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The Oldest Zero and Decimal Numeral System in the World: Vietnam, Cambodia or Indonesia?

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Abstract

Aczel (2013a,b) and ealier Ifrah (1998) claimed that the oldest zero in the world is from the Old Khmer-Cambodia and Campa-Vietnam respectively even though Diller (1995) and more detail, Shaharir (2001) have shown that Zero from Sriwijaya Kingdom in Sumatra, Indonesia, is as at least as old as the Old-Khmer Zero. Then Shaharir and Zahrin (2019) provide strong arguments that the Sriwijaya Zero is the oldest and simultaneously give reasons behind the error made by Aczel and Ifrah. However, inspired by verbal comments of our readers we have reexamined our paper and indeed found some weaknesses in our arguments. This paper explains those short comings and make a thorough and rigourous amendments and improvements. We now believe even stronger that the oldest decimal numeral system containing zero in the world is from Sumatera, Indonesia, which was invented in the 7th Century AD.

Keywords: history of decimal numeral system, history of malay mathematics, history of mathematics, history of zero

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INTRODUCTION

The oldest zero in the world has not been settled especially after publications by Aczel in May 2013 (Aczel, 2013a,b) followed by writers who reacted to Aczel notably by many contributions in Internet RA; Schrisomalis (2013); Alexander (2015) and Swetz (2015). They raised six points to refute the Aczel's claim and we criticise each of those points here:

1). One of them said that an Indian mathematician, Aryabhatta 476-550 AD, already had introduced a dot to represent zero. However he did not realise that the dot was actually only used by Aryabhatta to represent a power of ten and did not use it in the present manner of a numeral decimal system.
2). A critic mentioned that there exists an Indian inscription, Khandela Inscription, which he claimed contains a symbol of zero and this is earlier than the Cambodian zero. However the existence of such inscription is not clear and the nearest inscription is Chandela Inscription which exists only in the 10th -13th century AD, much later than the Cambodian inscription.
3). Another one of them mentioned the writing of Dutta (1931, 2001) who said that there was an Indian astronomer in the 6th century AD, Varah Mihir, who had used a numeral decimal system in his book, Panchsidhanth. However this is also not true because Varah Mihir is a teacher of Aryabhatta and the later did not use zero in his numeral system as mentioned above.
4). A critic reminds that the Indian mathematician, Brahmagupta, had used zero in his writing, Brahmasphutasiddhanta 628 AD. However the reminder actually mistakenly not to differentiate between numbers and numerals. Brahmagupta only used the concept of zero number without inventing a zero numeral in his writing.

5). Another critic mentioned that the Mayans in 300-800 AD had invented zero much earlier than the Cambodians. However he missed the point that the Mayan zero numeral is not used in a decimal system but in an additive-duodecimal as shown by UniProyecta (nd) and Dantzig and Mazur (2007) such zero numeral only for even number bigger than nineteen.
6). Another critic mentioned the existence of zero in Mesoamerica 37 BC. Again he missed the point that the zero in this civilisation is used as an abstract number or a numeral which is not part of a positional number in the decimal system of numerals.

More importantly none of those critics or commentators refer to in effect a refutation of their claims decades earlier by Diller (1995, 1996) and to stronger refutations by Shaharir (1998, 2000, 2001) briefly described below. Inspired by Swetz (2015), we then have been searching for an even stronger evidences in proving that the oldest zero in the world is not from Cambodia (Kampuchea) and some results have been obtained and presented by Shaharir and Zahrin (2019). We have reached a conclusion that the oldest zero numeral in a decimal numeral system is from Sumatera, Indonesia. But soon we realised that the arguments in Shaharir and Zahrin (2019) could still be contested based on the incomplete set of numerals for zero, one ,…, nine found so far from Indonesian inscriptions, the Sriwijaya inscriptions, due to a few numerals were obtained from the Campa/Champa inscriptions (Campa or Champa here means Campa or Champa Kingdom in presently Vietnam, briefly Campa-Vietnam which exists strongly in 2nd -15th century AD). Reasons for the famous numeral on the Cambodian inscription, the Sambor Inscription, does not belong to the Khmers presented in Shaharir and Zahrin (2019) could still be improved and the improvement is done here. Meanwhile, Shaharir and Swetz (2022) and Swetz and Shaharir (2022) do not venture on strengthening either the Old Khmers (presently Cambodians) or the Old Malays (Srivijayans presently and mostly Indonesians) invented the oldest zero and decimal numeral system. The authors concentrate on giving a reflection on various candidates for the first abstract concept of zero number and numeral even though they show an inclination towards an agreement on the conclusion made by Shaharir and Zahrin (2019) mentioned above.

Earlier, Shaharir and Zahrin (2019) had already realised that in Shaharir (1998, 2000, 2001) the Srivijaya numerals were not obtained from all inscriptions in the Old Malay and dated during the period of the Srivijaya Kingdom, the 7th-13th century AD. In fact, in the papers, there are only five inscriptions in the Old Malay and dated during the Srivijaya Kingdom namely Kedukan Bukit Inscription (Palembang, Sumatera) dated equivalent to (eqt) 604/05 Saka (S); Talang Tuwo Inscription (Palembang, Sumatera) dated eqt 606 S; Kota Kapur Inscription (Bangka Sumatera) dated eqt 608 S; Polengan Inscription (Yogyakarta, Jawa) dated 797 S; and Gunung Tua Statue Inscription (Tapanuli, East Sumatera), dated eqt 946 S. The remaining inscriptions, 9 of them, are either not in the Old Malay or dated beyond The Srivijayan Period. One of them is in the Old Malay but dated eqt 1385 Saka (=1463 AD), the Ahmad Majanu Tombstone Inscription (at Pangkalan Kempas, Port Dickson, Malaya) and thus still needed to be replaced by the Old Malay inscriptions during the Srivijayan Period.

