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The Concept of Measure in the 19Th Century Javanese: An Ethnomathematics Study

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ABSTRACT
This study examines the traditional concepts and mathematical practices of the Javanese people, as documented in Sĕrat Cĕnthini Kamajaya volumes IX–XII, with a focus on their methods of measurement. The research employs a qualitative ethnomathematical approach using a framework based on four key questions: where to look, how to look, what it is, and what it means. Data were drawn from the transliteration of *Sĕrat Cĕnthini* volumes IX–XII and analyzed using content analysis, triangulation, and pattern identification across six basic mathematical activities. The study identifies sixteen traditional Javanese measurement terms in *Sĕrat Cĕnthini* IX–XII, including *sacengkang*, *lengen*, *sapungge*, *ula sawa*, *kilan*, *pêcak*, *sagêgêm*, *glintir*, *sairis*, *jodho*, *sakêpêl*, *saklêmuk*, *saontong*, *poros*, *pulukan*, and *tangkeb*. These terms illustrate the close relationship between culture and mathematical reasoning. The findings highlight the embeddedness of mathematical concepts in Javanese cultural expressions, supporting the integration of ethnomathematics into culturally responsive education.

Keywords:
ethnomathematics; *Serat Centhini*; Javanese culture; traditional measurement

INTRODUCTION

Science plays a pivotal role in everyday human life. In physics, for instance, we observe phenomena such as the transformation of liquids into solids (ice), the use of batteries as energy sources, and the operation of touchscreen devices. Among the various scientific disciplines, mathematics stands out as one of the most enduring fields of inquiry, having evolved in tandem with the development of human civilization. Historical accounts suggest that mathematical ideas first emerged in ancient Mesopotamia and Greece, particularly in association with agricultural practices such as land surveying and food storage (Denbel, 2023). Over the centuries, mathematics has evolved through intricate cultural processes and has been gradually formalized into the structured discipline it is known for today.

Throughout history, mathematics has been deeply embedded in daily human activities, including commerce, measurement, construction, strategic planning, categorization, and calculation (Suprayo et al., 2019). This intrinsic relationship between mathematics and culture gave rise to a distinct area of study known as ethnomathematics. The emergence of this field highlights the reciprocal growth of mathematical knowledge and human culture, demonstrating how both domains enrich and inform each other (Nurbaeti et al., 2019).

The term *ethnomathematics* was first introduced by Ubiratan D'Ambrosio in 1985, who defined it as the study of mathematical practices developed and utilized by various cultural groups, ranging from indigenous communities and craft guilds to generational cohorts (Cimen, 2014; D'Ambrosio, 1985). Within these cultural frameworks, mathematical ideas become situated and take on meaning. In

educational contexts, for example, drawing upon local cultural traditions can enhance the relevance and engagement of mathematics instruction, making abstract concepts more tangible to students (Meeran et al., 2024). Likewise, mathematical analysis can facilitate the interpretation of cultural symbols and expressions, thereby deepening our understanding of heritage and tradition (Suherman & Vidákovich, 2024).

Recent developments in ethnomathematics reflect a growing scholarly interest in its application across diverse cultural settings. For instance, several studies have emphasized the theoretical underpinnings of contextualizing mathematical learning through ethnomathematical approaches (Rosa et al., 2017), while others have explored the historical evolution of numerical systems and measurement practices from ancient Mesopotamian civilization onward (Valério & Ferrara, 2022). In the Indonesian context, scholars have demonstrated how Javanese cultural practices can be integrated into mathematics education, underscoring ethnomathematics as a powerful pedagogical tool for bridging traditional knowledge with contemporary learning (Wiryanto et al., 2022).

The present study examines traditional measurement systems found in the *Sĕrat Cĕnthini Kamajaya*, particularly volumes IX through XII. It aims to uncover the cognitive and cultural foundations of measurement practices in 19th-century Java by analyzing the terminology and reasoning embedded in traditional Javanese units of length, volume, and mass. Terms such as *sacengkang*, *kilan*, *sagêgêm*, *sairis*, *sakêpêl*, and *saklêmuk* are more than linguistic curiosities; they represent practical applications and symbolic articulations of spatial and quantitative understanding.

This study adopts an interdisciplinary approach, offering insights that intersect four fields: mathematics, history, linguistics, and cultural studies. From a mathematical perspective, it explores how logical reasoning is evident in traditional Javanese measurement. Historically, it situates these measurement terms within the socio-cultural context of 19th-century Java. Linguistically, it analyzes the morphology, semantics, and usage of measurement-related vocabulary. Culturally, the study documents and interprets indigenous knowledge embedded in daily practices and ritualistic traditions.

Traditional measurement systems worldwide demonstrate the ingenuity of human communities in quantifying physical phenomena using locally relevant and often anthropometric units. For example, the ancient Egyptians used the cubit, approximately 52.3 cm, for purposes such as architecture and land surveying (Waziry, 2020). In ancient India, units such as the angula (a finger breadth) and hasta (an elbow length) were standardized during the Mauryan era and still retain cultural significance today (Rab et al., 2020). The Roman system utilized the *pes* (foot) and *uncia* (inch), which later contributed to the development of modern imperial units (Stone, 2014). Similarly, the Chinese system included the *chi* (foot), *cun* (inch), and *zhang* (10 *chi*), units that were essential for artisanship and construction (Siebert et al., 2021).

