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The Scale of Accounting: An Examination of High-Volume Numerical Records in Proto-Elamite Tablets from Susa hosted in Iran National Museum

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Abstract

This article presents an in-depth analysis of four Proto-Elamite tablets, housed in the Iran National Museum, specifically chosen for their demonstrably high-volume numerical entries. The selection of these tablets offers a unique opportunity to investigate the scale of commodity accounting within the proto-urban center of Susa, a pivotal site in the study of early complex community. The research delves into the intricate numerical signs and systems employed by Proto-Elamite scribes to record these substantial quantities, with a particular focus on the application and interplay of the Sexagesimal (S), Decimal (D), Bisexagesimal (B and B#), and Capacity (C, C#, and C") systems. The analysis reveals a sophisticated administrative apparatus that was not only capable of managing but also meticulously recording significant quantities of goods. These goods encompassed a wide range of resources crucial to the functioning of the proto-urban center, including various types of grains, which formed the basis of the region's agricultural economy, the accounting of human laborers, who constituted a vital part of the workforce, and potentially rations, indicating a system of distribution and resource allocation. The presence of such high-volume data within these tablets provides invaluable insights into the economic complexity of Susa during this period. It underscores the scale of resource management, the existence of well-organized distribution networks, and the potential reach of trade connections that extended beyond the immediate vicinity of Susa. While the Proto-Elamite numerical signs exhibit a distinct visual style when compared to their Mesopotamian counterparts, reflecting a unique cultural and scribal tradition, the overarching emphasis on large-scale quantification highlights a shared concern for efficient and accurate accounting practices. This focus on meticulous record-keeping was essential for the management of surplus production, the organization of labor, and the maintenance of economic stability within the developing center. This study emphasizes the significance of undertaking a detailed analysis of the numerical data contained within these four tablets. By doing so, it becomes possible to reconstruct, at least in part, the scale of commodity counting and its profound implications for Proto-Elamite economic and administrative practices.

Keywords: Proto Elamite, Susa, Administration, High- Volume tablets, Commercial Hub.

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Introduction

The Proto-Elamite period, blossoming in Susa during the late fourth millennium BCE (Yousefi *et al.,* 2025), left behind a significant corpus of clay tablets inscribed with a unique, largely undeciphered scripts[1] (Le Burn& Vallat, 1978; Vallat,1971; Vallat, 1973; Vallat, 1985). Among these, tablets exhibiting high-volume numerical entries offer invaluable insights into the administrative and economic practices of this early complex society (Etemadifar & Yousefi, 2024). As demonstrated by the numerical signs depicted, their administrative system employed a sophisticated approach to quantitative record-keeping, utilizing a suite of specialized systems tailored to diverse commodities (Desset, 2016). The sexagesimal system (S), mirroring later Babylonian practices, facilitated the enumeration of inanimate objects, showcasing their capacity for handling large numerical values (Friberg, 1994;2019; Damerow, 2006). In contrast, the decimal system (D) was reserved for animate beings, specifically domesticated animals and human laborers, reflecting a distinct method for quantifying living resources (Friberg, 1978; 1999). Furthermore, the bisexagesimal systems (B and B#), dedicated to grain products and potential rationing, and the capacity systems (C, C#, and C"), used for measuring grain, underscore the importance of precise agricultural accounting (Scheil, 1923; Friberg, 2019).

The existence of these diverse numerical systems, coupled with the presence of signs denoting high numerical values (e.g., "3,600," "600" in the sexagesimal system), (e.g., "10,000," "1000" in the decimal system) and (e.g., "1200" "120" in the bisexagesimal system) points to a highly organized administrative structure and a developed economy capable of managing substantial resources. Such large-scale accounting implies complex administrative operations, including the distribution of goods, the organization of labor forces, and the tracking of agricultural yields, vital for a complex economical center like Susa. Given Susa's strategic location, it likely functioned as a pivotal commercial hub, facilitating the exchange of goods between the sedentary agricultural societies of southern Iran and the pastoral nomads of the Iranian highlands (Yousefi *et al.,* 2025). As Alden (1982) and Potts (1999) discuss, the Proto-Elamite tablets, particularly those with high-volume numerical data, provide critical evidence of such trade, with the diverse numerical systems reflecting the varied commodities exchanged and the standardized units and large numerical values suggesting organized trade networks and administrative oversight.

This article posits that a comprehensive analysis of the high-volume numerical data contained within four selected Proto-Elamite tablets from Susa hosted in Iran National Museum will yield critical insights into the scale and complexity of their administrative and economic practices. The sheer volume of numerical data inscribed on these tablets presents a unique challenge, requiring meticulous analysis and innovative methodological approaches. The methodology involves a quantitative analysis of the numerical signs and their associated values, focusing on the four selected tablets. We will explore the implications of these numerical records for understanding Proto-Elamite administrative and economic practices, specifically focusing on the scale of resource management and distribution.

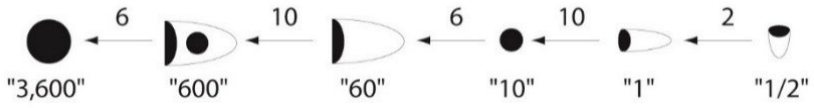
Deciphering the Proto-Elamite Numerical System

The Proto-Elamite numerical system, as evidenced by the corpus of numerical signs found on tablets primarily from Susa, presents a complex and multi-faceted structure (Dahl, 2005; Hessari & Yousefi, 2023). This part aims to provide a comprehensive analysis of this system to elucidate its intricacies and implications for understanding Proto-Elamite administrative and economic practices. The numerical signs, as depicted in the below images, reveal a sophisticated approach to quantification, with multiple systems employed for diverse commodities. The Proto-Elamite scribes did not utilize a singular numerical framework. Instead, they employed a suite of distinct systems, each tailored to specific categories of counted items (Desset, 2016; Englund, 1998). This differentiation suggests a highly organized administrative structure and a nuanced understanding of quantification.