Those inscriptions which are not in the Old Malay are considered not relevant for the purpose of establishing the existence of the Sriwijaya numeral system since the first three most important Sriwijaya inscriptions (Kedukan Bukit, Talang Tuwo and Kota Kapur inscriptions) are in the Old Malay which provide numerals for numbers zero, four or five, six, and eight. (Coedes and Damais, 1992; Noriah, 1999). Thus the hypotesis is that a complete set of decimal numeral system were invented by the Sriwijayan scholars written in the Old Malay. Thus Polengan Inscription dated eqt eqt 797 S is appropriate inscription and indeed provides numerals for one, two, four, seven, eight and nine (de Casparis, 1975; Gusti, 2014a, b). Thus only the numeral for number three is still missing and a convincing numeral for five is also needed. One available inscription, Gunung Tua Statue Inscription dated eqt 946 S mentioned in Shaharir (2000) is another appropriate inscription which would provide the missing numerals but the inscription fails to provide such numerals (Chaterji, 1967) since it contains only a vaid numerical date of the inscription eqt to 946 S which is discussed further later.

Shaharir and Zahrin (2019) introduced two new Old Malay inscriptions, namely the Laguna Copper Plate Inscription (found in Manila), dated in the Srivijaya numeral eqt 822 S or 900 AD (Internet LI; Internet TranslaPL; Internet TransliPL) which provides numerals for eight and two (but which are no longer needed); and Manjusrigrha Inscription (found in Yogyakarta), dated in the Srivijaya numeral eqt 714 S or 792 AD (Ferrand, 1922; Suhadi, 1983; Boechari, 1991-1992; Jateng, 2014a; Dumarcay, 2018; Internet MI; Internet PM; Internet TPM) which would provide older numerals for numbers one, four and seven, but we could not identify them at that time; however now

we obtained them via a new source which we present it later to sterengthen the other findings. The missing numeral for number three and convincing numeral for five are still unsettled. For this Shaharir and Zahrin (2019) had included two Campa inscriptions, namely Bakul Inscription dated eqt 751 S or 829 AD (Aymonier, 1891, pp. 25-26; Finot, 1903, 1915c) to obtain older numerals for numbers one and seven, and more importantly a convincing numeral for number five; and Mison I, Mi Son 1 or My Son I (C75) Inscription dated eqt 713 S (Finot, 1904b) but actually eqt 913 S or 991 AD (Griffiths et al., 2012a, pp. 457) to obtain the missing numeral for number three by assuming that the Campa numerals are inherited from the Srivijaya numerals. However, the assumption is weak or in fact incorrect (which is discussed further below). Thus, in this paper we appeal to the eight listed inscriptions in the introduction and other newly founded Srivijaya and Javanese inscriptions to settle these problems. This gives a complete set of basic Srivijaya numerals, zero to nine, using only inscriptions written in the Old Malay during the Sriwijaya Kingdom, the 7th Century AD till the 13th Century AD. At the same time we establish the Old Javenese numerals are the adopted Srivijaya numerals in about 80 years after the invention of the numerals and it evolved during 14th century AD to become finally a distinct Javenese numerals known as Kawi numerals today.

Another important issue in this paper is regarding zero and the Campa numerals vis-a- vis the Srivijaya numerals. The existence of set of the Campa decimal numeral system from the Campa Kingdom (in presently Vietnam especially during 5th -15 century AD) as presented by Aymonier and Cabaton (1906); the claim made by Ifrah (1998) that the zero from Campa is the oldest in the world; and the nature of the oldest zero numeral either a dot or a circle are also resolved here in this paper. Shaharir and Zahrin (2019) have already discussed that the Campa zero is not the oldest but still need to be rectified since they have made some errors on the dates on the relevant Campa inscriptions and further strengthened the justification concerning the error made by Ifrah (1998). Before this, Diller (1995, 1996) only acknowledged both zero numerals as a dot and a circle, and satisfied that the oldest zero numeral is from South East Asia (Cambodia and Sriwijaya) without emphasising either Cambodia or Sriwijaya zero is the oldest.

RESULTS AND DISCUSSION

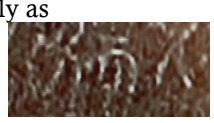
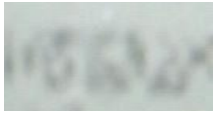
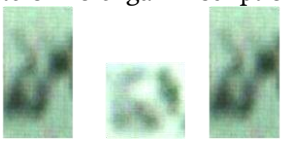
In 1998, after collecting many existing Srivijaya inscriptions traced through a period of the 7th - 12th century AD, we have partially established the Zarkov-Swetz hypothesis that the oldest decimal numeral system with zero is the Srivijayan product (Shaharir, 1998) and this fact is represented in Shaharir (2000) and later, with a different emphasis, in Shaharir (2001). Later, we came to know Diller (1995, 1996) but to our surprised, our result is stronger as mentioned earlier, since we provide for the first time a complete set of Srivijaya decimal numeral system, albeit it is found later contains some technical errors which are explained in the introduction above and further improved here in this paper.

Then came Aczel (2013-2015) who repeatedly announced the "oldest zero" in several prominent magazines (Aczel, 2013a; 2013b;2014a; 2014b; 2015a); and in his book (Aczel, 2015b). Almost immediately after the Aczel first report on his "rediscovery", we reexamined and recollected all available Sriwijaya inscriptions based on Coedes and Damais (1992), Noriah (1999) and other sources mentioned appropriately later; and the Old Khmer or Funan inscriptions from the earliest Old Khmer inscriptions containing numerals, the Angkor Borei Inscription dated in the Old Khmer language equivalent to 533 S or 611 AD (Coedes, 1937; Internet AB), and other Old Khmer inscriptions up to 735 S found in Coedes (1931; 1936; 1937; 1942; 1937-66; 1942-66); Finot (1918); Jenner (1980; nd); Billard and Eade (2006); and internet (Internet K; Internet OK) which contains numerals. All these are to ascertain the invalidity of Aczel's claim and evaluate it along with our earlier findings in Shaharir (2000, 2001) and Diller (1995, 1996) mentioned above. Aczel papers and Swetz (2015) motivated us to reexamine our earlier works on the old Malay numeral system which we have shared our finding in Shaharir and Zahrin (2019).