The classical Roman theorist Vitruvius systematized human-based measurement ratios in 15 BC. Many of these proportional relationships, derived from the human body, served as foundational principles in architectural design. For instance, a person's full height was considered equal to the span of their outstretched arms—one fathom or two yards, which was equivalent to four cubits, six feet, and so on (Pheasant & Haslegrave, 2018). These anthropometric concepts laid the groundwork for classical architecture. In Polynesian navigation traditions, body-based

units also played a crucial role in calculating distance and orientation across the sea (Finney et al., 2023). Collectively, these examples highlight the cultural specificity, practicality, and adaptability of traditional measurement systems in various civilizational contexts.

By focusing on the *Sĕrat Cĕnthini*, this study contributes not only to the preservation and revitalization of Javanese linguistic and cultural heritage but also to the broader discourse on integrating local wisdom into modern educational frameworks. The findings underscore the value of incorporating indigenous mathematical knowledge into contemporary curricula, thereby fostering culturally responsive pedagogy and facilitating intergenerational transmission of cultural knowledge.

METHOD

This study investigates ethnomathematical concepts within 19th-century Javanese measurement terms found in *Sĕrat Cĕnthini* volumes IX–XII. It adopts a qualitative approach grounded in ethnolinguistic methods. Ethnolinguistics is particularly useful for examining how language and culture intertwine to give meaning to their identity (Widayat & Dwiadmojo, 2023). This approach helps uncover how language reflects cultural identity in specific historical contexts (Diko, 2023).

Ethnolinguistic analysis enables the researcher to examine measurement as a culturally variable concept, influenced by social values, norms, and linguistic structures. It reveals how the use of measurement terms in historical texts can reflect the logical reasoning and worldview of the society that produced them. Ethnolinguistics aligns closely with ethnomathematics, which posits that mathematical reasoning is shaped by human environmental diversity—including religion, morality, economics, social systems, language, and politics (Rosa et al., 2017). Thus, ethnolinguistics serves as an appropriate methodological framework to explore measurement terms in *Sĕrat Cĕnthini* as expressions of both cultural and mathematical identity.

The study employs an ethnomathematical analysis framework built on four guiding questions (Alangui, 2010; Utami et al., 2019):

Table 1. Framework for Ethnomathematical Studies

Question	Initial Answer	Critical Construct	Specific Activity
Where is it to look?	The cultural practices of using Javanese measurement terms in the 19th century	Culture	Analyzing *Sĕrat Cĕnthini* volumes IX–XII and explaining how terms were used in Javanese society.
How does it look?	Qualitative investigation of relational and spatial aspects in Javanese measurement terms	Alternative thinking	Determining the qualitative, relational, and spatial aspects of cultural practices.
What is it?	Alternative evidence of conceptualization	Philosophy of mathematics	Identifying external criteria for accepting Javanese measurement concepts.
What does it mean?	The relationship between culture and mathematics	Anthropology/Ethnolinguistics	Describing how measurement reflects variations in social and cultural contexts.

Research data were drawn from the online transliteration of Sĕrat Cĕnthini volumes IX–XII, available at: https://www.sastra.org/kisah-cerita-dan-kronikal/serat-centhini?start=10. The researcher identified and collected Javanese measurement terms embedded in the text. The data analysis process involved content analysis, triangulation, and the identification of patterns. The analysis was based on the six universal dimensions of mathematical activity outlined by Bishop (1988): measuring, playing, calculating, explaining, designing, and discovering. These dimensions were used to interpret how measurement terms reflect deeper cultural and mathematical reasoning (Umbara et al., 2021).

RESULTS AND DISCUSSION

1. Results

A great literary work in the era of New Javanese was born from a poet of the Surakarta palace, i.e. *Sĕrat Cĕnthini* (Hartati et al., 2023). It was written in 1815 by Ki Ng. Ronggasutrasna, R.Ng. Yasadipura II, and Ki Ng. Sastradipura, when the Surakarta palace was being led by Pakubuwana V. Consisting of 722 *kanto* (long poems) and 247,766 lines of poetry, this work was written during the United Kingdom occupation in Java (1811-1816) and became the largest literary art ever written in Javanese (Day, 2021). The people of Java, Indonesia, and Western academics have read and studied *Sĕrat Cĕnthini* as a source of knowledge or encyclopedia of Javanese culture in the 19th century (Day, 2023). Therefore, *Sĕrat Cĕnthini* is one of the media to represent the thoughts of the people at that time, one of which is measurement.

Sĕrat Cĕnthini consists of twelve volumes and is composed in the form of tembang Macapat. The Macapat metrum is quite complex, as the number of lines in each stanza is predetermined, along with the final sound of each line and the number of syllables per line. This metrical form developed significantly in Java; even the Ramayana and Mahabharata, which were originally written using the Kakawin metrum, were later adapted into the Macapat style under the titles Sĕrat Rama and Sĕrat Bharatayudha (Arps, 2016; Ding & van der Molen, 2018; Pigeaud, 1967; Supomo, 1993; Zoetmulder, 1974).

The poetic system used, tembang macapat, not only determines rhythm and structure but also encodes symbolic, moral, and philosophical teachings. Macapat plays a crucial role in preserving local wisdom and transmitting ethical values, as every pupuh, such as Sinom or Dhandhanggula, serves specific emotional and narrative purposes (Widayat & Dwiadmojo, 2023). The use of mathematical measurement in these contexts suggests a philosophical convergence between tangible experiences and metaphysical reflection. In addition, the diction used in tembang Macapat tends to be literary and poetic, thus requiring deep comprehension when analyzing its content. Based on heuristic and hermeneutic readings, the following types of measurement in Javanese culture were identified.

