

Project Report

Metrological Traditions of South India*

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Abstract

Accurate measurement across the landscape was an important concern from the medieval period, when state formation took place in South India. The measurement scales of medieval period marked in Tamil Nadu have largely been ignored so far and detailed studies are lacking. Hence, the current research on the *Metrological Traditions of South India* was undertaken to fulfill this gap, and it focuses on the linear measurement system used in South India, more particularly, the region of Tamil Nadu from about 500 AD to 1500 AD. The objectives are to explain the variations in the use of spatial measurements in space and time and to analyze the pattern of standardization of spatial (linear and area) measurements in the region of Tamil Nadu. To collect empirical data, temples and archaeological sites in Tamil Nadu were surveyed and the medieval inscriptions were scrutinized. Twenty-five new measurement scales were identified during the surveys and the results of the study is discussed in this report.

1. INTRODUCTION

A Tamil Proverb says, “God has given a measured tail to goat”. Goat has shorter tail compared to many other animals, and the above-mentioned Tamil proverb, implies that God has given each creature what it needs or deserves. It appears that the size of many particles and organisms in nature is determined by nature itself within a particular range. The attributes of measurement and symmetry might have ornamental and functional values. The ancient measurement systems are often found to be based on natural and human body-parts.

In India, evidence for the use of a measurement system is found from the time of the Indus civilization, i.e. from ca 3000 BC (Danino, 2005, 2008; Balasubramanian and Joshi, 2008). Ancient texts such as the *Śulbasūtra* (Sen and Bag, 1983), *Arthaśāstra* (Kangle 1968), and architectural treatises mention about the

measurement units that were used in ancient India, and many of these measurement units have the names of human body-parts.

Numerous references to measurement rods are found in the inscriptions of medieval period in South India (Shanmugam, 1987; Subbarayalu, 2001; Shanmugam, 2006). State formation and intense architectural activities (especially temple building and carving of rock cut caves) began in South India, mainly from the middle of the first millennium AD. In the early medieval period (from c. 6th century AD), numerous rock-cut temples were carved in the rocks and hills, and later on from the early eighth century AD, structural buildings were constructed using stone blocks. The medieval structures which are generally datable to c. 7th to c. 15th century AD were built with specific schemes and plans. With the formation of the state system and expansion of agriculture in the medieval period, there was a necessity for

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measuring the lands accurately for sale transactions and tax calculation. It appears that there were attempts at standardization of measurements in the medieval period. Numerous references are found in the inscriptions to spatial measurement units such as *muntrikai* (1/320), *kuzhi* (one square rod), *kaani* (1/80), *maa* (1/20) and *veli*, and the measurement rods (*kol* in Tamil or *danda* in Sanskrit) that were used for land measurements. The measurement rods are marked at several places on temple walls and rocks in the countryside in order to help people to use them as standards for periodically checking the wooden measurement rods that they used for ground survey in the fields. However, the nature of the measurement rods used for land measurement, for the construction of temples and many other structures has not been studied in detail and the information found in various source categories has not been correlated. The studies on temples often analyse their measurements using modern metric measures and they rarely correlate the measurements of traditional structures with traditional measurement system. The study on the Metrological Traditions of South India, which was undertaken to fulfill this gap, focuses on the linear measurement system used in South India, more particularly, the region of Tamil Nadu from about 500 AD to 1500 AD. In the area of archaeology, very little research has been carried out on the cognitive aspects of ancient communities of India in general and South India in particular. This work, which is a part of cognitive archaeological research, seeks to systematically investigate the spatial measurement units used by the people in South India in the early medieval period.

The research project aims is to explain the variations in the use of spatial measurements in space and time, i.e. to analyze the regional and chronological variation in the use of spatial measurement units and to analyze the pattern of standardization of spatial (linear and area) measurements. The report of the research is

presented in two parts. The first part deals with the various themes related to land measurement in South India, discussions and conclusions. The second part provides the dataset that was collected and documented from primary and secondary sources.