Sexagesimal System (S)

Advancements in decipherment have significantly clarified the role of the sexagesimal system (S) in Proto-Cuneiform and Proto-Elamite accounting (Friberg, 1978; Nissen, 1986; Nissen *et al.,* 1990; 1993; Englund, 1998; 2004; 2011). This system, as depicted in the Figure 1, was primarily employed for counting discrete inanimate objects, encompassing a wide range of commodities (Nissen *et al.,* 1991; Damerow, 2006). The numerical signs reveal a sophisticated capacity for handling large quantities, with values such as “3,600,” and “600,” indicating a complex administrative framework capable of managing substantial resource flows. This bears a resemblance to the later Babylonian sexagesimal system, suggesting a potential shared origin or influence, although crucial differences highlight

the independent development of Proto-Elamite numerical practices (Friberg, 1978). The objects counted using the sexagesimal system (S) likely included a variety of bulk commodities and manufactured goods as grains and other agricultural products defined as large quantities of stored or distributed grain, as distinct from the capacity measurements in system C, could be recorded using this system (Friberg, 1978; Nissen, 1986; Nissen *et al.,* 1993). Given the importance of textile production in early urban centers, fabrics or finished garments could have been quantified using these units (Friberg, 1978). Metal tools, pottery, or other manufactured items might have been recorded in large numbers, particularly if they were being distributed or stored centrally (Nissen *et al.,* 1993). Quantities of raw materials such as wood, stone, or metal might have been tallied using the sexagesimal system, especially if they were being traded or distributed. The signs themselves, as visualized in the image, represent distinct numerical values. Understanding their meaning is crucial for interpreting the tablets. For example, the sign representing "3,600" implies a high level of administrative organization capable of tracking very large quantities of specific commodities. The presence of the fraction "1/2" also indicates a high level of sophistication (Desset, 2016). It's important to note that while the sexagesimal system shares a numerical base with the Mesopotamian systems, the specific forms of the signs and the ways they were used may have differed. This suggests that while there may have been a common origin or influence, the Proto-Elamite scribes adapted and developed their own unique numerical practices to meet the specific administrative and economic needs of their society (Friberg, 1999; Desset, 2016).



◀ **Fig. 1: Sexagesimal Numerical System (S), (After: Desset, 2016).**

Decimal System (D)

The decimal system (D), employed by Proto-Elamite scribes for enumerating animate objects, specifically domesticated animals and human laborers, stands out as a significant characteristic of their numerical practices (Friberg, 1978). This system, featuring signs representing values like "10,000," "1,000," "100," "10," and "1," indicates a clear conceptual separation between living and non-living resources, a distinction that is not consistently observed in contemporaneous Mesopotamian accounting (Fig. 2). The consistent application of this decimal system across Proto-Elamite communities suggests a standardized administrative practice, reflecting

a degree of societal organization and a focused management of living resources. The meticulous recording of livestock numbers, using decimal notation, implies a systematic approach to animal husbandry, potentially linked to herding, taxation or distribution. Notably, the presence of signs representing “10,000” and “1,000” suggests the ability to manage and account for large herds or labor forces, indicating a sophisticated level of administrative control (Yousefi Zoshk, 2010). Similarly, the enumeration of human laborers, possibly using these larger denominations, suggests organized labor practices, possibly related to large-scale agricultural or animal husbandry. The exclusive use of this decimal system for animate objects within the Proto-Elamite corpus highlights a unique aspect of their socio-economic structures and administrative needs (Desset, 2016). The ability to record such high numbers within the decimal system is crucial. It suggests the Proto-Elamites were not merely counting small groups of animals or laborers, but rather managing significant populations. This capability is indicative of a centralized administration capable of tracking and controlling substantial living resources, potentially for economic, political or social purposes. While the precise reasons for this conceptual separation remain speculative, it is clear that the Proto-Elamites treated animate resources differently from inanimate commodities. This distinction could stem from cultural beliefs, economic priorities, or specific administrative requirements. Further research, including comparative analysis with other early counting systems and a deeper understanding of the Proto-Elamite socio-economic context, is necessary to fully elucidate the significance of this distinctive decimal system.

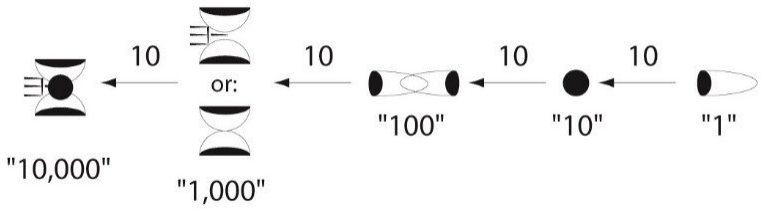
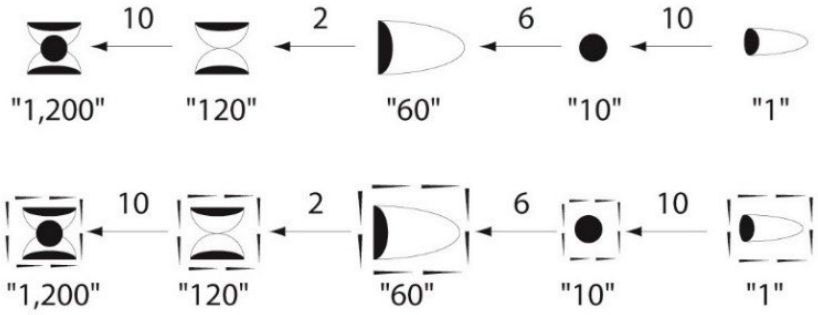


Fig. 2: Decimal Numerical System (D), (After: Desset, 2016). ▶

Bisexagesimal Systems (B and B#)

