts to validate (Johansen & Fischer, 2023) that there are no other verbs than defective verbs that are collected in the list. The morphological forms are also checked to make sure that all the verbs were written correctly.

The generative phonology theory by Chomsky and Halle (1968) is utilised to analyse phonological rules that are applied in the Arabic diphthong which are collected from the dictionary. The theory (A → B / X __ Y) is applied with the distinctive features (binary mode, [+] or [-]) to produce a rule that would explain the phonological phenomenon found. Distinctive features will be identified for the consonants involved to refine the rule for application to Arabic diphthong sounds.

Then, the data are derived to form syllables and analyse the syllable structure and segments to study phonological changes occured among the data. Based on Crowley (1987), the researchers analysed the defective verbs by categorising the results into three categories: 1) no change syllable, which segments in the syllable stay as are; 2) reducing segment in syllable, which diphthong will be deleted as segment in the syllabl; 3) reducing syllable, which the number of syllables will decrease, for example from trisyllabic becomes bisyllabic, or bisyllabic becomes monosyllabic. Related phonological processes from Crowley (1987) are applied to both categories 2 and 3 to study how the processes work to change the Arabic defective verbs' syllables in the past tense forms, as well as the vocals changed from the short type into the long type.

RESULTS AND DISCUSSION

Most Arabic nouns with diphthongs in the syllables are formed monosyllabically by this particular structure: CVC, exemplified by /maʊt/ and /maɪl/. For bisyllabic and longer nouns, the nouns are formed from dual accusative nouns, such as /madrasataɪn/, and diminutive pattern, such as /ṭufaɪl/ with the same structure CVC, happening at the last syllable. There is no /aʊ/ in the final syllable in dual accusative nouns and diminutive pattern. All diphthongs in Arabic nouns remain whether in monosyllabic, bisyllabic, trisyllabic, or above. However, as for Arabic defective verbs, there are suffixes that produce different output when attached at the end of the defective verbs. The examples are as follows:

Table 3. Past Tense For Arabic Defective Verbs With Suffixes

/aɪ/ verbs + suffix (input)	/aɪ/ Verbs + suffix (output)	/aʊ/ Verbs + suffix (input)	/aʊ/ Verbs + suffix (output)
/ramaɪ/ + /a/ → /ramaya/	[ramā]	/daʕaʊ/ + /a/ → /daʕawa/	[daʕā]

he threw		he prayed	
/ramaɪ/ + /t/ → /ramaɪt/ she threw	[ramat]	/daʕaʊ/ + /t/ → /daʕaʊt/ she prayed	[daʕat]
/ramaɪ/ + /w/ → /ramaɪw/ they (m) threw	[ramaw]	/daʕaʊ/ + /w/ → /daʕaʊw/ they (m) prayed	[daʕaw]
/ramaɪ/ + /na/ → /ramaɪna/ they (f) threw	[ramaɪna]	/daʕaʊ/ + /na/ → /daʕaʊna/ they (f) prayed	[daʕaʊna]
/ramaɪ/ + /tu/ → /ramaɪtu/ I threw	[ramaɪtu]	/daʕaʊ/ + /tu/ → /daʕaʊtu/ I prayed	[daʕaʊtu]

Table 3 shows changes in Arabic defectives verbs when attached with different suffixes and producing different output. There are some suffixes that do not affect the root verb, like suffixes /na/ and /tu/. As for suffixes that are formed by non-consonantal sounds, such as /a/ and /w/, and also /t/ that refers to third person (female), the defective verbs affected and changed in the output (Mirziyatov, 2020).

Phonological Rules

Based on these findings, the Arabic defective verbs are analysed further as the diphthong among the nouns do not apply any phonological rules. As observed from the findings, the /y/ in /ramaya/ and /w/ in /daʕawa/ are found to be deleted when the root verbs are attached to the suffix /a/ which refers to the single third person. The phonological rule for them therefore, would be:

(1) $\left\{ \begin{matrix} W \\ \\ Y \end{matrix} \right\} \rightarrow Ø \; / \; \_\_\_\_ + /a/ \,]_v$

Brame (1970) proposed a more detailed rule to repair the first rule due to some existing defective verbs that keep the glide sound /y/ in the verbs, such as /nasiya/ and /taliya/; and the rule is as follows:

(2) $\left\{ \begin{matrix} W \\ \\ Y \end{matrix} \right\} \rightarrow Ø \; / \; /a/ \; \_\_\_\_ \; /a/ \,]_v$

The second rule explains that the glide sounds are deleted if located between the /a/ sounds. Then, Brame (1970) proposed distinctive features to explain more behind the justification of the elision of the glide sounds /w/ and /y/ as follows:

(3) $\left\{ \begin{matrix} W \\ \\ Y \end{matrix} \right\} \rightarrow Ø \; / \; /+low/ \; \_\_\_\_ \; /+low/ \,]_v$

Based on Table 1, it can be illustrated that the three consecutive sounds for the third rule is as shown below:

Table 4. Distinctive Features Of Non-Consonantal Sounds

/a/	/w/ @ /y/	/a/
[+low]	[-low]	[+low]

The [-low] sound is deleted because of the different distinctive features among the [+low] sounds from the /a/ sounds and affects the tongue's movement. As observed, the tongue stays low as the /a/ sound is pronounced, then the tongue moves up when the /w/ and /y/ are pronounced. To smoothen the pronunciation, the [-low] sounds are omitted to make the tongue stay low.