Part I has six chapters

1. Introduction,
2. Study of Architectural Sites
3. Study of Measurement Rods
4. Study of Epigraphical Records
5. Study of Ethnographic Information
6. Conclusions

Part II containing three appendices have been provided for supplying the source information and additional data. Appendix 1 containing epigraphical information on measurement rods gives the data collected from the Tamil inscriptions on measurement rods and scales. Appendix 2 has architectural data collected on the temples and medieval structures of Tamil Nadu and Appendix 3, measurement rods from Tamil Nadu, presents the data on actual measurement rods and scales marked on the temples and rocks. It also includes the data on newly identified measurement rods.

2. DISCUSSIONS

2.1 Methods

Survey of texts: The literature published on the Medieval Tamil Nadu and measurement rods was surveyed. The inscriptions discussed in various publications were studied and analyzed. The journals on inscriptions such as *South Indian Inscriptions* (30 Volumes, New Delhi, Archaeological Survey of India), *Annual Report on Indian Epigraphy*, New Delhi, Archaeological Survey of India; *Avanam*, Journal of Tamil Nadu Archaeological Society and *Varalaaru*, Journal of

Rajamanikkanar Historical Research Centre, were analyzed.

Field Research: Field studies were undertaken in several regions of Tamil Nadu for documenting archaeological, architectural and epigraphical information. The research method involved here includes, the study of the architectural plans of the temples. Measurement of the dimensions of various temple structures of the medieval period was undertaken to understand the units of measurements used in the design and construction of structures. For this purpose a few sites were selected for the study (Fig. 1). The temple parts were measured with tape and also with the Disto tool. During the study we found that many of the temples have strict rules related to conducting research, and permission was necessary from several agencies and we had to make more than one trip to the temples to obtain permission and also appointment to undertake measurements. In many temples it was difficult to access the inner areas for photography and for the preparation of the top plans. Wherever necessary, plan of the

temples were prepared and existing data on the ancient temples were checked on the ground to find out their authenticity. From the initial study, it was felt that the temples presented more varied patterns and hence, the focus of the study was equally placed on locating the measurement rods marked on the temples.

Field archaeological study was conducted for locating the evidence related to the measurement rods. The surfaces of the temples were searched with naked eye to locate the marking of measurement rods. Four sites were proposed for the study of measurement rods (Idayalam, Lalgudi, Thirupputkuzhi and Thirukkoyalur) during the initial stage of the project; and the survey suggested the presence of more number of measurement rods and therefore more than 75 archaeological sites were visited to document the measurement rods, in addition to the temples that were surveyed as part of architectural study. Under ethnographic study interviews were made with *sthapathi* for understanding the traditional measures used by the