The bisexagesimal systems (B and B#), as evidenced by the Proto-Elamite tablets, were specifically dedicated to the quantification of grain products (Englund, 2004; Desset, 2016). The base-60 structure, combined with decimal components, indicates a complex system likely used for both large-scale grain accounting and the allocation of rations. These systems reflect the paramount importance of grain as a staple commodity within the Proto-Elamite economy and the necessity for precise distribution to

sustain a growing population. The derivative B# system, while its precise function remains debated, appears to have been employed for counting rations, potentially indicating a structured system of food distribution or labor management. The commodities counted using these bisexagesimal systems (B and B#) likely included barley as given its prevalence in early Mesopotamian and Iranian agriculture, it was likely a primary commodity accounted for using these systems and emmer wheat might also have been quantified using these systems, especially considering the graphical relationship of the C" system to the Mesopotamian emmer measurement system. It might also use for counting flour and other processed grain products as a way to track the distribution of flour, groats, or other processed grain products. The presence of a bisexagesimal system for grain accounting bears similarities to early Mesopotamian practices, where base-60 systems were employed for various commodities, including grain (Friberg, 1984). However, the Proto-Elamite adaptation of this system, particularly the derivative B#, suggests a unique development tailored to their specific administrative needs. The signs within these systems, as shown in the image, illustrate the capacity for precise measurement and accounting. The values "1,200," "120," "60," and "10," along with the unit "1," demonstrate a detailed approach to quantifying grain, suggesting a complex administrative apparatus (Fig. 3). This level of precision would have been essential for managing large-scale storage, distribution, and consumption of grain within Proto-Elamite society.



◀Fig. 3: Bisexagesimal Numerical Systems (B and B#), (After: Desset, 2016).

Capacity Systems (C, C#, and C")

The Capacity Systems (C, C#, and C") represent a crucial component of the Proto-Elamite numerical framework, primarily employed for measuring grain, particularly barley, and, in some cases, bisexagesimally counted cereal products (Friberg, 1978; Desset, 2016). Their widespread use across numerous Proto-Elamite tablets underscores the centrality of agricultural accounting and resource management in this Proto- Urban society (Afshari & Desset, 2022). These systems provide critical insights into the precise

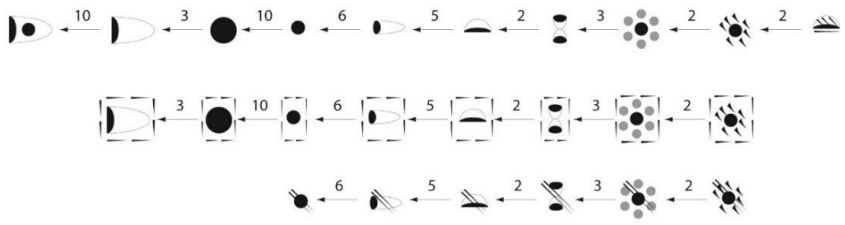
methods used to quantify and distribute grain; a staple commodity vital for sustaining a settled population. The C system, as the primary capacity measure, likely served as the foundation for the derivative C# and C" systems. The C# system, possibly related to the bisexagesimal system B#, may have been employed for specific types of grain measurements or related products, although its precise function remains debated.

The C" system, however, is particularly significant due to its graphical relationship with the Mesopotamian system used to measure emmer (Englund, 2004). This connection suggests potential cultural exchange or shared accounting practices between the Proto-Elamites and their Mesopotamian neighbors. One notable feature of the Capacity Systems is the use of fractions, as seen in the "1/2" sign within the sexagesimal system (S) and implied within the structure of the capacity signs themselves (Englund, 2004; 2011; Desset, 2016). This indicates a sophisticated understanding of measurement and a need for precise quantification, crucial for managing grain stores and distributing rations. The ability to record fractional units would have allowed for detailed accounting of grain volumes, ensuring equitable distribution and efficient resource management. Comparing these systems with Mesopotamian counterparts, we find both similarities and differences. While Mesopotamia also employed capacity measures for grain, the specific forms of the signs and the relationships between the systems may have varied.

The graphical similarity between the Proto-Elamite C" system and the Mesopotamian emmer measurement system suggests a potential shared tradition, but further research is needed to fully understand the nature of this connection (Nissen *et al.,* 1991). The existence of variations within the Capacity Systems (C, C#, and C") likely reflects the nuanced needs of Proto-Elamite agricultural administration. Potential reasons for these variations include different Grain Types, The C, C#, and C" systems might have been used to measure different types of grain or grain products. For example, C could have been used for barley, while C" was specifically for emmer, as indicated by its Mesopotamian connection. The variations might represent different units of measurement, reflecting regional differences or specific administrative requirements. This would allow for a more granular approach to accounting. The systems could have been used in different contexts, such as storage, distribution, or taxation.

The C# system, for example, might have been used for rationing, while C was used for larger storage measurements. The variations might also represent an evolution of the capacity measurement system over time,

with new systems being introduced or adapted to meet changing needs. The C# system, being related to the Bisexagesimal system B#, could indicate a bridge between the two systems, and a specialized function, in relation to grain-based rations, or other specialized goods. The meticulous recording of grain volumes using these systems highlights the importance of agricultural surplus in Proto-Elamite society and the need for efficient administrative control.



◀**Fig. 4: Capacity Numerical Systems (C, C#, and C"), (After: Desset, 2016).**

This section presents a detailed analysis of four Proto-Elamite clay tablets, originating from Susa, selected for their demonstrably high-scale numerical records. These tablets, pivotal administrative documents dating to approximately 3100-2900 BC, offer a unique opportunity to explore the scale of commodity management and distribution in this Proto-Urban context. By examining the numerical signs and their associated values inscribed upon these tablets, we aim to elucidate the quantitative methods employed by Proto-Elamite scribes and gain insights into the economic and administrative practices of this period.