The term "measurement" in Javanese is divided into three types: units to describe the number of objects, units to describe area, and units to indicate distance. There are 60 terms that describe the number of an object, the units are *ajar, bedhol, bendhel, beruk, bojog, bongkok, bungkul, buntel, candhik cawuk, deleg, dhapuran, dhompol, dulit, gada, gagrag, gedheng, gegem, gendhok, glintir, gluntung, grigih, ipit, iris, janjang, jinah, jodho, jumput, kakab, kepel, keris, las, ler, lining, lirang, lonjor,*

mata, muk, ombyok, ontong, pangadeg, papah, pasang, poros, puluk, rakit, rongge, ros, sele, siyung, tampang, tangkeb, tundhun, ukel, until, unting, uyun, wawar, wuli, dan *wungkus.* Measurement terms used as indicators of area size include *bata, bau, clebek, iring, kedhok, lupit, paron, prowolon,* and *ru*. The numeral indicating the unit of distance consists of *bedhug, jangkah, kesuk,* and *kilan* (Sasti, 2017).

In *Sĕrat Cĕnthini* volumes IX-XII, 16 terms indicate measurements. These findings are presented in Table 2, which also constitutes the main result of the study. The table illustrates a comparison between the measurement units used in the 18th century, as found in Sĕrat Cĕnthini, and those used in contemporary times. The terms are described in Table 2 below.

Table 2. Javanese Terms of Measurement in Sĕrat Cĕnthini volumes IX-XII and Comparative Analysis of Traditional Javanese Measurement Systems

No.	Pupuh, The Order of Gatra	Measurement Unit (Meaning, Description)	Kinds of Measurement	Still in Use Today?	Modern Equivalent	References
1.	532. Sinom (1)	*Sacengkang (Distance from thumb to index finger)*	length and/or width	Rare-ly	~7 cm	(Poerwadarminta, 1939)
2.	523. Asmaradana (29)	*Lengen (Arm's length)*	length and/or width	Yes, in informal contexts	~50 cm	(Prahmana, 2020)
3.	667. Dhandhanggula (42)	*Sapungge (Volume of a durian seed)*	Vol./ mass	No	Scoop volume	(Fang et al., 2022)
4.	547. Girisa (34)	*Ula sawa (Length of a rice snake)*	length and/or width	No	50–140 cm	(Wiradana et al., 2021)
5.	561. Gambuh (16)	*Kilan (Little finger to thumb span)*	length and/or width	Yes	16–20 cm	(Agustapraja & Wahab, 2023)
6.	539. Wirangrong (32)	*Pêcak (Length of foot sole)*	length and/or width	Occasionally	22–28 cm	(Agustapraja & Wahab, 2023)
7.	522. Bêlabak (43)	*Sagêgêm (Granulated unit or one handful)*	granulated things	Yes	Handful	(Prahmana, 2020)
8.	618. Dhandhanggula (67)	*Glintir (Small amount)*	Amount	Yes	Few pieces	(Sasti, 2017)
9.	541. Sinom (20)	*Sairis (A slice)*	Amount	Yes	Slice	(Sasti, 2017)
10.	603. Sarkara (77)	*Jodho (A pair, usually animals)*	Amount	Yes	Pair	(Prahmana, 2020)
11.	522. Bêlabak (33)	*Sakêpêl (One fist)*	Vol./mass	Yes	0.5 kg	(Prahmana, 2020)
12.	693. Gambuh (62)	*Saklêmuk (A clay pot volume or ~2.5 L)*	Vol./mass	No	~2.5 liters	(Mijianti et al., 2022)
13.	581. Pocung (24)	*Saontong (One corn cob)*	Amount	Yes	1 corn cob	(Prahmana, 2020)
14.	518. Jurudêmung (10)	*Poros (Three betel leaves)* *Two cupped hands (bananas)*	Amount	Rare	3 leaves	(Sunan Pakubuwana V, 2018a)
15.	708. (95) Dhandhanggula	*Pulukan (A mouthful of rice)*	Amount	Yes	1 mouthful	(Rhamayanti et al., 2022)
16.	538. Kinanthi (31)	*Tangkeb (Two cupped hands-usually for bananas)*	Amount	Yes	20 fruits	(Sunan Pakubuwana V, 2018d)

Table 2 presents a comparative analysis of the traditional Javanese measurement units found in Sĕrat Cĕnthini, assessing their usage in contemporary contexts and aligning them with modern measurement equivalents. This analysis not only illustrates the historical depth of Javanese ethnomathematical knowledge but also indicates the extent of its continuity and transformation in present-day society.

The comparative table (Table 2) illustrates the richness and diversity of traditional Javanese measurement systems in Sĕrat Cĕnthini. The body-part-based units, such as 'kilan', 'pecak', and 'lengen', still hold cultural significance in rural communities and traditional markets, where estimation is an informal practice integral to daily trade and agriculture (Prahmana, 2020). The continuity of this proves what Rosa et al. (2017 illustrate as the contextual and functional relevance of ethnomathematics in daily life.

Measures such as 'sakepel' (denoting a fistful), 'glintir' (a small amount), and 'sairis' (meaning a slice) are still relevant, particularly in activities like cooking and traditional herbal medicine. This serves to highlight the fact that ethnomathematical practices are deeply rooted in embodied cognition and practical, everyday (Nurbaeti et al., 2019). However, other terms such as 'saklêmuk' and 'sapungge', which denote units of seed measurement or specific containers, are not used in current practice, indicating a slow transition due to modernization and the adoption of metric units. Internationally, the continued use of culture-embedded measure units has also occurred among the Sasak of Lombok (Hardiani & Putrawangsa, 2019) and the Bengkalis Malay (Anriana et al., 2023). These results affirm the validity of incorporating this type of knowledge into school curricula as a cultural preservation and contextualization process for mathematical ideas in abstract terms (Meeran et al., 2024; Rosa et al., 2017). These conventional units in Sĕrat Cĕnthini not only explain past practice but can also find application in contemporary educational settings.