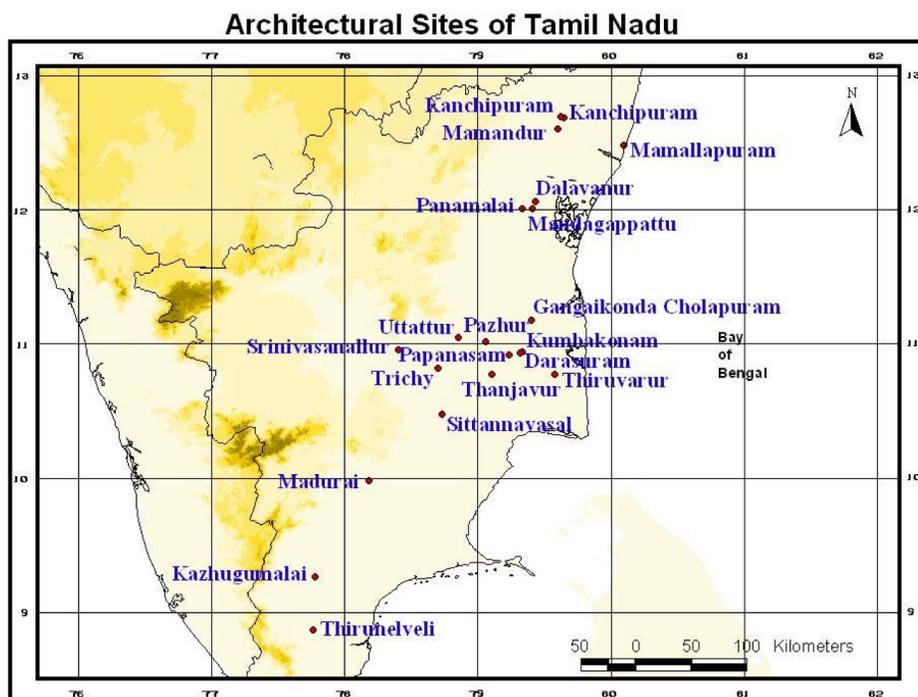


Fig. 1. Select temples of Tamil Nadu for Architectural Study

contemporary architects and certain fields from Thanjavur region were measured to understand their relationships with ancient measurement system.

2.2 Data Analysis

The data was analyzed from two approaches from *apriori* perspective without any preconceived notions.

Etic approach

The term *etic* represents outsider's perspectives. This can be equated to *apriori* approach to material culture. Without any preconceived notion, this analysis was undertaken. Here the medieval rods and their measurements were analyzed from an empirical approach without being influenced by any outside references in the texts, inscriptions and other published materials. From the discussions with many scholars, it was realized that looking at the data independent of *Arthaśāstra* or other architectural treatises was very important. When we discuss and correlate the textual reference for understanding ancient measurements, it confuses and preconceived assumption gets into the scenario. Hence, at one level this type of analysis was adopted.

Emic Approach

The emic approach is about viewing data from insider's perspective; here it involved "Indian or native perspective" represented in the ancient texts. Here the evidence from the ancient texts is used and the *angulam* measurement is equated. In the case of architectural parts the use of emic approach was adopted, since most of the temples were built according to the traditional measurement system.

Issues

While undertaking the survey in the temples we had to approach several authorities.

Accessing the temple *garbhagriha*, inner *prakara* and certain other areas was restricted. Hence we had to depend upon the published data on measurements and plans. We took measurement of *gopurams* and the enclosures in many of the temples. Many of the temples have been renovated several times and as a result the stones have been shifted and placed in different areas, and as a result the measurement marks have been dislocated. Due to this factor, in numerous instances we could document only one + mark and its corresponding mark has been lost. Interpreting the meaning of the markings in the temple was difficult. Not all the measurement rods marked on the temple were meant for land measuring. Sometimes marks have been placed to convey the position where the pillars had to be placed and they indicate that placing of the pillars and other members was determined by certain uniform measurements. Some of the natural rocks that have the measurement rods have been destroyed due to quarrying activities.

3. SUMMARY OF THE WORK UNDERTAKEN:

Under this project, 15000 inscriptions have been scrutinised to collect data on the measurement rods, more than 100 archaeological and temple sites have been surveyed to identify the measurement rods, twenty-five architectural sites have been surveyed and studied to understand the measurement units, references to more than 270 measurement rods/scales have been identified from the inscriptions. Fifty measurement rods have been documented and twenty five new measurement rods have been identified (Table 1).

3.1 Inferences

Analysis of different scales and rods marked in the temples reveals that different categories of Muzham (two *span* or *Vitasti*) can be observed as shown in the table 2.