MDP 26 Corpus

The initial excavations pertaining to the Proto-Elamite period in Susa were conducted by Jacques de Morgan (De Morgan, 1900: 52). Following the commencement of his excavations, numerous Proto-Elamite tablets were discovered. Subsequently, in 1905, de Morgan and Scheil published the first corpus of these tablets, comprising 198 specimens, within a volume of the "Mémoires de la Délégation en Perse" (MDP.6) under the auspices of the Louvre Museum. This publication also included 989 illustrations of "sign-glyphs" or "ideograms," along with their variants, under the heading "Proto-Elamite" (Scheil, 1905).

In subsequent years, from (1907 to 1923), a substantial number of tablets were unearthed from both the northern and southern sectors of the Susa acropole. This led to the publication of a collection containing 490 tablets in MDP.17 in 1923 (Scheil, 1923). Until this time, all Proto-Elamite tablets were transferred to the Louvre Museum. However, following a new agreement between the governments of Iran and France in 1927, all

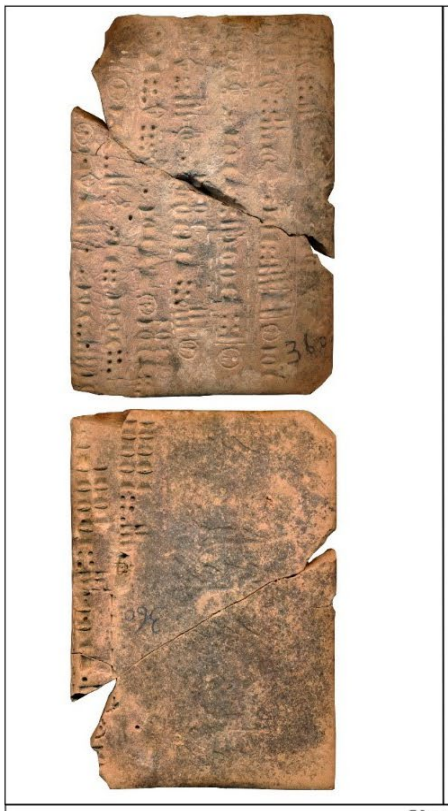
subsequent finds were divided equally between Iran and France (Dahl, 2013). The tablets that came into the possession of the Iranian government and the National Museum of Iran were published in a volume titled "MDP 26" in 1935 (Scheil, 1935).

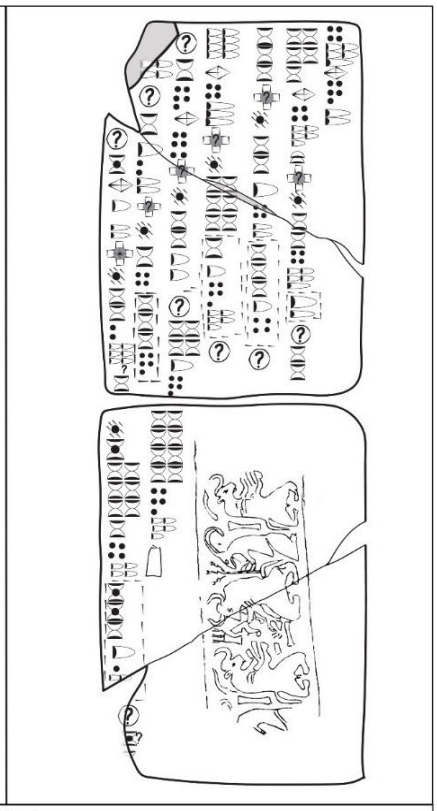
This collection is comprised of two parts: MDP.26, containing 485 Proto-Elamite tablets, and MDP.26S, which includes tablets from de Morgan's "Grand Trench" (Scheil, 1935). The latter collection is currently housed in the Louvre Museum. The MDP 26 collection is of particular significance, as its tablets likely originate from a single trench and include multiple tablets related to the same subject matter. These tablets potentially represent a relatively unified archaeological context. Comparative analysis of these texts can elucidate the reasons behind their variations and greatly contribute to the decipherment of this writing system. The drawings of the tablets in this collection were initially produced by de Mecquenem's daughter using a lucida camera. However, the resulting unnatural and poor quality of these drawings, coupled with the absence of any photographic documentation (Dahl, 2013), meant that they remained inaccessible to Western researchers for many years.

MDP 26, 360

This tablet, currently housed in the National Museum, Tehran, published initially by Vincent Scheil in Mémoires de la Délégation en Perse (MDP. 26: 360) in 1935, dates to the Proto-Elamite period, approximately 3100-2900 BC (Fig. 5). As a primary administrative document, this tablet, like others from Susa, offers crucial insights into the numerical systems and accounting practices employed during this period in southwestern Iran. The tablet is made of clay, roughly rectangular, although it appears to be fragmented or broken, with pieces separated.

The tablet appears to follow a pattern where entries are grouped, and within each group, there's a sequence of M signs and numerical systems: |M327+M348| M354 (Bisexagesimal system B), M354? (Bisexagesimal system B#), |M351+X| (Bisexagesimal system B), M222 (Capacity system). The grouping layout entries is a significant observation. It suggests that the tablet's information is organized in a structured manner, possibly representing distinct transactions, accounts, or categories. The consistent sequence within each group is also crucial. It indicates a standardized format for recording information. The pattern starts with |M327+M348| M354, which are counted using the Bisexagesimal system B. This could represent a primary commodity or category. It's followed by M354?