If we look at the frequency of use in everyday life today, it can be described more simply in the following chart:

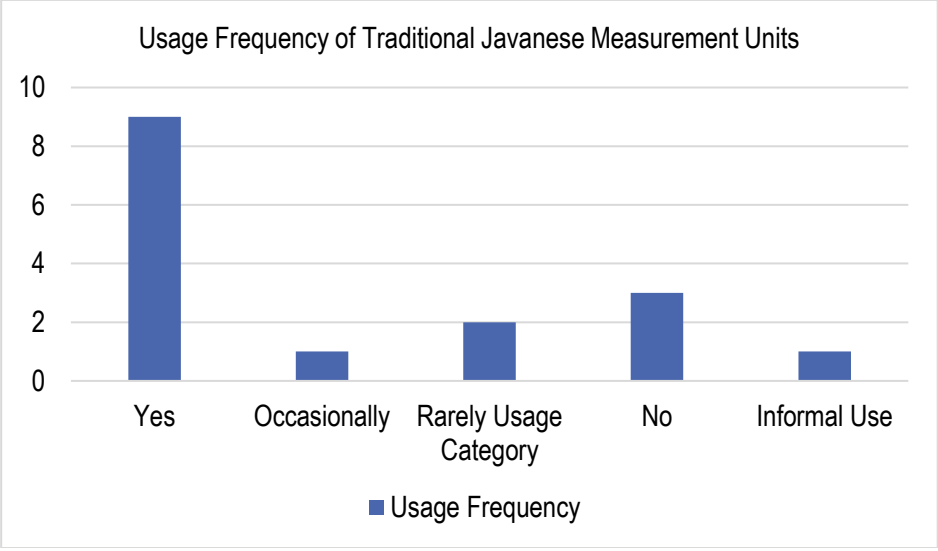

Figure 1. Usage Frequency of Traditional Javanese Measurement Units

This chart indicates that most traditional Javanese measurement units are still in use today in various informal and rural contexts. Only a few, such as 'sapungge' and 'saklêmuk', have become obsolete due to changes in daily material culture.

Based on Table 2, it can be concluded that Javanese society in the 19th century relied

more heavily on body parts as units of measurement compared to other sources of measurement. The use of body parts as units of measurement aligns with patterns observed globally in ethnomathematics. Object-based and symbolic units reflect the integration of natural and spiritual elements into practical mathematics. It can be described more simply in the following chart:

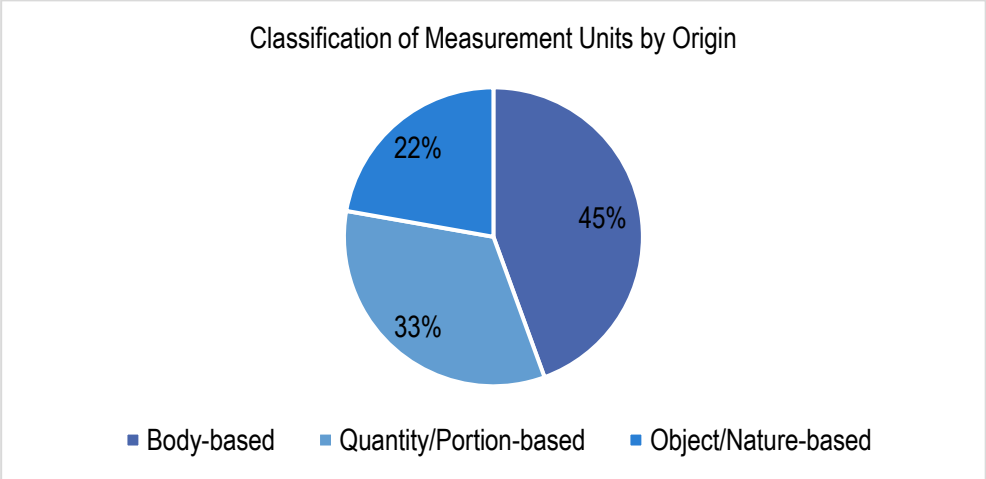

Figure 2. Classification of Measurement Units by Origin

Length measurement in Javanese culture tends to use relatively short-range units, as nearly 90% are based on human body parts, which have limited lengths. The range of these traditional length units typically varies between 7 and 50 centimeters. In contrast, the use of *ula sawa* (python) as a unit of length is considered indefinite, as a python's size changes with age. However, pythons generally range from 50 to 140 centimeters in length. The *ula sawa* serves as a more flexible unit of measurement compared to other more standardized or fixed-length units. The following diagram illustrates the estimated lengths represented by these traditional measurement units.