Table 1. Newly Identified/Documented Measurement Rods/Scales (*Kols* or *Dandas*) in Tamil Nadu (Fig. nos. correspond to the measuring scales mentioned after the table)

Sl No	Village	Location of Measurement Rod/Scale	District	Length of the Kol in cm	Remarks	Figure Number
1	Thirumanikuzhi	On the northwest side of the <i>prakara</i> of the Vanapurisvarar temple	Cuddalore	230 cm	With a division separating 120 cm and 110 cm units (Perhaps re-modified after reconstruction of the temple)	Fig. 2
2	Thirumanikuzhi	On the northwest side of the <i>prakaara</i> of the Vanapurisvarar temple	Cuddalore	52 cm	One end is marked with a trident like mark (Perhaps re-modified after reconstruction of the temple)	Fig. 3
3	Thirumanikuzhi	On the northwest side of the <i>prakara</i> of the Vanapurisvarar temple	Cuddalore	359 cm	With three Divisions (102 cm each) and has wall at the other end. The mark on one side might have been disappeared	Fig. 4
4	Thiruvamattur	Abhiramesvarar temple	Villupuram	419.5cm	Divisions with subunits of 208.5 cm , 105 cm and 106 cm	Fig.5
5	Thiruvamattur	Abhirameshvarar temple of sanctum, inner enclosure wall	Villupuram	423 cm	-	Fig. 6
7	Thiruvamattur	On the north <i>adhistana</i> the back entrance of the west <i>gopura</i> Abhirameshvarar temple	Villupuram	167 cm	Divisions marked indicate subunits of 82 cm and 85 cm.	Fig.7
6	Thiruvamattur	On the south c (the back entrance) of the west <i>gopura</i> Abhirameshvarar temple	Villupuram	167 cm	Divisions marked indicate subunits of 82 cm and 85 cm.	Fig. 8
8	Thiruvamattur	Abhirameshvarar temple outside wall of the north side	Villupuram	327 cm	Divisions marked with subunits of 164 cm and 163 cm	Fig. 9
9	Thiruvannainallur	Kirubapurishvarar temple, Main <i>gopura</i> outside the Enclosure wall, in the south side <i>adhistana</i>	Villupuram	200 cm	Divisions marked indicate subunits of 50 cm, 50 cm and 100 cm	Fig.10

SI No	Village	Location of Measurement Rod/Scale	District	Length of the Kol in cm	Remarks	Figure Number
10	Thiruvonnainallur	Kirubapurishvarar temple - <i>mandapa</i> north wall	Villupuram	640 cm	Divisions marked indicate subunits of 261 cm, 56 cm and 323 cm	Fig. 11
11	Thiruvonnainallur	Kirubapurishvarar temple of precinct east side	Villupuram	359 cm	Divisions marked indicate subunits of 162 cm, 81 cm and 116.5 cm	Fig. 12
12	Thiruvonnainallur	Kirubapurishvarar temple of precinct north side	Villupuram	752 cm	-	Fig. 13
13	Thiruvakkarai	Chandramoulisvarar temple	Villupuram	362.5cm	-	Fig. 14
14	Kanchipuram	Varadarajaperumal temple <i>abhiægamandapa</i> west of north side	Kanchipuram	189 cm	-	Fig. 15
15	Kanchipuram	Varadarajaperumal temple <i>abhiægamandapa</i> west of south side	Kanchipuram	152 cm	Divisions marked indicate subunits of ca. 22.75 cm, 22.75 cm, 22.75 cm, 22.75 cm and 61 cm (with Tamil inscription reading "Taccamuzham" which means "Architect's scale", reported earlier)	Fig. 16
16	Thirumaharal	Sri Thirumaharalishvarar temple of sanctum back side	Kanchipuram	312 cm	Divisions marked indicate subunits of 38.5 cm, 77 cm and 156.5 cm	Fig. 17
17	Uthramerur	Sri Viyakrapurishvarar temple of sanctum back side	Kanchipuram	207 cm	Divisions marked indicate subunits of 104 cm, 52 cm and 52 cm	Fig. 18
18	Thirukkazhukundram	Vedakirishwarar temple of back side	Kanchipuram	694 cm	Damaged?	Fig. 19
19	Thirukkazhukundram	Vedakirishwarar temple of second entrance <i>gopura</i> south side	Kanchipuram	404 cm	Divisions marked to mark subunits of 363 + 41?	Damaged?