Obverse			
0.	M?		
00.	|M327+M365| M354(?), ?(N?)		
1a.	|M351+X| , 1(N54)	1b.	M222 , 1(N34) 2(N01)
2a.	|M327+M365| M354 , 2(N51) 2(N14) 6(N01)	2b.	, 1(N51), ? (N?), 4(N01)
2c.	|M351+X| , 1(N51) 1(N34) 2(N14) 2(N01)	3a.	|M327+M365| M354, 1(N51) 4(N14)
3b.	M354? , 3(N51@b) 5(N14@b)	3c.	|M351+X| , 1(N51) 5(N14)
3d.	M222 , 6(N14)	4a.	|M327+M365| M354, 2(N51) 2(N34)
4b.	M352~h , 4(N51) 1(N34) 5(N14) 8(N01)	4c.	M222 , 4(N14) 3(N01)
5a.	|M327+M348| M354 , 6(N51)	5b.	M354?, 1(N51@b) 1(N34@b) 5(N14@b) 5(N01@b)
5c.	M352~h , 3(N51)	6a.	|M327+M365| M354, 2(N51) 1(N34) 4(N14) 2(N01)
6b.	M354?, 3(N51@b) 1(N34@b) 4(N14@b)	6c.	|M351+X| , 5(N51)
6d.	M222 , 4(N14) 5(N01) 2(N39B)	7a.	|M327+M365| M354, 2(N51) 4(N14) 5(N01)
7b.	M354? , 1(N34@b) 1(N1@b)	7c.	|M351+X|, 2(N51) 4(N14) 5(N01)
7d.	M222 , 5(N14) 2(N01)		
Reverse			
1.	M354 , 1(N54) 7(N51) 4(N14) 4(N01)	2.	M354? , 2(N54@b) 1(N51@b) 1(N34@b) 1(N14@b)
3.	|M351+X| , 2(N54) 8(N51) 5(N14) 5(N01)		

◀**Fig. 5: Proto Elamite Tablet, MDP 26, 360 (©Image courtesy of the Cuneiform Digital Library Initiative (CDLI), Drawing and Transliteration by: Authors, 2024).**

counted in B#. This might indicate a sub-category or a related commodity. Then comes |M351+X|, again in Bisexagesimal B, possibly another primary commodity. Finally, M222, counted in the Capacity system, which as we know is associated with barley. totals for M354 and M351+X on the obverse and reverse sides of the tablet; Obverse Totals: M354: 1744, M351+X: 2972, and Reverse Totals; M354: 2084, M351+X: 3605.

The consistent structure suggests a well-defined administrative or accounting practice. This format might have been used across multiple tablets or within a specific institution. The presence of sub-categories (like

M354? in B#) within the groups hints at a hierarchical organization of information. This could reflect different grades or types of commodities, or different stages in a transaction. The sequence of M signs might reveal relationships between different commodities. For example, |M327+M348| M354 and |M351+X| might represent different types of grain, while M222 (barley) is recorded separately, perhaps as a final product or output.

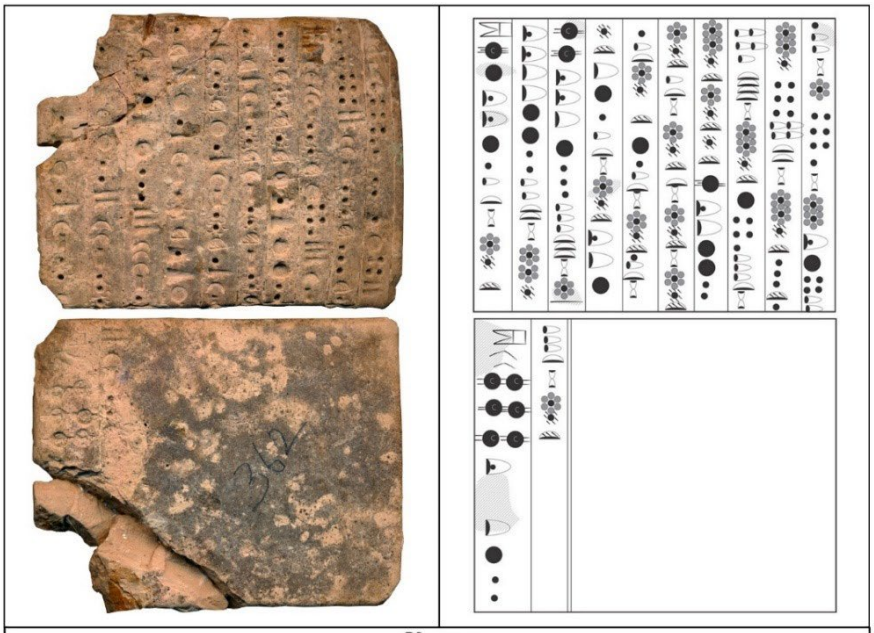
Observation on the reverse side summarizing the totals is very important. It suggests that the reverse side provides a consolidated overview of the information recorded in the groups on the obverse. The absence of M222 on the reverse side might indicate that it was a final product distributed or consumed, rather than an input. Considering this structure, we can refine our interpretation of the tablet as the script records a series of transactions or accounts, each involving specific types and quantities of grain. The obverse side details the inputs or components of each transaction, organized by grain type and category. The reverse side summarizes the totals for each grain type, providing an overview of the overall transaction. This Proto-Elamite tablet, with its distinct numerical systems and commodity designations, likely represents a sophisticated accounting system that goes beyond our basic understanding of debits and credits. The tablet, rather than representing a single static balance, may contain a set of interconnected records functioning as an inventory management tool. These records could encompass: 1) the tracking of inflows and outflows of various commodities, particularly different types of grain; 2) transactional documentation of specific transfers or exchanges between individuals, locations, or resource pools; and 3) detailed accounts of resource allocation for distinct purposes, such as rations, seed grain, or trade. In this sense, the tablet reflects ongoing activities over a defined period, rather than a one-time economic snapshot. It is possible that the reverse side served as a summary of the transactions recorded on the obverse.

Such a tablet would have provided administrators with the means to monitor economic activity, ensure accountability, and make informed decisions in resource management. It was likely associated with the operations of an agricultural trading center. The obverse may list grain inputs received from surrounding areas, alongside allocations for seed and internal consumption; alternatively, it could detail tribute payments received in various grains, or document deliveries of grain to a brewery. Correspondingly, the reverse may record the distribution of cereal rations to the workforce, the redistribution of grain from this central storage facility to various settlements or public works projects, or the allocation

of barley malt, a key ingredient in beer or even the distribution of finished beer.