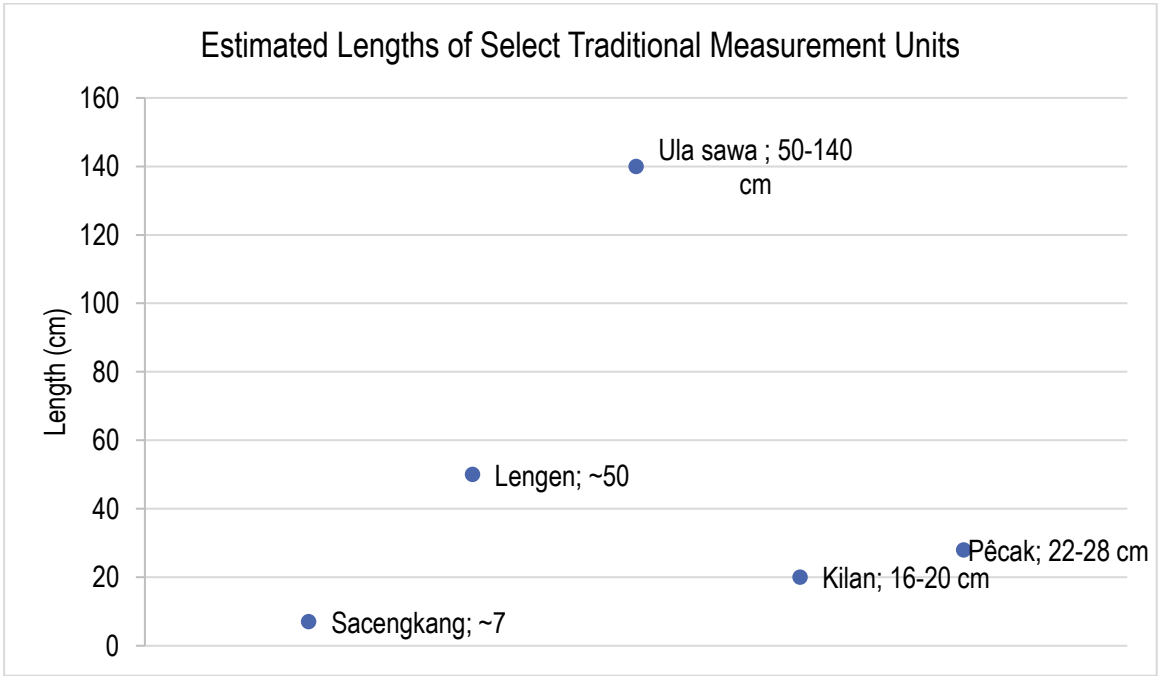

Figure 3. Estimated Lengths of Select Traditional Measurement Units

2. Discussion

The utilization of anatomical markers as measurement units is a shared and long-standing tradition among a wide range of cultural populations. An extensive survey (Kaaronen et al., 2023) cataloged body-based measurement systems that occur in 186 cultures worldwide, thereby indicating their widespread occurrence and persistence despite global adoption of standardized metric systems. Traditional units like the cubit, span, and fathom not only embody practical ergonomics but also possess profound cultural and intellectual meaning, especially in cultures where access to formal education and instruments can be restricted.

If we go back to the history of how measurement terms were invented and developed to these days, we have to pull the thread back during the development of Mesopotamian civilization, namely in 3,500 BC when the first written documents originated. The document carved using clay is believed to be a record of transaction receipts. The documents found contain about the daily life of people with various subjects, such as the size of the land area, loans, grains produced in the fields, and so on (Kasprik & Barros, 2020). Through this evidence , it can be seen that the concept of measurement has existed in community life for a very long time.

The use of the measurement terms at that time had three basic elements, namely *hasta* (cubit) for length, *ca* for volume, and *pon* for weight. The measurement terms mentioned above will later become the origin of the International System of Units (Kasprik & Barros, 2020; Taton, 1959). The term arm or *hasta* was first discovered in the Ancient Egypt civilization, which was around 2,700 BC. The size of the arm or *hasta* is the length of the arm to the fingertips, which if measured in centimeters is about 48 cm (G. Kula, 2023). At that time, the people of Ancient Egypt relied heavily on this measurement term. In fact, some studies mention that this measurement term was used in determining the pyramids construction (Waziry, 2020). There is another opinion stating *hasta* is approximately 50 cm in size. This opinion is based on cuneiform found by archaeologists who at that time measured the base of the Tower of Babel (Kasprik & Barros, 2020).

The use of the unit of cubits, also used by the Ancient South Arabs, where there are more than 12,000 texts mentioning the term *ammat* or *hasta* as the measurement term ranging from 33 to 75 cm long (Emery & Schiettecatte, 2021). This is also agreed by the 19th Javanese people who use limbs as the basis for measurement. For example, the word *lengen* (arm), which is found in the 523rd Pupuh of Asmaradana. The excerpt reads: "*Dèn-ukur lan lêngênnèki, gumuyu cès ilêrira, cipta ge ya tumamane, panêkême sinungkêman, ingambung asengokan, cinêcêp mangang ingamut, -amut pucuke kewala."* It is translated as: being measured using arms, laughing and his saliva falls down *ces* (drips), he thinks to quickly put it his possession, the tip of the weapon is placed on his forehead, kissed, squeezed. Her mouth opens and suck the glans (Sunan Pakubuwana V, 2018a). The term arm is also commonly referred to as *hasta* (cubit).

In addition to the hand, fingers have also been used since the Mauryan Empire. About 2,400 years ago, the system of weights and measurements was well defined. According to the system, small lengths are measured in *angular* units or the middle segment of a medium-sized male middle finger, *jengkal* (inch), and *hasta* (cubit) (Rab et al., 2020). This term was also used by the Ancient Egyptians to measure naturally.

They analyzed that four finger lengths are equal to one *jengkal* (inch), while seven inches is one *hasta* (cubit) (Waziry, 2020).