We found that there is only one and only one Old Khmer inscription, namely the famous Sambor inscription first discovered by Coedes (1931), and rediscovered by Aczel (2013a,b), which does contain a decimal numeral system with zero and that is in the famous date written on the inscription as  and interpreted by Coedes (1931) as  eqt 605 S; whereas, as we have already shown in Shaharir (2000), the Srivijaya inscriptions (in the Old Malay) have a complete set of decimal numeral system (See Fig. 2 below) with three inscriptions contains zero (mentioned above). One of the three Srivijaya inscriptions and the oldest is Kedukan Bukit Inscription, dated

 Saka (Coedes and Damais, 1992; Noriah 1999) or  (Internet KB) which is interpreted by Coedes (1930) as  eqt 605 S, the same as the popular date for Sambor Inscription mentioned above, but others, namely Damais **(**1952**,** 1955**),** de Casparis **(**1956) dan Boechari (1986) read it differently,  eqt 604 S. Thus we can assume the correct date for the oldest Srivijaya inscription is eqt 604 S, and hence the Srivijaya zero is **at least a year older than the "Cambodia zero".**

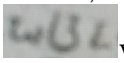
The Srivijaya numerals in Fig 2 is actually an improved list compared to the previous list in Shaharir (1998, 2000, 2001) and even in Shaharir and Zahrin (2019) as explained in the introduction. The new list in Fig. 2 are all based on Srivijaya inscriptions in the Old Malay, referred by the Greek as Kolan language (Greek Anonymous, 1st Century AD), and the Old Chinese as Kunlun language (Manansala, nd; Manguin, 1980) and constitutes a new finding. Details are explained below. It should be noted that the first recorded Kunlun name for the southern people was, according to Schafer (1963), the Old Chinese poem Li He (early ninth century AD) but actually ealier the famous Chinese Buddhist monk I'Ching (671-695 AD) has described the Kunlun people particularly the people of Srivijaya as "wavy hair and dark skin"; in fact Manguin (1980) said that a Chinese historian in the 3rd century AD, Wan Chen, had recorded the arrivals of huge Kunlun ships in China. Other chinese perceptions on Kunlun (or according to Schafer also known as *Gulong/Gulun/Gurong)* is found in Kang (2015).

Our findings (presented in Fig 2) was based on the relevant Sriviijaya inscriptions, namely Kedukan Bukit Inscription (Palembang, Sumatera), dated eqt 604 S (or wrongly 605 S); Talang Tuwo Inscription (Palembang), dated eqt 606 S; Kota Kapur Inscription (Bangka, Sumatera), dated eqt 608 S mentioned above and thus obtained numeral  or  for zero,  for four,  for five,  for six, and  for eight. Polengan Inscription (Yogyakarta) dated eqt 797 S (Gusti, 2014a, b; de Casparis, 1975) provides some other numerals. The date of Manjurisgrha Inscription eqt 714 S was not able to be identified than but with the new source (Internet PMj) we were able to identify it partially as  =  (Internet PMj). The date of Polengan Inscription can be identified as  Saka, which can be sharpened as  = 797 (Andreanto, 2008; de Casparis, 1975; and Internet PP).

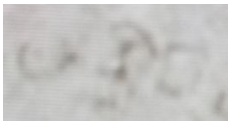
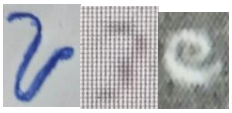
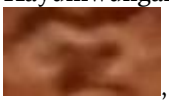
The Polengan Inscription had already been listed in Shaharir (1998, 2000, 2001) and Shaharir and Zahrin (2019) but made some errors in copying the numerals individually and thus we reproduce them here for number seven  =  =  ; nine  =  from the date of the

inscription; and one  ; two  ; and four  from the text of the inscription. The numerals for seven and nine here are not the same as in the two Campa inscriptions, Bakul Inscription and Mi Son I Inscription mentioned in the Introduction but the numeral for the numbers one and four in the two inscriptions are (coincidently?) the same as  and  and this is discussed further below. The numerals for numbers one and two in Polengan Inscription are respectively the same as  and  in another Sriwijaya inscription, the Laguna Copper Plate Inscription, Manila 822 S (mentioned earlier), but the former is two and half decades earlier (Shaharir and Zahrin, 2019). Previously we did not highlight the numerals in Polengan Inscription due to the vaidness of the numerals and mistakenly prefer to take from the Campa inscriptions assumed to be dated earlier. The Campa inscriptions are Mi Son I inscription mistakenly thought to be dated eqt 713 S but realised later that the correct date is 913 S (containing clear numerals for number three, four and five) and Bakul Inscription dated eqt 751 S containing clear numerals for number seven, five and one (mentioned in the Introduction). We now realised that the Campa numerals are inappropriate to represents the the Sriwijaya numerals.

Now, in summary, the first three oldest Srivijaya inscriptions provide numerals for *zero, four, five, six* and *eight;* the fourth Sriwijaya inscription, Manjurisgrha Inscription dated eqt 714 S provides numerals for numbers *one, four* (unclear) and *seven;* the fifth Sriwijaya inscription, Polengan Inscription dated eqt 797 S provides numerals for *one, two, four, seven* and *nine;* and Laguna Copper Plate inscription, Manila dated eqt 822 S also provides numerals for *one***,** and *two* which strengthening the numerals found in Polengan Inscription**.** Thus so far the Sriwijaya inscriptions in the Old Malay provide only numerals for *zero, one, two, four, five, six, seven, eight* and *nine***.** The numeral for number *three* is still missing and discussed later. However first we make sure no other Srivijayan inscriptions have had numerically dated other than those discussed below.

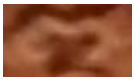
The numerals for numbers four, seven and nine actually could have been obtained from another Sriwijaya inscription, Gondosuli/Gandasuli I Inscription dated 749 S (Jateng 2014b; Damais 1955) and similarly with Gandasuli II Inscription dated eqt 754 S (de Casparis 1956) which would had been provided numerals for numbers four, five and seven as well. Unfortunately we were unabled to identify the numerals in the inscriptions due to the vaidness of the picture of the writings available to us. However these inscriptions are important in asserting that the numerals concerned (especially numeral for nine) exist more than 50 years earlier than 797 S (Polengan Inscription). There are yet another two Srivijayan inscriptions, namely Hujung Langit Inscription or Bawang Inscription, Lampung, Sumatera numerically dated eqt 919 S (Boechari, 1962; Damais, 1962; 1995; Endang, 2010) which was unabled to identify then but now with the new source (Internet HL) its is found it as  =  which strengthen previous results; and Gunung Tua Statue Inscription numerically dated eqt 946 S (mentioned in the introduction) but some scholars dated the inscription as eqt 961 S (Nasoichah, 2009) whereas the actual date provided by a copy of the inscription presented in the paper is  which should be read as a corrupted numeral 925 or 975. These inscriptions would also be able to strengthen the form of the Srivijaya numerals obtained so far with two versions of nine,  and  .