MDP 26, 362

The Proto-Elamite clay tablet, cataloged as NMI BK 03416 within the National Museum, Tehran, originates from Susa and dates back to approximately 3100-2900 BC. This tablet, bearing the primary publication reference MDP 26, 362 (P009050) in Vincent Scheil's work, is classified as a tablet (Fig. 6).



	Obverse
1.	M288 , 1(N46) 1(N45)# 2(N48) 1(N45) 1(N14) 1(N01) 1(N39B) 1(N24) 1(N30C) 1(N30D) 1(N39C)
2.	[...] , 2(N48) 2(N34) 2(N45) 2(N14) 2(N01) 2(N39B) 1(N24) 2(N30C) 1(N30D)
3.	2(N46) 2(N48) 1(N34) 1(N45) 3(N14) 3(N01) 3(N39B) 1(N24) 1(N30C) 1(N30D) 1(N39C)
4.	1(N34) 1(N45) 1(N14) 1(N01) 1(N39B) 1(N24) 1(N30C) 1(N30D) 1(N39C)
5.	1(N48) 1(N34) 1(N45) 1(N14) 1(N01) 1(N39B) 1(N30C) 1(N30D) 1(N39C)
6.	1(N45) 1(N14) 1(N01) 1(N39B) 1(N24) 1(N30C) 1(N30D) 1(N39C)
7.	1(N14) 1(N01) 1(N39B) 1(N24) 1(N30C) 1(N30D) 1(N39C)
8.	1(N01) 1(N39B) 1(N24) 1(N30C) 1(N30D) 1(N39C)
9.	1(N39C) 1(N24) 1(N30C) 1(N30D) 1(N39C)
10.	1(N24) 1(N30C) 1(N30D) 1(N39C)
11.	2(N30C) 1(N30D) 1(N39C)
12.	1(N30C) 1(N30D) 1(N39C)
13.	1(N30D) 1(N39C)
14.	1(N46) 1(N48) 1(N34) 2(N45) 2(N14) 5(N01) 4(N39B) 1(N24) 2(N30C) 1(N30D) 1(N39C)
15.	1(N45) 5(N14) 3(N01) 1(N39B) 1(N24) 2(N30C) 1(N30D)
16.	6(N14) 4(N01) 2(N39B) 1(N24) 2(N30C) 1(N30D) 1(N39C)
17.	3(N14) 1(N39C)
18.	1(N14) 1(N01)# 1(N24) 1(N30C)
19.	7(N14) 1(N24) 2(N30C)
20.	1(N48) 1(N45) 4(N14) 2(N01)
	Reverse
1.	M288# , 6(N46) 1(N48) 1(N34)# 1(N45) 2(N14) 2(N01) 1(N39B) 1(N24) 1(N30C) 1(N30D) 1(N39C)

◀ **Fig. 6: Proto Elamite Tablet, MDP 26, 362 (© Image Drawing and Transliteration Courtesy of the Cuneiform Digital Library Initiative (CDLI)).**

Tablet MDP 26, 362 is an administrative document from Proto-Elamite Susa, designed to meticulously record barley accounting within standard containers. The tablet's structure is organized around the sign M288, which denotes a large container for cereals, specifically barley. The obverse begins with a crucial entry (line 1) that defines the full capacity of this standard container. It lists various units from the capacity values (N46, N45, N48, N14, N01, and the less understood N39B, N24, N30C, N30D, N39C), quantifying the precise amounts of each needed to fill one M288. Subsequent obverse entries (lines 2-20) omit M288 but implicitly refer to it, documenting different volumes of barley held within these containers. These variations in quantities suggest records of additions, removals, transfers, or allocations of barley. In contrast, the reverse entry serves as a summary, providing a consolidated view of the barley transactions or measurements.

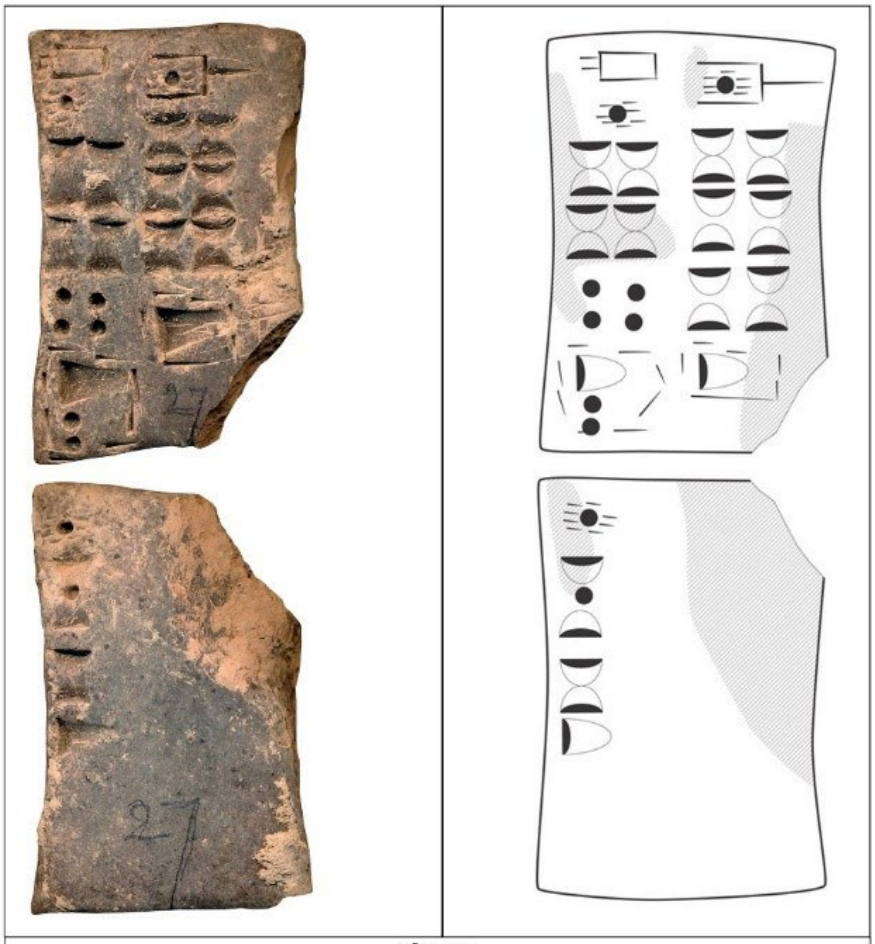
This tablet appears to document the distribution of rations, most likely grain, employing the Proto-Elamite capacity measurement system. To assess the relative quantities recorded, the values in each line may be converted to the N01 unit using the established conversion factors. It is assumed that the entries on the obverse represent individual distributions, while the first entry on the reverse constitutes the aggregate total of the obverse entries. The rations are recorded with the use of the numerical sign M288, which most plausibly denotes distinct types of containers, potentially associated with different commodities or functional purposes.