Sl No	Village	Location of Measurement Rod/Scale	District	Length of the Kol in cm	Remarks	Figure Number
20	Keezhakuruchi	Siva temple of entrance of Mukamandapa side	Pudukkottai	89 cm	-	Fig. 20
21	Viralimalai	Siva temple of front <i>gopura</i> Shrine facing side of the Adhistana of the northern unit.	Pudukkottai	74 cm	It has divisions of 2, 10, 2, 18 and 42 cms.	Fig. 21
22	Kodumpalur	On the <i>muppattai</i> (<i>tripattakumuta</i>) of the <i>adhistana</i> of the Amman shrine in the Mukundesvara temple	Pudukkottai	25.5 cm	Indicates a span unit	Fig. 22
23	Kodumpalur	On the north side of the <i>mukamandapa</i> of the Mukundesvara temple	Pudukkottai	78 cm	It has divisions of 54, 12 and 12 cms	Fig. 23
24	Thiruvandarkoil	On the north side of the <i>mahamandapa</i> of the Sri TripurasundariS ametha Sri Panjanathisvara temple	Pondicherry State	694 cm	-	Fig. 24
25	Thiruvattar	On the entrance of the Aathikesavaperumal temple	Kanniya-kumari	220 cm	-	Fig. 25
26	Thanjavur	On the northern side <i>adhistana</i> of the <i>mahamandapa</i> of the Brihadhiswara temple	Thanjavur	276.7		Fig. 26

Figs. 2-26

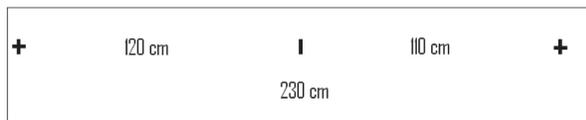


Fig. 2. Measurement Rod from Thirumanikuzhi



Fig. 3. Measurement Rod from Thirumanikuzhi (Perhaps re-modified after reconstruction of the temple)



Fig. 4. Measurement rod from Thirumanikkuzhi (Perhaps re-modified after reconstruction of the temple)