There are two more old Malay inscriptions, with numerical dates on it namely Kayumwungan Inscription or Karangtengah inscription, Temanggung, Central Java, dated 746 S (actually a bilingual inscription: the Old Malay and the Old Javanese; but some say Sanskrit and Old Javanese) (Kompas, 2022; Internet KI); and Sukabumi Inscription or Harinjing Inscription, Central Java dated 726 S (actually an inscription in a Western Malayo-Polynesian language which could be regarded as an Old Malay language but others said that this is the earliest Inscription in the Old Javanese) (Internet PSB1; Internet PSB2; Koran Makassar, 2002). In Sukabumi inscription there are two other numerical dates eqt 843 S and 849 S referring to the beginning of two kings respectively. Thus Sukabumi Inscription should

provides us with Srivijaya numerals for numbers two, three (the missing numeral), four, seven, eight and nine but unfortunately we manage to identify only the earlier date albeit vaidly  which can be recognise as  =726 and unable to recognise particularly the numeral three which we are seeking for in the date eqt 843. Finally it is the Kayumwungan inscription saved us as it provides us the missing numeral for the number three,  ,, in the text of the inscription. However the numerals from this inscription are for sure questionable because the controversies of the inscription on the language of the inscription either Old Malay or Old Javanese. But on the contrary this should be acceptable if we can show that all the numerals in the Old Javanese inscription during Sriwijayan period are actually the Sriwijaya numerals. This is established below.

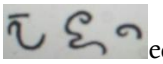
We have no longer found any Old Malay inscription during Srivijayan period to obtain the missing numerals for numbers *three* and *five*. We then appealed to the Old Javanese inscription, the next nearest (physically as well as linguistically) inscriptions during the Srivijayan period. But first we must make sure that the inscriptions in the Old Javanese have a complete numerals identical to the available Srivijayan numerals. Indeed, it is interesting to note that the Sriwijaya numerals are completely used in the Old Javanese inscriptions: numerals for numbers two, six and eight are found in Dinaya Inscription, East Java dated eqt 682 S (Chatterji, 1967); and other numerals are found in Javenese inscriptions discussed in de Casparis (1975) such as numerals for numbers *one* and *four* (other than two again) are found in The Copper Plate inscription at Randusari, Surakarta dated eqt to 827 S; numerals for numbers *zero* and *five* (other than six) are found in the Ganesa Statue Inscription at Karanarejo, Kediri, East Java dated eqt 1056 S; numerals for numbers *three* and *seven* (other than one and two again) are found in Candi Singosari/Singhosari Inscription, Malang, East Java dated eqt 1214 S; the numeral for the number *eight* (other than one and two again) is found in the Penaggungan/Penang-Gungen Copper Plate Inscription, Kretarajasa, Jawa dated eqt 1218 S; numerals for numbers *three* and *six* are found in Copper Plate Inscription, Renek, Jawa dated eqt about 1301 S (de Casparis, 1975); and lastly the numeral for the number *three* and *nine* **(**other than one**,** two, seven and eight again) is found in the Tralaya Tombstone Inscriptions, East Java dated eqt 1298, 1389 S and 1397 S (de Casparis, 1978). All these are listed and discussed in Shaharir (2000) but simply assumed that they are Srivijaya numerals. However now we have established that the Javenese writers simply used the Srivijaya numerals, not the inventors.

In summary the Javenese inscriptions contain a complete set of Srivijaya numerals for *zero, one, two, three***,** *four***,** *five, six, seven, eight, nine* which includes the missing numerals for three in the Srivijayan inscriptions. This is not surprising since Java was under the Sriwijaya domination until the 13th century A.D and it is believed that the Old Java numeral system is the product of the evolution of the the Sriwijaya numerals, since according to de Casparis (1975, 1978) also that the Kawi characters (the Old Javanese characters) are the product of the evolution of the Pallawa characters used by all Sriwijayan inscribers. If Sukabumi Inscription dated eqt 726 S and Kayumwungan Inscription dated eqt 746 S as discussed earlier then it is much stronger proof that Javanese inscribers or engravers used a complete Srivijaya numerals in their writings since 680's Saka.

We now confidently assert that the earliest Srivijaya numeral for number *three* is found to be  in Kayumwungan Inscription dated eqt 746 S (Kompas, 2022; Internet KI); and later evolved to  in Candi Penataran Inscription, East Java dated eqt 1301 (de Casparis, 1978) ;  in Copper Plate Inscription, Renek, Jawa (de Casparis, 1975) dated eqt about 1301 S;  in Candi Singosari Inscription, Malang, East Java dated eqt 1273 S (de Casparis, 1975) and  in Tralaya Tombstone Inscriptions, East Java dated eqt 1389 S and 1397 S (de Casparis, 1978) which is similar to .  three in the Old Malay inscription, at Pengkalan Kempas, Port Dickson, Malaya (Othman

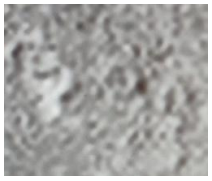
and Halim, 1990) mentioned in the Introduction. Incidently the numeral for the number three has a closed resemblance with the Campa numeral  for number three found in the Campa inscription, Mison I or My Son I Inscription, dated eqt to 913 S mentioned earlier, in fact similar to the earlier Campa numeral  for the number in Ban Lanh Inscription dated eqt 820 S (see Fig 3). This is discussed further below.

Thus we have shown a complete basic set of decimal Sriwijaya numeral system presented in Fig 2 below (Almost all numerals are copied directly from the respective inscriptions). Clearly this numeral system exists since the seventh Century AD. The numerals are not exacly the same as in Shaharir (2000, 2001) and in Shaharir and Zahrin (2019) especially for numbers *three, four* and *seven* because previously these numerals were taken from the two Campa inscriptions mentioned above, whereas now the numerals were taken from Sriwijayan inscriptions Manjurisgrha, Polengan and Kayumwungan inscriptions.