As for the Javanese language, there is also the term *sacengkan*, which if translated in the Javanese Bausastra dictionary (Poerwadarminta, 1939) means *sadawaning panuding lan jêmpol kabênggang*. The sentence is translated as follows, the size is as the lenght of extended index finger to the tip of the thumb. This term is used to measure the thickness of an object. This is shown in the 532nd *Pupuh*, namely the first line of *Pupuh Sinom*. The excerpt reads: "*Jayèngrêsmi lon ngandika | paman ngong têtanya malih | punapa wus adatira | guwa Pêdhali puniki | waringin woh gori |[31] babal madu kucing arum | manira ngalap nangka | lan Jèngraga angsal niji | ingong bubak nangka kandêle sacêngkang ||*". The snippet of the pupuh means that Jayengresmi said quietly, "Uncle, I ask again, has it become a habit in the Pedhali Cave, the banyan tree bears the fruits of *nangka* (jackfruit), *babal madu kucing* is fragrant. I picked jackfruit and Jayengraga got one each. I opened the flesh of the fruit, and it was one *cengkang* (shell thick) (Sunan Pakubuwana V, 2018a). One *cengkang* (shell) measured in centimeters, is about 7 cm long.

In addition to the shell, there is also the measurement term of *kilan*, which is still used today. In Indonesian, *kilan* equals to the length of the little finger to the thumb which is stretched out with a length of approximately 16-20 cm (Agustapraja & Wahab, 2023). The use of *kilan* is found in the 561st *pupuh* of the 16th line of Gambuh. The excerpt reads: "*Wênèh bêdudanipun | pring kuda pat kilan panjangipun | myang pring pêtung jêjalêran kang pring lêgi | pring lutung tutul wulung |[112] lumrah kang cêndhak inganggo ||*". The translation of the excerpt reads that there is another *bebudan* of horse bamboo that is 4 *kilan* long and *jejaleran* of *petung* bamboo and sweet bamboo, as well as bamboo with black shackles (Sunan Pakubuwana V, 2018a). So, the length of the bamboo is approximately 64 – 80 cm.

In some ancient documents of the United Kingdom in the Middle Ages, or rather in the post-Conquest period of Britain, it is written that the way they measured cloth was by using physical objects of body parts, such as feet, aune/ell/ulna (Chambers, 2017). In Javanese society itself, there is *pecak* or sole, which has the meaning of the length of the foot sole from heel to toe. If measured, the length of one *pecak* is approximately 22-28 cm (Agustapraja & Wahab, 2023). The word is mentioned in 539th *pupuh* of Wirangrong, i.e. "*Nuripin ngling saking wuri | punapi niku sayêktos | towokipun sela (ng)gih puniku | dede waja wêsi | iba landheyanira | towok ambane pat pêcak ||*". The song means that *Nuripin* responded from behind. "If this is really a *towok* stone, not steel, the *towok* or spear is four feet wide (Sunan Pakubuwana V, 2018a). If converted, the width of the spear is approximately 88-96 cm.

If you look at the description above, the human body is considered to meet measurement standards. This is a simple utilization based on what humans had at that time. So it is no wonder that more than 186 cultures use the body as a tool to measure (Kaaronen et al., 2023). So, it can be concluded that the use of the body in terms of measurement is a common thing, including in Javanese society at that time.

It is already known that people have always been able to measure mass or volume. At that time, grains of fruit could be used to measure volume or mass. This practice was widespread in ancient civilizations. They usually used sesame seeds as the smallest unit of measurement. For example, the ancient Mesopotamian civilization used seeds of the carob tree (*Ceratonia siliqua*) as a measure of weight (Williams,

2020). The Mesopotamian people used carob trees according to the conditions of their habitat. The Javanese use *pongge* or durian seeds to determine volume or mass. *Sapongge* (a *pongge*) has an oval shape with a length of 5-7 cm and a width of 2-4 cm (Fang et al., 2022). The oval shape of durian seeds may represent the volume of rice taken from their place. This is recorded in the 667th Pupuh of Dhandhanggula. The excerpt reads: "*Sêmune mèh dèn-irus-irusi* | *kaya katêmbèn lèh nadhah kathah* | *de ukur kalong sapungge* | *krowake sêkulipun* | *kongsi bêngkêng tan bisa osik* | *jawane wong mono ta* | *salêgutanipun* | *yèn wus lêguta alapa* | *nora kêna kaluwiyan bukti thithik* | *amêlarati badan* ||". The translation is: it seems that you have been spooned. Yes, this is the first time I have eaten a lot. Yes, the rice is only one durian seed if shaved. Yes, indeed, the portion is only a *lugut* (a fur). So take it according to what has been determined, if it is too much, it can make the body ill (Sunan Pakubuwana V, 2018c).

In addition to using seeds, the measurement of volume in Ancient Egypt used tools such as vessels or jars. In a study conducted by Bárta (1996), it was found that there were 39 beer jars found during the Old Kingdom of Abusir with various volume variations. The variation in the volume of the jars found ranged between 1.9 and 2.6 liters (0.39–0.54 hectare), with circumferences varying between 47 and 57 cm (25.2–30.2 fingers). The beer jars found in Kaaper's tomb were smaller in size although they were about the same volume, about 1.5–1.6 liters (0.31–0.33 hectare) with their capital circumference varying between 43.9 to 47.1 cm (23.5–25.2 fingers). These jars are used for daily activities, namely the measurement of food rations or beer (Zapassky et al., 2012).