The obverse seems to list individual distributions, while the reverse provides a total. This tablet shows a significant difference between the total rations recorded on the obverse (17921.171 N01) and the reverse (2416.35 N01). Several factors could explain this discrepancy. The tablet might be damaged, with missing parts on the reverse, or the obverse and reverse might use different accounting methods. Recording errors are also possible. The reverse could show a subtotal, exclude some obverse entries, or use rounded numbers. Further research, including a physical examination of the tablet, comparisons with similar texts, and linguistic analysis, could help clarify these differences. Overall, this tablet exemplifies a sophisticated accounting system developed to track and manage barley, highlighting its economic importance in Proto-Elamite society and the administrative rigor employed in its control.

MDP 26, 027

The Proto-Elamite clay tablet, cataloged as (NMI BK 03577) within

the National Museum, Tehran, originates from Susa and dates back to approximately 3100-2900 BC. This tablet, bearing the primary publication reference MDP 26, 027 (P008715) in Vincent Scheil's work, is classified as a tablet (Fig. 7).



obverse			
1.	M157,	2.	M354 , 4(N51) 4(N14)
3.	M354?, 1(N34@b) 2(N14@b)	4.	|M036+1(N30D)| , 6(N51)
5.	|M036+1(N30D)|?,1(N34@b)		
reverse			
1.	M354 , 1(N54) 1(N51) 1(N34)		

◄ **Fig. 7: Proto-Elamite Tablet, MDP 26, 027 (©Image and drawing courtesy of the Cuneiform Digital Library Initiative (CDLI), Transliteration by: Authors 2024).**

This Proto-Elamite tablet is a significant administrative artifact dedicated to the accounting of grain, utilizing the complex Bisexagesimal B and B# numerical system. The structure of the tablet suggests a meticulous record-keeping practice, essential for managing this vital commodity in Proto-Elamite society. The obverse presents individual entries detailing grain quantities, where the sign M354 likely represents a large unit or standard measure of grain, perhaps a specific container volume or a collective term for stored grain. The sign M036, often associated with grain containers,

when modified with "1(N30D)," may indicate a particular type or size of container, or even a specific variety of grain. Functioning as a header, M157 at the top of the obverse likely designates the overall context of the record, such as the type of grain being tracked (e.g., barley or emmer wheat) or the purpose of the tablet itself (e.g., distribution log or inventory summary).

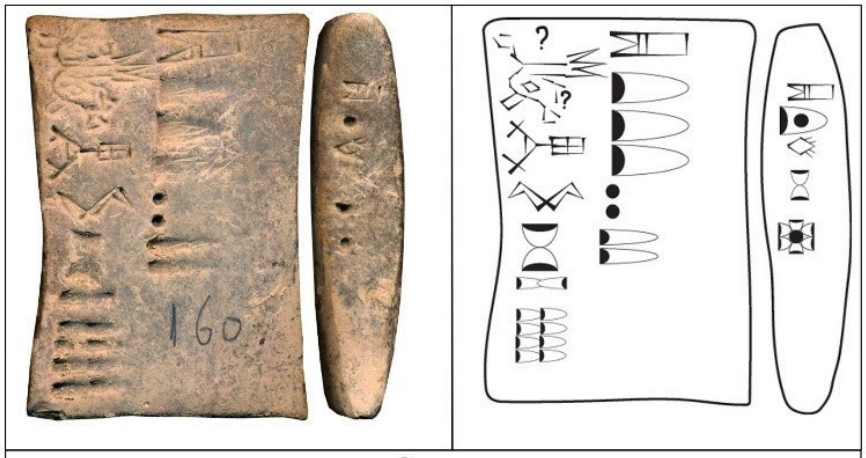
On the obverse, entry 1 (M157) has no numerical value, seems to the header for which the transactions were recorded. Entries 2 and 3 record quantities of grain. The notation with N34 and N14 in entries 3 and 5 on the obverse might indicate that these quantities are counted in the (B# system). On the reverse, the single entry records a quantity of grain, seemingly counted in the standard Bisexagesimal (B system). The use of the (B# system) on the obverse, combined with its absence on the reverse, could indicate a few things as the obverse might record specific types of grain transactions (e.g., incoming grain, or grain for a particular purpose) using the (B# system), while the reverse records the total distribution of grain using the standard B system. The obverse and reverse might represent different levels of accounting, with the (B# system) used for more detailed tracking on the obverse and the (B system) used for a simplified summary on the reverse. The question marks in the transliteration, "M354?" and "|M036+1(N30D)|?", indicate uncertainty in the reading of those specific M signs. This uncertainty doesn't affect the numerical calculations, but it suggests that the scribes might have had some variations or complexities in how they labeled the entries.