Even though the Polengan Inscription dated in the Sriwijaya numeral eqt 797 S was listed by Shaharir (1998, 2000, 2001) but the numerals for the numbers needed at that time were not taken then from this inscription. Instead it was taken from the Campa inscription dated earlier,  eqt 751 S, the Bakul Inscription (Aymonier 1891: 25-26; Finot 1903, 1915a) because it was assumed that the Campa and Sriwijaya numerals were of the same heritage which is suggested by the similarity of the Campa and Sriwijaya numerals for numbers one and five in this inscription but why not the numeral for seven? Is it possible that the Campa numeral for seven could have been evolved to the Sriwijaya numeral? This does not occur as shown in Fig 3.

This shows that the Campa numeral system possibly was originally from the Srivijaya numeral system but then evolved independently to become uniqely Campa numeral system since the middle of eight century Saka (= the early nineth century AD); or the Campa numeral system was originally invented by Campans about 150 year later than the Srivijayans and their resemblances of some Campa numerals with the respective Srivijaya numerals are accidental (see Fig. 2 and 3)

Srivijaya Zero, Khmer Zero and Campa Zero

The Srivijaya zero numeral is actually a circle (not a dot as apparently seen in the date of Kedukan Bukit Inscription,  = 6.4/6.5 or 604/605 as highlighted by Coedes and Damais, 1992) because other two Sriwijaya inscriptions, Talang Tuwo Inscription and Kota Kapur Inscription clearly show zero numeral as a circle as shown by the actual numeral in the dates of the inscriptions  = 606 and  =608 respectively. In fact the actual date of Kedukan Bukit Inscription itself is not necessarily a dot as shown by the actual picture of the date  in the recent picture taken by Kementerian Pendidikan dan Kebudayaan Indonesia (Internet KB). As discussed above, the invention of zero by the Srivajayan is in 604 Saka (= 682 AD), a year older than the zero as a dot appears in the Cambodia inscription, Sambor Inscription  . This is already highlighted in Shaharir and Zahrin (2019) when they claimed that the Srivijayan zero is the world oldest numeral. Their claim also based on the presence of the Old Khmer numerals for all other numbers in the same Sambor Inscription and here (in the section below) we strengthen the reasons that the singular numeral similar to the Sriwijaya numeral to signify the date of the Sambor Inscription does not belong to the Old Khmers. Shaharir and Swetz (2022) and Swetz and Shaharir (2022) do not address on this matter but they only provide a review on the ancient nature of the Old Malay (Indonesian) zero and the Old Khmer (Cambodian) zero numbers and numerals separately. In that papers, they mentioned the terminologies for zero in Sanskrit (*syunya*), Arabic (*shifr*), Latin (*zepherum*), Italian (*zefero*), Spanish

(*nada*), German (*null*), and American-British slangs (*zilc*, and *zip*) but they missed the corresponding words in the Old Malay, Campa and the Old Khmer. They should have mentioned the terminologies for zero in the Old Malay, Campa and the Old Khmer, namely *khun/khung/khaung* for the Old Malay and Campa which is recorded in Aymonier and Cabaton (1906) (now in modern Malay, *kosong* which could be found in an English-Malay dictionary such as Dictionnary EM, whereas in the Old Khmer and Funan, the term for zero is *soh* which is recorded in Pou (2004) (now in modern Khmer, *saun* or *saoh* which could be found in Encyclopedia WL). Zero in modern Campa-Khmer is *saoh* which could be found in an English-Cambodian dictionary such as Dictionary EC; and modern Campa-Vietnam, *so khong* which could be found in an English-Vietnamese dictionary such as Dictionary EV). In the two papers above also, they do not venture on the comparative study of the originality of the numerals, and thus the issue is dealt with here in this paper. Readers should note that Campa or Champa here means the people of the Old Campa or Campa-Vietnam Kingdom which exists strongly in 2 AD-1471 AD in the region presently known as Vietnam, whereas Campa-Khmer means the present people of Campa in Cambodia originally refugees from Vietnam in Cambodia since 1471 at the time the Old-Campa Kingdom was badly defeated by the Viet; the remnant of the Campa Kingdom exists in Vietnam and survives until the last Campa king died in 1835 (Wikipedia HC).

The Old Khmer and Funan inscriptions have a complete set of a non-decimal numeral system similar to the Chinese and the Roman numeral Systems (see Fig 1 below). Clearly the Sambor Inscription is just a singular Khmer inscription fancily written by a Khmer writer who liked to introduce the Sriwijaya numeral decimal system to the Khmers just like Fibonacci introduced the "Hindu-Arabic" numeral system to Europeans in the 12th century through his translation of the al-Khwarizmi's book. In fact, in the same Sambor Inscription, the numbers one to four were not written in the Srivijaya numerals (see Fig 2 below) but in her own numeral system (See Fig. 1 below). Only the date of the Sambor Inscription is purposely written fancily not in the usual Khmer numerals; in fact all other dates of the Cambodian inscriptions (Coedes 1937-1966; 1942-1966; Majumder, 1953; Jenner, 1980; Jenner, nd) are written in words either in the Old Khmer language or in the Sanskrit (no numerals involved) whereas most of the dates of the Srivijaya inscriptions in the Old Malay are written in Srivijaya numerals (Coedes and Damais 1992; Noriah, 1990). This shows that such numerals are alient to the Funans and the Old Khmers but natural to Srivijayans.

Further evidence that the date of the Sambor Inscription  (605 by Coedes, 1931) or   (604 by Billard dan Eade, 2006) is not the Old Khmer numerals is that the original Old Khmer numeral for number five represented by  in the Sambor Inscription is actually represented by five vertical straight lines ||||| (in the Angkor Borea K.557/600 Inscription in Coedes, (1937, II: 21–23); Internet AB; Internet OK) or  (such as in Khao Rang K.505 Inscription dated in Sanskrit language eqt 561 S and available in Coedes (1937, V: 23) or later on represented by  (such as in the Longvek K.137 Inscription dated in the 6th century Saka and available in Coedes (1937, II: 115)) or much later  (such as in Vat Thasar Moroy K.124 Inscription dated in the Khmer language eqt 725 S and available in Coedes (1937, III: 170)) slightly a hundred year after the Sambor Inscription (See Fig. 1). No other zero numeral in all other Khmer inscriptions because the Khmer writers would prefer to use their own natural language or Sanskrit since their own numerals are not practical even though they have invented specific numerals for ten, twenty, forty and hundred (see Fig. 1 below). However, there are at least three Sriwijaya inscriptions (in the Old Malay) which contain zero, namely Kedukan Bukit Inscription dated  eqt 604 S (682 AD, the oldest), Talang Tuwo Inscription dated  eqt 606 S or 684 AD, and Kota Kapur Inscription dated  eqt 608 S or 686 AD. These inscriptions can easily be found in internet, or in a well known book by Coedes and Damais (1992).