The use of tools as a measurement is also not much different from the measurement that developed in Java in the 19th century. This is evidenced by the discovery of terms such as *sakêpêl* and *saklêmuk*. For example, the word *sakepel* has the meaning of one fist. The size of one fist has the weight of of approximately 0.5 kg (Prahmana, 2020). This term appeared in the 522nd *pupuh* of *Bêlabak.* The excerpt reads: *"Ki Duljaya panas ati muring-muring* | *nêpsune* | *golèk watu sakêpêl binalangake* | *anglimpe* ||". The meaning is that Ki Duljaya' emotion and anger is at its peak, he looks for a stone that is at the size of one *kepal* (fist) and he throws it (Sunan Pakubuwana V, 2018a).

The word *saklemuk* comes from the word *klemuk* which means a *kuali* (wide-mouth clay pot for cooking) or container made of copper (Mijianti et al., 2022). *Klemuk* is commonly used to store water, this is written in the excerpt of the 693rd *Gambuh pupuh*: "*Pan dèrèng sampun-sampun* | *yèn dèrèng têlas toya saklêmuk* | *sarêng têlas sêkul jangan lawan warih* | *salawuhane digêmpur* | *gêr gumuyu sadaya wong* ||*".* The free translation is: it will continue till the water in the *kuali* runs out. Instantly, the rice, vegetables, and side dishes ran out (Sunan Pakubuwana V, 2018d). If measured, *klemuk* has a volume of approximately 2.5 liters (Prahmana, 2020).

In determining length, ancient people also used animals to measure length. One of the animals that can be used as a parable is the rice paddy snake, which is written on the 547th pupuh of Gurisa. In the manuscript, it reads:"*Adawa lir ula sawa* | *anolih Ki Kulawirya* | *angling hus hus lho wong edan* | *calak tan angon duduga* | *Nuripin akacêmutan* | *Ki Wargasastra lingira* | *lêrês puniku mêningan* | *tanduk sêsambunging basa* ||". It means that it extends like a rice paddy snake. Ki Kulawirya turned his head and said, "Hus-hus! You're crazy, the joke is outrageous. Nuripin is overwhelmed. Ki

Wargasastra replied, "That's right, it's better to play with language." In some studies, it is mentioned that there are several species of snakes that usually live in rice fields. For example, at rice fields of Angantaka Village these snakes are such as *Dendrelaphis pictus* or bronzeback snakes, *Pareas carinatus* or keeled slug-eating snakes (Wiradana et al., 2021), or the genus *Hypsiscopus* such as mud snakes or gray water snakes (Bernstein et al., 2024). These snakes have varying lengths, such as bronzeback snakes that can grow up to 1.4 meters long or keeled slug-eating snakes, mud snakes, and gray water snakes that are only 50-100 cm long.

There is a type of number calculation that is a form of evolution of numerical data spoken in language. This kind of evolution has already progressed in the North Pacific and Polynesia from the Mesotopomian period, for example in the Nivkh or Gilyak languages, which are spoken around the Amur River (Outer Manchuria) and on the island of Sakhalin. In Nivkh language, numerical values can be illustrated through language phrases, such as a pair or a cup. This can be seen through the construction of the word, if the object of the word is paired, there will be suffixes, such as *vasq/-vysq/-vsq/-fasq*, derived from noun *pasq* “one of a pair (Valério & Ferrara, 2022). The construction of this word is almost the same as the Javanese language which adds the prefix *sa-*, to indicate the numerical value of one. For example*, saglintir, saiiris, sajodho, saontong, saporos, satangkeb*, and *sapulukan*, these words are examples of the use of numerical values that can be illustrated through language phrases in Javanese.

The word *seglintir* is found in the 618th *pupuh of Dhandhanggula* line 67. The excerpt reads: “*Kang ngong-tuturkên kula pribadi | datan wajat polèh ring utama | mung-mung rèh rèmèh gêndhingkrèh | batèh nêmpêg gêrèh wruh | têlung glintir dèn-dhèh-dhèh kêni | Ki Wirya saya latah | myarsa banyolipun | asor cucuting adhalang | sarwi angling lo nyanggup Kenthol Nuripin | gawemu milang lawang* ||”. The translation of the excerpt is: what I personally said that it does not deserve the main designation, he saw a salted fish, then he gave 3 *gelintir*. Ki Wirya was even more pleased with the puppeteer's joke when he said, "You know, as for Kenthol Nuripin, it's your job to count where the door goes."(Sunan Pakubuwana V, 2018b). The word *gelintir* can refer to an object; the excerpt above refers to three *gelintir*, which means three pieces. In addition to meaning a grain, the word *gelintir* can also turn into a classifier for an object or person of indeterminate number when supplemented with the prefix *sa-* to *sagelintir*.

Other indicators of number that you will find in volumes IX-XII of *Sĕrat Cĕnthini* are *iris, jodho, ontong, poros, tangkeb*, and *pulukan*. Each of these words has a certain number of indications for an object. As with the word *iris*, which has the meaning of cutting, the indication refers to objects that can be cut with a knife (Sasti, 2017). The term is found in the 541st *pupuh of Sinom*. The excerpt reads: “*Ambungkuk ingkang liningan | sarêng dènnira wiwijik | adan lêkas samya nadhah | Ki Sèh datan kêmbul bukti | namung sairis uwi | lêgi pala kang pinuluk | ingkang samya anadhah | rampadan ulam mawarni | parandene gêrago panadhahira* ||”. The translation is: the guests bow respectfully, after washing their hands, then eating. Seh Sidalaku did not participate in the meal, he only ate one *iris* (slice) of sweet *uwi* (yam) while others eat a rice banquet complete with *lauk pauk* (side dishes), but he was hesitant to eat(Sunan Pakubuwana V, 2018a). The word *jodho* is a word that indicates the number of animals in pairs, namely males and females (Prahmana, 2020).