The first rule is extended to another version due to the deletion of sounds /w/ and /y/ when the suffix /t/ is added at the end of the root verb to show that the verb is done by a third person female in the past tense form; and the rule is as follows:

(4) $\left\{ \begin{matrix} W \\ Y \end{matrix} \right\} \rightarrow Ø \; / \; \_\_\_\_ + /t/$

The fourth rule can be repaired by proposing [+verb] due to the existence of nouns that have the /t/ sound at the end of nouns, but the glide sounds are not deleted, and the pattern is similar to the defective verbs that end with the /t/, but the glide sounds are deleted. The comparison can be elaborated as follows:

Table 5. Comparison Of Diphthong Sounds Between Arabic Verbs And Nouns

	Verbs	Nouns
/w/	daʕawt → daʕat (w is deleted) she prayed	mawt (w stays) *death*
/y/	ramayt → ramat (y is deleted) she threw	bayt (y stays) *house*

Based on the Table 5, a repaired rule is suggested as follows:

(5) $\left\{ \begin{matrix} W \\ Y \end{matrix} \right\} \rightarrow Ø \; / \; \_\_\_\_ + /t/ \; _{[+verb]}$

The fifth rule seems to be incomplete due to the existence of other suffixes that start with the /t/ sound, but the glide sounds remain; and the suffixes are as follows:

Table 6. Phonological Processes Of Diphthong Sounds In Arabic Defective Verbs

/w/ Verbs + suffix /t/ or /t_ /	process of /w/	/y/ Verbs + suffix /t/ or /t_ /	process of /y/
daʕaw + t → daʕat she prayed	Deleted	ramay + t → ramat she threw	deleted
daʕaw + ta → daʕawta you (m) prayed daʕaw + ti → daʕawti you (f) prayed daʕaw + tumā → daʕawtumā you (2m & 2f) prayed daʕaw + tum → daʕawtum you (≥3m) prayed daʕaw + tunna → daʕawtunna you (≥3f) prayed	stay	ramay + ta → ramayta you (m) threw ramay + ti → ramayti you (f) threw ramay + tumā → ramaytumā you (2m & 2f) threw ramay + tum → ramaytum you (≥3m) threw ramay + tunna → ramaytunna you (≥3f) threw	stay

(m = male, f = female)

Based on Table 6, a repaired rule is suggested as follows:

(6) $\left\{ \begin{matrix} W \\ Y \end{matrix} \right\} \rightarrow Ø \; / \; \_\_\_\_ + /t/ \; \# \; _{[+verb]}$

The # symbol shows that the glide sounds are deleted if the suffix -t is not attached to any sounds after it. Another suffix that triggers the deletion of glide sounds is /w/, indicating completion by third-person males. For instance, "daʕaw" + /w/ becomes "daʕaw" and "ramay" + /w/ becomes "ramaw". The rule is as follows:

(7) $\left\{ \begin{matrix} W \\ \\ Y \end{matrix} \right\}$ → Ø / ____ + /w/

The seventh rule explains that the first glide sound is deleted if it is located before the second glide sound. Based on Brame (1970), distinctive features can be proposed to explain more on the justification of the elision of the first glide sounds /w/ and /y/ as follows:

(8) $\left\{ \begin{matrix} W \\ \\ Y \end{matrix} \right\}$ → Ø / /-high/ ____ /+high/

Based on Table 1, it can be demonstrated that the three consecutive sounds for the eighth rule is as follows:

Table 7. Distinctive Features Of Non-Consonantal Sounds

/a/	/w/ @ /y/	/w/
[-high]	[+high]	[+high]

The first [+high] sound is deleted because the two same consecutive distinctive features [+high] will produce a long vowel, which are only acceptable in two forms, namely /uu/ → /ū/, and /ii/ → /ī/ in Arabic (Khattab & Jalal, 2014). However, there is no long diphthong, such as *aww and *ayw. In order to make the sound acceptable, the first [+high] is deleted so that the correct diphthong can be produced, which are aw /aʊ/ and ay /aɪ/.