There is another interesting occasion where more than a hundred years later than the famous Sambor Inscription, we find that in the text of the Vat Thasar Moroy Inscription dated eqt 725 S (ibid.), the writer concerned used a symbol  similar to the Srivijaya numeral for the number four, instead of the usual Old Khmer numeral |||| (four vertical parallel lines) for the number (found in the Angkor Borea Inscription),  for five and  for six, similar to the Campa numeral for the number six (see Fig 2 below), instead of the usual Funan or Old Khmer numerals ||||| (five vertical paralell lines) and |||||| (six vertical paralell lines) respectively (found in Angkor Borea Inscription). The writer of this inscription obviously, like the writer of the famous Sambor Inscription, just to be fancy in writing these particular numbers in the Srivijaya numerals since numbers ten and twenty in the same inscription are still written in the Old Khmer numerals  and  respectively; similarly with other numerals equivalent to 1, 3, 9, 10, 18, and 24 each is written in the Old Khmer numerals. The date of this inscription itself is in the fully Old Khmer language (a Funan or an Old Khmer number, *pancadvinsottarasaptasata saka*). This is another strong proof that the zero numeral and the decimal system of numerals do not belongs to the Funans or Old Khmers. Another writer of an erlier Funan or Old Khmer inscription, Tuol Ang Khvav K562 Inscription dated the 7th century AD (Coedes, 1937, II: 196; Chhom and Cœdès, nd) could be the first to used fancily the Srivijaya numeral  =  for the number eight instead of the Old Khmer numeral |||||||| (eight vertical parallel lines). This can be used to argue that the Srivijayan numerals exist decades before 604 Saka (the oldest date recorded such numeral) since it must have taken some times for an Old Khmer scholar to familiar with a foreign numerals. Another words, the Srivijayan numerals must have existed in the late 6th century Saka.

Thus as far as the Cambodian numerals and Srivijayan numerals are concerned, we have shown the following:

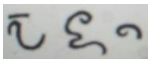
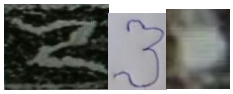
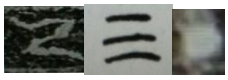
1) The Srivijaya zero numeral is at least a year older than the zero numeral written on the Cambodia inscription. In fact since most likely the Srivijaya decimal numeral system exit in the late 6th century Saka then the zero must have existed since then.

2) Zero numeral only found once on the Cambodia inscription whereas there are at least three ocassions zero numeral written on three different Srivijaya inscriptions.

3) In the same Cambodia inscription, Sambor inscription, which contains the famous decimal numeral with zero digit, eqt 605, the number one to four are written in the usual Old Khmer numerals. In fact for all other Cambodia inscriptions only the Old Khmer numerals or the Old Khmer words or Sanskrit word for numbers are used, except in two other exceptional inscriptions dated eqt 610's Saka and eqt 725 Saka respectively.

4) There is a complete Srivijaya numeral decimal system but a complete set of the Old Khmer numeral system is not a decimal system and without zero numeral just like the Roman numerals and the Chinese numerals, the additive numeral system.

5) The Srivijaya zero is a circle and the dot appears in the Cambodia inscription and in the oldest Srivijaya inscription are just misread of the product of an erosion of the symbol.

Now, we come to the issue of the Campa zero raised by Ifrah (1998). We found that the Campa decimal numeral system is much later than the Sriwijaya numeral decimal system since the oldest Campa inscription which contains some Campa numerals is the Bakul inscription dated  eqt 751 S (= 829 AD) mentioned above, and the Campa inscription contains zero numeral is in the Glai Klaong Anak C19 Inscription dated  which we identify it as  eqt 930 S (= 1008 AD), not as  (Finot, 1915b; Griffiths et al., 2012a). This is also in consistent with the numeral  eqt 935 on Po Nagar Nhatrang/Nha Trang Inscription (Aymonier 1891: 24; Bergaigne 1888: 76-77) or Po Nagar IV Inscription (Schweyer 2005:

116; Finot 1915c). The zero here is either a dot or a circle but it is shown in Fig 3, it is a circle just like our present zero numeral. Further more we find that, as discussed above (and shown by Fig 2 and Fig 3), up to the nineth century AD, numerals for numbers zero, one, three and five are the same as the corresponding Sriwijaya numerals but later, based on Aymonier and Cabaton (1906) by the 17th century AD, only numerals for zero, two and three have the resemblance with the Srivijaya numerals. Thus either the Campa numerals are originally from the Srivijaya numerals or as discussed earlier independent of the Srivijaya numerals. A complete set of Campa numerals in 750 - 1080 Saka (=828 - 1158 AD) is shown in Fig. 3 below.

Thus far, we have shown that there is no possibility that the Campa zero symbolised also by a circle is older than the Srivijaya zero since the Campa decimal numeral system exists explicitly slightly more than a hundred year later, and the oldest Campa inscription explicitly dated in the her decimal numeral system is 33 year later than the earliest Srivijaya inscription dated in her decimal numeral system. There is also a strong possibility that the Campa numeral system is from Srivijaya since the first six numerals correspond to 0,1,5,7 are originally looks the same, and there is one odd Campa inscription, My Son (C.75) Inscription dated eqt 913 S, in which the number four is fencily used the Srivijaya numeral.