In Sĕrat Cĕnthini volumes IX-XII, the word *jodho* is found in the 603rd *pupuh of*

Sarkara, stanza 77 to be precisely. The excerpt reads: "*Ragil-kuning tansah anangisi | kang raka cinènèng paningsêtnya | kakang aja anêlame | têka agandrung-gandrung | kapirangu ing prênjak muni | dudu Candrakirana | pinarêpa gandrung | gandrungmu asalah cipta | iku manuk parênjak rong jodho muni | (ng)gantêr nèng kayu teja* ||". The text is translated as: Ragil Kuning always cries on his older brother, pulled by his belt. "*Kanda* (a call for loved men), don't be sad, why are you crazy about the *prenjak* (bar-winged prinia) that is chirping, not with *Candrakirana* even though it is showered with affection. Your love is on the wrong address. Those are two pairs of *prenjak* chirping on the *teja* tree!" (Sunan Pakubuwana V, 2018b). If calculated, the number of birds is 4, namely 2 males and 2 females. Furthermore, the word *ontong* is a term that indicates the amount of corn (Prahmana, 2020). This is presented in the 581st *pupuh of Pocung*. The excerpt reads: *Amanipun cèlèng kang angungsir tandur | sarat uncêt wadhang | kêlawan têrasi abrit | jagung saontong pinêndhêm ing tulakan ||". The translation is: in farming, the pest is a wild boar, so the prepare a putrid *uncet* (the cone-shaped rice) with red shrimp paste, and a buried corn cob (Sunan Pakubuwana V, 2018a). The meaning of *saontong* refers to corn, which is translated as one piece of corn (Prahmana, 2020).

There is also the word *poros* which refers to the number or size of betel leaves (Prahmana, 2020).. The use of the word is depicted in *Serat Centhini* volumes IX-XII of 518th *pupuh* of *Jurudêmung*, The excerpt reads: "*Pinêndir sadangunira | sêmangsa lamun dinulu | ni lanjar gorèh alungguh | kinang têlung poros têlas | mêksih ngèngèhakên suruh | racikan sêmprit mèngkolan | saosan yèn kêrsa mundhut* ||. The translation of the excerpt reads: they restrain each other for long time, Nyi Lanjar begins to get anxious until she chews 3 pieces of betel leaves until it is crushed. Even so, she still prepares the betel concoction, which she wraps neatly as a reserve for guests who are pleased to have it (Sunan Pakubuwana V, 2018a). Another term indicating the number of things is *tangkep*, which is found in the 538th *pupuh* of *Kinanthi*. The excerpt reads: "*Rong tangkêb binopong ngayun | sinungkên dhatêng Nuripin | puniki dhi (n)dika bêkta | lowung dhinamik [72] nèng margi | gêdhang nulya tinampanan | ngling Allah niki utami ||". The translation of the excerpt reads: two *tangkeb* or two combs of banana was lifted and carried, then given to Nuripin. "here you are, *dhik* (a call for younger loved ones), bring this as a snack on your journey." The banana was then accepted. He then said, "Allah is indeed the Most Merciful." (Sunan Pakubuwana V, 2018a). The word *tangkeb* refers to two objects that are cupped with each other or in the context above, it indicates two hands of bananas that are in one group. So, if it is calculated, the number of bananas in the song is about 20 fingers.

Then, another word that indicates the term measurement of quantity is *pulukan*. *Pulukan* means a mouthful rice (Rhamayanti et al., 2022), this term is shown in the 708th *pupuh of Dhandhanggula*. The excerpt reads "*Ni Wilapa sinambramèng laki | rumangsa yèn kaluputannira | nulya tanduk lir sabêne | kokoh jangan nèng tuwung | lam-ulaman amêratani | cinaruh[38] rab-uraban | sapulukanipun | rong pulukan linut toya | Kae Bayi Panurta ngandika aris | manira yèn tumingal ||". The excerpt reads translated: Ni Wilapa was insinuated by her husband, then added to the meal. Rice, vegetables, fish were stirred together. He drank every two mouthfuls. Ki Bayi Panurta said, "I saw Ni Wilapan eating." (Sunan Pakubuwana V, 2018d).

CONCLUSION

Sĕrat Cĕnthini is a significant cultural artifact that encapsulates various forms of knowledge from 19th-century Javanese society. Among these is a rich system of traditional measurement, reflecting ethnomathematical concepts deeply rooted in daily life. This study identifies 16 Javanese measurement terms found in volumes IX–XII—*sacengkang, lengen, sapungge, ula sawa, kilan, pêcak, sagêgêm, glintir, sairis, jodho, sakêpêl, saklêmuk, saontong, poros, pulukan,* and *tangkeb*. These terms illustrate the ways in which measurement practices were linguistically and culturally embedded, offering insights from mathematical, historical, linguistic, and cultural perspectives.

This research further demonstrates the potential of traditional knowledge to inform contemporary pedagogy. Incorporating indigenous measurement systems into school curricula can enhance students' mathematical literacy while fostering cultural identity and appreciation. As shown by Meeran et al. (2024), integrating traditional games and units can significantly boost learner engagement and contextual understanding. Regular use of terms such as *kilan* and *sakêpêl* in rural markets underscores their ongoing relevance and appropriateness for educational strategies in ethnomathematics. This study thus supports the inclusion of culturally grounded content in mathematics education, contributing to both heritage preservation and curriculum innovation.

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