Table 8. Comparison Between Incorrect And Correct Structures And Segments

r	a	m	a	*y	w	r	a	m	**a**	**w**
			[-high]	[+high]	[+high]				[-high]	[+high]
d	a	ʕ	a	*w	w	d	a	ʕ	**a**	**w**
			[-high]	[+high]	[+high]				[-high]	[+high]
(* is incorrect)									(bold is correct)	

Based on the fourth and seventh rules, there is a rule that can be proposed by applying a combined rule as follows:

(9) $\left\{ \begin{matrix} W \\ \\ Y \end{matrix} \right\}$ → Ø / ___+ $\left\{ \begin{matrix} /t/\# \\ \\ /w/ \end{matrix} \right\}$ $\begin{matrix}]_{+\text{ verb}} \\ \\ ]_{+\text{ verb}} \end{matrix}$

The ninth rule explains that the glide sounds /w/ and /y/ are deleted if there are suffixes /t/ and /w/ at the end of the defective verbs.

As for syllable structure analysis, the researchers referred to Crowley (1987) to analyse the data. The syllable structure and syllable number can be comprehended as follows:

Syllable analysis

The syllable structures of Arabic verbs change according to which phonological process is applied (Rohbiah et al., 2019). Some syllables consist of simple segments, like CV only, while other syllables consist of long segments, like CVVC and CVV (Dib, 2019). The following tables show the phonological processes of the syllables change.

Table 9. Syllable Structure And Syllable Number Of Arabic Defective Verbs

/aʊ/ verbs + suffix	Syllable Structure	No. of syllable	/aʊ/ verbs + suffix	Syllable structure	No. of Syllable

(input)			(output)		
daʕaw + a → daʕawa /daʕaʊ/ + /a/ → /daʕawa/ he prayed	CV.CV.CV	3	daʕaa /daʕā/	CV.CVV	2
daʕaw + t → daʕawt /daʕaʊ/ + /t/ → /daʕaʊt/ she prayed	CV.CVVC	2	daʕat /daʕat/	CV.CVC	2
daʕaw + w → daʕaww /daʕaʊ/ + /w/ → /daʕaʊw/ they (m) prayed	CV.CVVV	2	daʕaw /daʕaw/	CV.CVV	2
daʕaw + na → talawna /daʕaʊ/ + /na/ → /talaʊna/ they (f) prayed	CV.CVV.CV	3	daʕawna /daʕaʊna/	CV.CVV .CV	3
daʕaw + tu → daʕawtu /daʕaʊ/ + /tu/ → /daʕaʊtu/ I prayed	CV.CVV.CV	3	daʕawtu /daʕaʊtu/	CV.CVV .CV	3
/aɪ/ Verbs + suffix (input)	Syllable Structure	No. of syllable	/aɪ/ Verbs + suffix (output)	Syllable structure	No. of Syllable
ramay + a → ramaya /ramaɪ/ + /a/ → /ramaya/ he threw	CV.CV.CV	3	ramaa /ramā/	CV.CVV	2
ramay + t → ramayt /ramaɪ/ + /t/ → /ramaɪt/ she threw	CV.CVVC	2	ramat /ramat/	CV.CVC	2
ramay + w → ramayw /ramaɪ/ + /w/ → /ramaɪw/ they (m) threw	CV.CVVV	2	ramaw /ramaw/	CV.CVV	2
ramay + na → ramayna /ramaɪ/ + /na/ → /ramaɪna/ they (f) threw	CV.CVV.CV	3	ramayna /ramaɪna/	CV.CVV .CV	3
ramay + tu → ramaytu /ramaɪ/ + /tu/ → /ramaɪtu/ I threw	CV.CVV.CV	3	ramaytu /ramaɪtu/	CV.CVV .CV	3

Based on Table 9, there are three categories of syllables. Category 1, no syllable structure and syllable segment change for the defective verbs that are attached with the suffixes /t_/ and /n_/ at the final syllable. For example, CV.CVV.CV remains the same for input and output (Utulu, 2020). In Category 2, the syllable structure undergoes changes while maintaining the same number of syllables. For instance, CV.CVVC transforms into CV.CVC, retaining two syllables, and CV.CVVV becomes CV.CVV (al-Wādī, 2005).