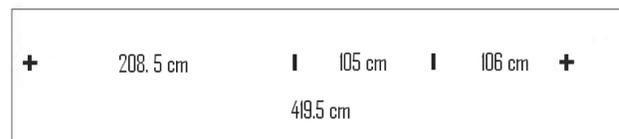


Fig. 5. measurement rod from Thiruvamattur



Fig. 6. Measurement rod from Thiruvamattur

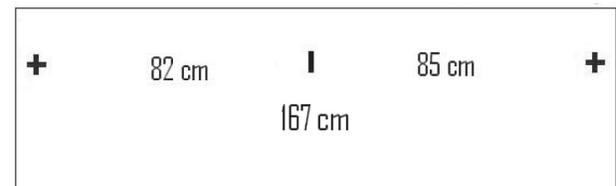


Fig. 7. Measurement rod from Thiruvamattur

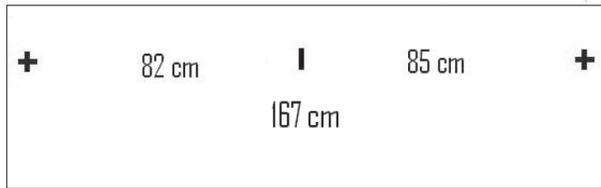


Fig. 8. Measurement rod from Thiruvamattur

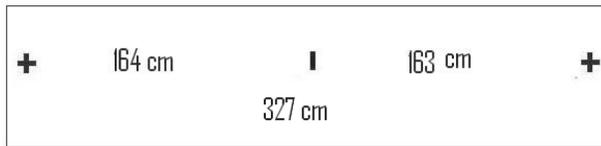


Fig. 9. Measurement rod from Thiruvamattur



Fig. 10. Measurement rod from Thiruvannainallur

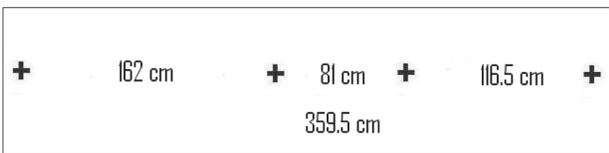


Fig. 11. Measurement rod from Thiruvannainallur

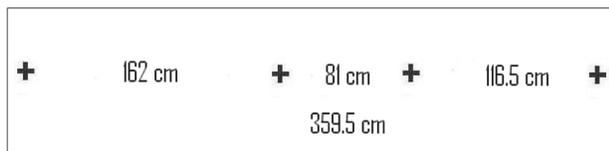


Fig. 12. Measurement Rod from Thiruvannainallur



Fig. 13. Measurement Rod from Thiruvannainallur



Fig. 14. Measurement Rod from Thiruvakkarai



Fig. 15. Measurement Rod from Kanchipuram

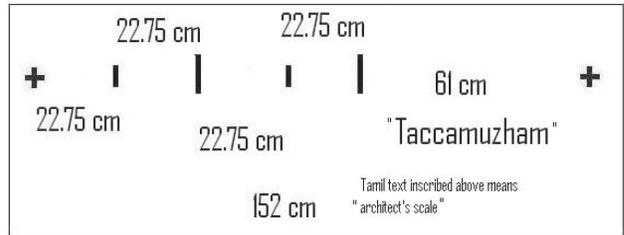


Fig. 16. Measurement Rod from Kanchipuram

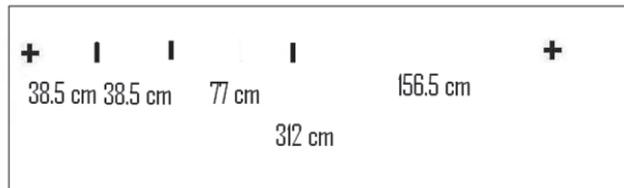


Fig. 17. Measurement Rod from Thirumaharal



Fig. 18. Measurement rod from Uttiramerur

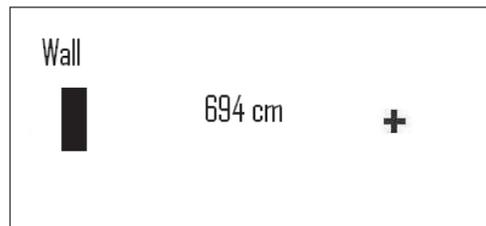


Fig. 19. Measurement rod from Thirukazhukunram

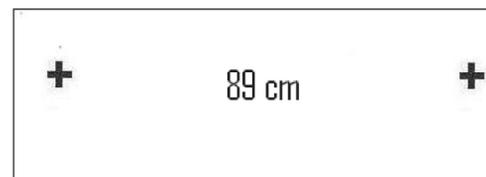


Fig. 20. Measurement Rod from Keezhakurichi

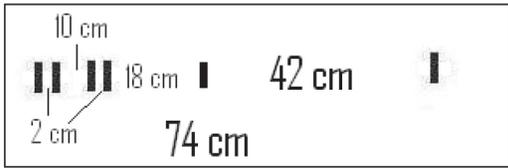


Fig. 21. Measurement Rod from Viralimalalai



Fig. 22. Measurement scale from Kodumpalur

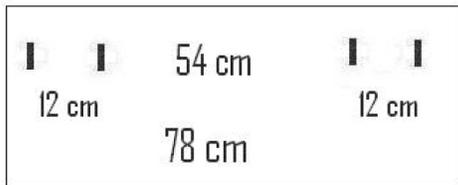


Fig. 23. Measurement scale from Kodumpalur

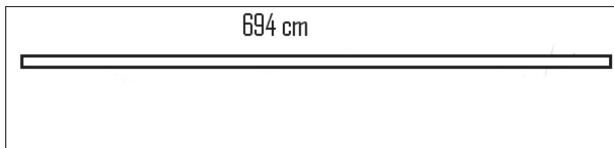


Fig. 24. Measurement Rod from Thiruvandarkovil



Fig. 25. Measurement Rod from Thiruvattar



Fig. 26. Measurement rod from Brihadhiswara temple, Thanjavur

Table 2. Possible smaller units of measurements represented in the scales/rods marked in Tamil Nadu