Finally, we like to refute the latest opinion by Medieval Indonesia (2024) regarding our claim on the oldest zero in the world. He refused to accept the fact that the southeast Asian zero is the oldest but simply the **earliest appearance** of zero in the world and assert that the earliest appearance is not the earliest origin. His assertion is based on his several wrongly assumptions, facts and arguments. We list each of his arguments and refute it:

A1. Inscriptions are few and the gap between the dates of inscriptions and the Malay manuscripts are too large, 700-year gap. This is not true since the inscriptions in Malay stocks, Austronesian language in Southeast Asia, are hundreds in numbers dated 6th- 15th century AD and there is no gap between the dates of the inscriptions and the Austronesian manuscripts. Besides the originality of numerals particularly zero in the inscriptions has nothing to do with the gap between the inscriptions and in the manuscripts concerned.

A2. The date on the Kedukan Bukit stone is using the 'Hindu-Arabic' numerals. This is a wrong assumption. Hindu-Arabic numeral symbols are completely different from the Old Malay numerals and the symbol for zero is not a dot of the Hindu Arabic numeral but a circle. The dot appears in the Kedukan Bukit inscription and the Sambor inscription is just due to the erosion or damage.

A3. The Bakhshali manuscript in Pakistan contains zero earlier than the Gwalior inscription. This is again at best a wishful thinking of the the group of the librarians at Bodlein Library, UK in 2017 who belief the new carbon dating of a part of the Bakshali manuscript in the library at earlier date than the the date of the al-Khwarizmi manuscript on zero, assuming that the dot in the Bakshali manuscript is indeed a zero (Bodleian Libraries 2017).

First and foremost, it is most interesting to note that in October 2024, Oxford University revised its, 2017, radiocarbon dating of the manuscript, to 799 - 1102 AD (Chivall drk. 2024). Thus all of those arguments for the oldest zero in the world is in the Bakshali Manuscript are irrelevant or null and void. However, we would still like to refute each of his arguments.

A group of international mathematics historians challenges this new finding and these includes scholars from USA, France, Japan, New Zealand and Canada and the two experts on carbon dating Plofker drk (2017) dan Houben (2018), each of them refutes the finding. It is reported in University of Alberta (2017). Even if the carbon dating is valid and the dot in the Bakhshali manuscript is accepted as zero, the date of the invention of the zero must be the last date of the three dates from the carbon dating namely 885-993 M. This is much later than the al-Khwarizmi invention of zero what more the Sumatran (Sriwijayan) invention. The dot in the Bakhshali manuscript does not even represent the number concept invented by the often mentioned the founder of zero (zero concept), Brahmaguta in his *Brahmasphuta Siddanta* dated 628 M but even Brahmagupta zero does not function the same as the zero invented by the al-Khwarizmi in 820. The Carbon dating itself is heavily criticed by the two scholars mentioned above, Plofker drk (2017) and Houben (2018), Bodlein Library herself, who started the controversy, then retracted her earlier claim and instead said that the dot in the Bakhshali manuscript does not represent "real" zero in a long explaination which is still misleading. Casselman (2023) and Dutta (2022) in effect show that the dot does not represents place value or place holder as the dot or circle in al-Khwarizmi zero and in the Sumatran (Sriwijaya kingdom) zero do respectively unless if some one would artificially, Casselman and Dutta called it conjecturally, and perhaps inconsistently (since dot in the manuscript has many meanings) want to do so. Pearce (2021?) just quoted the three sections of a series of large number in Brahmi numerals presented by Joseph (2000;

pp. 241) so that the dot can be interpreted as zero which is inconsisteant with the fact that the Brahmi numeral does not have zero. Infact according to the first sholar who studied the manuscript, Hoernle (1887), the dot in a series of a number in the manuscript does represent a place holder to signify an empty, not the place value of the present system of numeral. For example 2 5 with an empty space can be twenty five or two hundred and five, so to differentiate it the Bakhshali manuscript writes 2.5 with a dot in beween. "On the other hand, occurring in the statement of a problem, the 'empty place' could be filled up, and here the dot which marked its presence, signified a 'something" which was to be discovered and to be put in the empty place." This is perhaps a reason why a dot is also considered as an unknown and written on top of a number. "There is nothing in the Bakhshall arithmetic to show that the dot is used as a proper zero, and that it is any thing more than the ordinary 'mark of an empty place' ". So at best the dot in the Bakhshali manuscript is only a seed for a concept of zero number.

A4. The Indian mathematician Brahmagupta wrote a text in the early seventh century AD/CE, which outlines a concept of zero. This is already discussed in A3 above. Yes, Brahmagupta does outlines a concept of zero, albeit some statements are wrong, but more importantly he does not provide a symbol of zero which provides the place value or place holder which is functioning like the dot in the al-Khwarizmi numeral system.

A5. Other Indian inscriptions were already used zero implicitly in a system of positional notation, base-10 positional notation which requires a zero, before the 7th century AD, as shown by other inscriptions bearing dates that do not include zeroes. This is not clear since examples given are not inscriptions in such dates, in fact the earliest incriptions given are an inscription of Devendravarman said to be dated 675 in the Shaka, and a donation charter of Danidurga said to be dated 659 in the Shaka but both after the date of the Kedukan Bukit Inscripton. Furthermore, according to Harijan (2023) the oldest inscription of Devendravarman is the one issued by Devendravarman Rājarājadeva I between 1070-1078 A D. Thus it makes sense that some scholars claim the inscription is a forgery. The same thing happens to the donation charter of Danidurga (**MathFormulasSite** t.t, O'Connor and Robertson 2000). He should have given the oldest dated Indian document which contains a number written in the place-value earlier than 604 Shaka, the date of the Kedukan Bukit Inscription. If so he would have probably claimed that the ealiest of such date is equivalent to 346 in the Chhedi calendar which is equivalent to 594 on the of written a donation charter of Dadda III of Sankheda in the Bharukachcha region. Once again, many scholars claimed that this is a forgery. However, others claim that, despite the doubts, it can be fairly sure that this document provides evidence that a place-value system was in use in India by the end of the 6thcentury (O'Connor and Robertson 2000). But the same thing can be said to the Sumatran people, based on the Kedukan Bukit Inscription the Sumatran people must have used a place-value numeral system decades before 604 Shaka. In fact the Funans or the Old Khmers, the Sumatran neigbour and linguistically of the same stock, use a place-value numeral sytem, albeit not the base-10 positional notation, at least since early 6th century AD (Angkor Borea Inscription 533 Shaka).