As for the Category 2, although the syllable number remains the same, the syllable structure changes from the syllable segments, where the vowel in the second syllable is deleted as follows:

Table 10. Segments Of Arabic Defective Verbs In The Category 2

	Input	Output	
Structure:	C V . C V V C →	C V . C V C	
Segment:	/d/ /a/ . /ʕ/ /a/ /w/ /t/	/d/ /a/ . /ʕ/ /a/ /t/	= [daʕat]
Structure:	C V . C V V V →	C V . C V V	
Segment:	/d/ /a/ . /ʕ/ /a/ /w/ /w/	/d/ /a/ . /ʕ/ /a/ /w/	= [daʕaw]
Structure:	C V . C V V C →	C V . C V C	
Segment:	/r/ /a/ . /m/ /a/ /y/ /t/	/r/ /a/ . /m/ /a/ /t/	= [ramat]
Structure:	C V . C V V V →	C V . C V V	
Segment:	/r/ /a/ . /m/ /a/ /y/ /w/	/r/ /a/ . /m/ /a/ /w/	= [ramaw]

Based on the analysis above in Table 10, all the glide sounds that form diphthong sounds are deleted in the second syllable. The Arabic phonetics does not allow the defective verb to end with /t/ and /w/ sounds; so, the diphthong sound changes to a basic vowel sound by deleting the segments /w/ and /y/ to make the /aʊ/ and /aɪ/ become /a/ due to the features' difference. As for the Category 3, the syllable structure reduces along with the structure segments that change from trisyllabic to bisyllabic; and the changes are as follows:

Table 11. Segments of Arabic Defective Verbs In The Category 3

	Input		output
stage	1	2	3
Structure:	C V . C V . C V →	C V . C V . →	C V . C V V
Segment:	/d/ /a/ . /ʕ/ /a/ . /w/ /a/	/d/ /a/ . /ʕ/ /a/. /a/	/d/ /a/ . /ʕ//a//a/ = [daʕā]
Structure:	C V . C V . C V →	C V . C V . V →	C V . C V V
Segment:	/r/ /a/ . /m/ /a/ . /y/ /a/	/r/ /a/ . /m/ /a/ . /a/	/r/ /a/ . /m/ /a/ /a/ = [ramā]

According to Crowley (1987), as indicated in Table 11, this reduction of syllables begins with syncope, whereby the segments formed by glide sounds /w/ and /y/ located between the two vowels /a/ are deleted. Then, the deletion process applies haplology where the syllable is deleted from the structure resulting in reduced final syllable, because they are considered similar to each other in terms of distinctive feature [+ vocoids] (al-Wādī, 2020). As observed in the second stage, if the final syllable is not deleted, it will be incorrect to start the third segment with a vowel only. Then the third segment is deleted by merging the second vowel /a/ with the first vowel /a/, which results in a long vowel /ā/ (Tūrābī, 2020).

Table 12. Comparison Between Incorrect And Correct Structures And Segments

C V . * C V . V	C V . **C V V**
/d/ /a/ . /ʕ/ /a/ . /a/ = [daʕaa]	/d/ /a/ . /ʕ/ /a/ /a/ = [daʕā]
C V . * C V . V	C V . **C V V**
/r/ /a/ . /m/ /a/ . /a/ = [ramaa]	/r/ /a/ . /m/ /a/ /a/ = [ramā]
(* = incorrect)	(bold is correct)

Table 12 explains that two same vocals are considered incorrect in Arabic if the same vocals are located at the different syllables, like [da.ʕa.a] and [ra.ma.a]. Therefore, the two same vocals need to be merged into one long vocal, like [da.ʕā] and [ra.mā], as long vocals are accepted in Arabic phonetics (Mohamed et, al, 2024).

CONCLUSION

The phonological rules proposed in this research are considered as an updated version of Brame (1970), where Brame primarily focused on the suffixes that come in the form of distinctive feature [±high]. However, the researchers expanded upon these findings to include other Arabic suffixes like /a/, /t/, and /w/, resulting in various outcomes, including the deletion of glide sounds /w/ and /y/, leading to a change in the diphthong sound to the long vowel /aa/ → ā. The other outcome is keeping the glide sounds /w/ and /y/ when the suffixes /n_/ and /t_/ have vowels after them. On the other hand, the syllable segments are affected by the phonological rules that change the glide sounds and diphthongs. Based on the analysis, the Arabic syllabic among the defective verbs was found to apply/undergo/experience haplology at the final syllable and in turn, reduces the number of the syllable from trisyllabic to bisyllabic (Abu Guba et al. (2023).

The analysis also supports findings by Smith (2001) that showed nouns in Fukuoka Japanese, Spain, and Sinhala exhibit resilience against general positional neutralisation processes that target weak positions, granting nouns the capacity to accommodate more phonological contrasts and withstand a greater number of phonological processes compared to verbs. As found in this research, the diphthongs in

Arabic nouns are not affected by any phonological changes and do not adhere to any phonological rules, regardless of whether the nouns are monosyllabic, bisyllabic, trisyllabic, or longer. In contrast, defective verbs in Arabic undergo phonological rule applications, leading to changes in syllable segments, particularly in the final syllable. This is due to the variety of Arabic suffixes for verbs, which differ according to the gender, number and type of person, resulting in different features between the diphthongs (from the root verb) and the suffixes.

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