Sl. No.	Span or <i>Caan</i> or <i>Vitasti</i> (cm)	Cubit or <i>Muzham</i> or <i>Hashta</i> (cm)
1	18.5	37
2	20.5 to 21.25	41 to 42.5
3	22.5 to 27.5	45 to 45.5
4	23.625 to 23.75	47.25 to 47.5
5	24.5 to 50	49 to 50
6	25.5 to 26.25	51 to 52.5
7	27	54
8	30.5	61

is found in the marking of the rods or scales. Perhaps they must have done the marking using a wooden scale and the error might have come due to the error in the original scale or due to lack of accuracy while marking on the walls. The above table reveals that at least eight basic units of measurements were used in Tamil Nadu. It seems that body-part measurements were independently taken by the people for devising the scales/rods.

Because of lack of inscriptions it is not possible to accurately date the measurement rods. Their date perhaps varies from tenth century to 20th century AD and they comprise measurement rods used for land measurement and architectural measurement.

Interestingly, some of the measurement rods match with the three types of *hashtas* suggested by Balasubramanian (2009) which fall in the range of 42 cm, 49 cm and 95 cm. The *Arthaśāstra* perhaps attempted to standardize the measurement scales based on the prevailing conventions. However in reality people were using different types of scales all over India, till the arrival of the British. Even the arrival of the new kingdoms could not completely replace the old scales or rods since it was an impossible task in the medieval period, considering the nature and perception of administration. The reasons for this are understandable as the Indian states and agencies gave space for diversity and they did not

The marking of the scales/rods found in various localities in Tamil Nadu indicates a lack of accuracy. Sometimes an error of 1 cm to 3 cm

want to or spend efforts to maintain uniformity all across the regions of their control.

The lack of accuracy of measurement rods could be attributed to the changes in the structures of the temples due to the ravages of time and reconstructions. The measurement rods marked on the rocks and single large stones are stable.

4. CONCLUSIONS

The findings and conclusions of the research are listed below.

- From the study, it is certain that well developed measurement scales were used in Tamil Nadu from the Medieval period (from ca. 6th century AD). While in the early historic period (3rd century BC to 3rd century AD), the use of measurement scales was limited. The extensive use of measurement scales in the medieval period could be attributed to the formation of states, the emergence of proper land administration and taxation measures in the Medieval period. The above observation proves that the medieval state was comparatively well organized.
- Measurement rods were integral part of medieval land administration. However, there was no attempt to introduce a uniform type of measurement rods or system all over the territory in the medieval period. The central political administration could not and probably did not want to standardize the measurement system and each region was allowed to use its own (local) measurement system. While certain measurement rods were in use for a long duration, a few of the measurement rods underwent modification in the later period. The measurement rods of “16 spans” appear to have been very popular, as it has more occurrences. The presence of numerous measurement rods suggests that land measurement was not standardized during the time of Rajaraja I or other Chola kings as claimed by researchers, although there was a limited attempt to standardize the measurements. The Chola monarch, especially Rajaraja I and Rajendra I could standardize the measurement rods only to a limited extent, which suggest that the medieval states were not as totalitarian as the modern states and they had allowed the local traditions and rules to some extent.
- The size of the *aṅgulam* used in medieval Tamil Nadu in some contexts matches with the basic *aṅgulam* measurement of 1.76 cm suggested by Balasubramaniam (2008). However, in several cases the measurement does not match with the standards suggested by *Arthaśāstra*. There existed *aṅgulams* of different types from those discussed by *Arthaśāstra*.
- The length of traditional *aṅgulam* cannot be stated to be very accurately, and it was not uniform. A variation of 1.70 to 1.90 cm could be suggested for one type of *aṅgulam* and its average may fall around 1.75 cm. This may be treated as a basic *aṅgulam*. There were several other varieties of *aṅgulam* measurements that were derived from the combination of the basic *aṅgulam* measurement.
- Several varieties of rods were used by the kings and the local administration. This was probably for different purposes. Different types of measurement rods were used for dry lands and wet lands, in some contexts. The use of variety of rods was necessitated by the variation in the production of the land.
- A vast variety of measurement rods were used during the medieval times and they vary from four *piti* (bow-grip) to 24 *ati* (foot) in length in traditional scale. In the later period measurement rods of 54 foot were also used. Some of the scales were used for construction activities.