A6. The well-known works on Indian numerals by al-Khwārizmī suggest that Indian numeral, particularly the zero numeral is earlier than the Arabic numeral invented by al-Khawarismi. This is an old controversy of the Latin translation of the Arabic word *hind* or *hindi* said to be used by al-Khwarizmi (in his hand writting) to describe the origin of his numerals, at least since beginning of the 20th century. Many scholars notably Kaye (1918) and Carra de Vaux (1931) thought that the word *hind* or *hindi* could easily be mistaken by the word *hindasi* or *handasī* which has a different meaning. The words *hind* and *hindi* have at least two meanings namely Hindu or India and East or Eastern; wheres *hindasi* or *handasi* means "what relates to geometry or the art of the engineer" or simply geometry or engineering. Mavroudi (2023) mentioned that Carra de Vaux suggested the word *al-hindi*, may be a misunderstanding of *Baṭlamīyūs al-handasī* ('Ptolemy the Engineer').The first European scholar who translated al-Khwarizmi work into Latin, albeit incomplete, was Adelard/Adelhard of Bath in 1126 stated that the al-Khwarizmi's numerals were due to the Hindus while the famous Latin translation of another al-Khwarizmi work by Leornado of Pisa son of Fibonacci 1202 is titled *Numero Indorum* (Wickens 1976; Smith and Karpinski 1911) which means the Indian or Hindu Numbers (of al-Khwarizmi). Rosen (1831) in the preface (pp. viii, x) of his translation of the famous al-Khwarizmi's *al-jabr wa al-Muqabbala* made a conjecture which he said said that even though al-Khwarizmi based his work on an Indian source (not specific), but "he seems to have been independent of them in the manner of digesting and treating it …..:differs considerably from that of the Hindu mathematical writers.". In his *notes* pp. 196-199, regarding *al-hind* which he related it to the word *handasah* and *hindisah* and translated it as geometry and measurement and size respectively, and the later includes the reference to numerals.

Rosen even suggests that the Arabic word *handasah* and *hindisah*, can mean numbers in the sense of decimal notation. Despite he acknowledged "a fact well known, and admitted by the Arabs themselves", that the decimal notation was the Hindu discovery, but he was still puzzling the uncertainty of time the communication between al-khwarizmi and the Hindu source took place. Al-Futuhat. (2012) provides many other scholars during 1915-2000 other than Kaye and Carra de Vaux who engage in the controversy. The most quoted statement that the al-Khwarizmi numerals are from Hindia/Hindu is in the work of al-Biruni 1030 in his *Tārīkh al-Hind* as elaborated by Boucenna (2007) and Smiths and Karpinski (1911), and of course al-Biruni's work is contested by Kaye (1918). Boucenna (2007) provides new arguments against the Hindu origin of the al-Khwarizmi numerals. He also reminds the readers that in the Arabic sociology, "Hindi" does not necessarily mean the Indian origin but it can mean: magic, bizarre, surprising and exotic.

The evolution of the al-Khwarizmi numerals in Europe to become a distinct numeral system presently used almost all over the world, whereas the al-Khwarizmi numerals in the Arab world remain almost unchanged; thus the historians invented the name for the European numeral system as the Guber Numeral System or the Western Numeral System and in Arabic it is refered to as *al-arqam al-ghubariyah* or *al-arqam al-maghribiyyah* respectively; whereas the al-Khwarizmi's numeral in the Arab World is refered to as the *al-arqam al-hindiyah* or the Estern Numeral System. Note that the term *al-hindiyah* from *hind* or *hindi* is translated as the eastern, not the Indian or Hindu. It is a general consensus of opinion in the Middle Ages that the al-Khwarizmi's numerals were of Hindu origin (Smith and Karpinski 1911) and hence the terms Hindu numeral or Hindu-Arabic is used through out the years until the 20th century the terms Arabic numerals became more popular instead. This is because the scholars could not prove that al-Khwarizmi did take his numerals from India in fact the Indian zero was found much later than the al-Khwarizmi's zero. Further more, Coedes (1931) published his findings on the Sambor inscription and declares that the oldest zero in the world is from Cambodia, even though he knew the Kedukan Bukit Inscriptions, Sumatera also dated at the same time (Coedes 1930). It takes another 65 years for another scholar, Diller (1995), to declare that the Sumateran was the oldest inventor of zero. These findings somehow left fossilised in the publications until Aczel (2013a,b; 2014a,b; 2015a,b) rediscovered and publicised the zero on the Cambodian inscription, and Shaharir (2000, 2001), Shaharir and Zahrin (2019), and Shaharir and Swetz (2022) reestablished more concrete evidence on the earliest zero on the Kedukan Bukit Inscription and decimal numeral system of the Sumaterans. It is no doubt that these findings would influence more scholars to believe that the correct translation of *hind* and *hindi* in the al-Khawarizmi writings on numbers and numerals is the East or to be exact, East Indies as suggested by Keye (1919) and Carra de Vaux (1931).

A7. The Kedukan Bukit inscription may preserve the oldest known zero sign, but we really shouldn't assume that the concept of zero itself originated in Sumatra. Extraordinary claims require extraordinary evidence — and when little evidence survives, we must refrain from making extraordinary claims. This is a misconception of the concept of number and numeral. Number is a concept of counting whereas numeral is a symbol of a number which comes much later in any civilisation. It may well be that the oldest number in the world is conceived by Indians particularly the zero number via their term *sunya* but the evidences so far do not suggest that Indians are the first inventor of numerals, particularly the decimal numeral system with zero numeral as the placeholder and placevalue like the al-Khwarizmi numeral system.

CONCLUSION

The oldest decimal numeral system in the world is the invention of the people of Sumatera in 604 S =682 AD or earlier and hence the oldest zero numeral in the world (symbolised by a circle) is at least in the same year, neither did from Cambodia nor from Vietnam but from Sumatra (Kedukan Bukit, Palembang), Indonesia. The Cambodian has no zero numeral, but the Campan has zero numeral about 150 years later than the Indonesian; whereas the Indonesian zero is at least 138 years ealier than the Arabic (al-Khwarizmi) zero and 194 years ealier than the Indian (Gwalior) zero.

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