- There was a gradual increase in the size of the measurement rods from the early Medieval to Later Medieval period. The precise reason for the increase of the rod is not known. Perhaps, it could be for faster measurement of land, as more lands were brought under cultivation.
 - The *Arthaśāstra* standard was used in the land measurement of the Cholas in a few contexts. However, several measurement rods differ greatly from the *Arthaśāstra* standard
 - In the land area units, both decimal and binary based systems were used. Sometimes units of 100, 1000 are met with. In some cases 128, 256 and 512 units (*kuzhi*) are seen. These types of units are because of the measurement in multiplication of 8 or 16.
 - The kings asserted their political power by giving their names to the measurement rods (e.g. Ulagalanthankol, in the later context, Rayavibhadan kol, Kandara Kandan kol), for gaining symbolic power and authority over the subjects and territory.
 - From the architectural survey, we do notice variation in the use of measurement units. Not much uniformity is seen and it appears that each temple was designed according to different *muzham*(cubit) unit and sometimes the units were based on the *danda* of 82 to 84 cm in length. In the size of *aṅgulam* too we notice variations.
 - Another important issue is the inaccuracy in the execution of measurements in various temples. Although the planners might have come up with accurate designs, the artists who executed did make some mistakes. However, in the case of Brihadhiswara temple we notice some degree of standardization.
 - The ethnographic information on human body parts indicates a huge diversity in the measurement units. Therefore, it cannot be argued that *aṅgulam* had a standard measure.
- However, there have been attempts to standardize *aṅgulam* and it is reflected in the case of some measurement rods.
- The data from the contemporary agricultural fields reveal that the fields were laid out according to a scale. It is likely that in the medieval period, fields were formed according to a measured scale in order to have specific units and this is attested by the evidence from the inscriptions.
 - The measurement rods are distributed mainly in the Kaveri valley and in the northern Tamil Nadu and this could be attributed to the intensity of wet cultivation undertaken in these regions.
 - In terms of size, the smallest measurement scale measures 25.5 cm and the longest measurement scale is 697 cm in length.
 - The measurement rods of early Medieval period are smaller in size, generally less than 400 cm in length. Post-14th century, their length increases and it could be attributed to the changes in the taxation system. Perhaps to reduce the time taken for measurement of vast areas of land they might have adopted such long scale rods.
 - The field survey indicates that the measurement rods were marked only on certain temples which were regionally important. For example, in the medieval period, there were certain centers that functioned as headquarters of the administrative division of *naatu* (which can be compared to modern taluk in the administrative hierarchy). These centers have the temples, which were sung by saints as part of the Bhakti movement (called Devāram temples). From this research, we learn that temples in such towns with higher administrative status have markings of such measurement rods.

- Apart from the measurement rods, several games related markings and other unknown marks are engraved or carved on the temples. They were also documented during the survey.
- The traditional units of fraction used in the ancient inscriptions are interesting and important (e.g. *maa*, *munirikai* 1/320) and they can be taught in the schools.

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