This tablet appears to be a well-balanced account, where the total grain recorded on the obverse matches the total on the reverse. This suggests a careful administrative practice, possibly within an agricultural trading center. The tablet might represent a record of grain received (obverse) and then distributed (reverse). Here are some suggestions about why the M signs before the numerical (Bisexagesimal B#) might be omitted, and what they could be that the M sign might be omitted because the context makes it clear what commodity is being counted. If the tablet consistently deals with grain, the scribe might have assumed that the reader would understand that the numbers refer to grain, even without the M sign. Omitting the M sign could have been a way for scribes to save time and space, especially if they were dealing with large numbers of tablets. The M sign could denote the type of grain being counted. The M sign could represent the units of measurement used for the grain (e.g., bushels, liters, etc.). In this tablet, the obverse total is (1380 N01), and the reverse total is (1380 N01).

In conclusion, this tablet offers a glimpse into the sophisticated administrative apparatus developed by the Proto-Elamites to manage and distribute grain, a cornerstone of their economy. The precision of the Bisexagesimal system and the detailed recording practices underscore the importance of grain as a resource and the centralized control likely exercised over its allocation within Proto-Urban settlements.

MDP 26, 160

The tablet appears to be an administrative record, from Susa, dating back to the late fourth millennium BCE. It documents the allocation of resources (rations) to a group of workers. The text uses a combination of the decimal system (D) for counting workers and the capacity system (C) for measuring rations, which, according to Dahl (2005) and Friberg (1978), is a characteristic feature of Proto-Elamite accounting practices (Fig. 8).



obverse	
1.	x ,
2.	M210~f M054 , 1(N51) 1(N23) 8(N01)
3.	M288 , 3(N34) 2(N14) 2(N01)
4.	M288 , 1(N48)
5.	x , 1(N24) 2(N30C)

◀ **Fig. 8: Proto Elamite Tablet, MDP 26, 160 (©Image courtesy of the Cuneiform Digital Library Initiative (CDLI), Drawing and Transliteration by: Authors, 2024).**

In line one, “x” is likely representing an unknown sign used as a heading or a general descriptor. In line 2, “M210~f M054, 1(N51) 1(N23) 8(N01)”, records the first entry. “M210~f M054” could be worker identifiers or job titles. “1(N51) 1(N23) 8(N01)” indicates the number of workers. Given that (N01 = 1, N14 = 10, N23 = 100, and N51 = 1000), the calculation is (1108) workers. In line three, “M288, 3(N34) 2(N14) 2(N01)” records the amount of rations distributed using container “M288”. “3(N34) 2(N14) 2(N01)” indicates the capacity of “M288” containers. In line four which

is on the edge, “M288, 1(N48)”. This line records another number of rations distributed, again using container “M288”. In line five, “x, 1(N24) 2(N30d)”, likely records the amount of rations. “1(N24) 2(N30C)” probably indicates the quantity of grain or other commodity, measured using the capacity system (C). To analyze the relationship between the number of workers and the number of rations, we need to express the rations in to N01 units[2]. The tablet documents the distribution of a significant amount of rations (2355.33 N1) to a large workforce (1108 workers). Workers are counted using the decimal system, while the rations are measured using the capacity system. The entries seem to be organized by worker group or category (M210~f M054) and rations paid through (M288). The calculation shows that each worker received an average of (2.126 N01 units). This suggests a system of organized resource allocation, where a central authority managed and distributed rations to support its labor force. The relatively small number of rations per worker might indicate basic sustenance rations for a large labor force involved in non-intensive labor. Based on the Immersive amount in Line 2 records “1108 workers”, here’s an analysis of this large number and its potential implications:

The most straightforward interpretation is that the tablet documents labor allocation for a significant construction or agricultural project. Proto-Elamite Susa was a major Proto-urban center, and such a workforce could have been involved in building or maintaining large-scale infrastructure like, Irrigation canals, essential for agriculture in the region, monumental architecture or city walls or perhaps large agricultural fields for organized farming. At the meantime, the recorded number might represent a seasonal workforce employed during peak times, such as harvest season requiring a large number of laborers for a short period or construction season when weather conditions were most favorable. Moreover, the 1108 workers might represent the total available workforce in a specific region or under the control of a particular institution (e.g., an administrative center). This doesn’t necessarily mean they were all employed on a single task simultaneously but rather that they could be assigned to various projects as needed. It is also possible that the recorded number is the cumulative number of workers over a specific period of time.

A large, centralized administration in Susa would have been capable of organizing and managing a substantial workforce. The Proto-Elamite writing system and accounting practices, as evidenced by the tablets, support this idea. A large workforce indicates a complex economy with a significant surplus of resources. This surplus could be used to support

a large number of non-subsistence laborers. The presence of a large workforce may imply a stratified social structure, with a class of laborers working for the benefit of the elite. Given the context of Proto-Elamite society, the workers were likely involved in labor-intensive tasks such as working in fields, harvesting crops, maintaining irrigation systems or building and maintaining infrastructure and perhaps producing pottery, textiles, or other goods.

Conclusion

The analysis of the Proto-Elamite tablets MDP 26, 362 and MDP 26, 027 offers valuable insights into the administrative and economic structures of Proto-Elamite society. These tablets, originating from Susa, underscore the critical role of organized accounting in managing essential resources, particularly grain. Tablet MDP 26, 362, reveals a sophisticated system for tracking barley. The consistent use of M288, denoting a standard grain container, and the detailed recording of capacities using a complex system, highlight a standardized approach to measuring and managing this staple commodity. The tablet's structure, with an initial entry defining the container's capacity and subsequent entries detailing transactions or inventory levels, suggests a rigorous administrative practice. The reverse entry likely represents a summary, consolidating the data from the obverse. The presence of the Bisexagesimal system in MDP 26, 027, dedicated to quantifying grain products, further emphasizes the importance of grain in the Proto-Elamite economy. The system's blend of base-60 and base-10 elements indicates a nuanced approach to accounting, potentially serving both large-scale grain management and the allocation of rations. The M signs on this tablet likely denote units of grain, with variations possibly indicating different types or measures. MDP 26, 160 provides a glimpse into the logistical operations of a large-scale labor organization, detailing the accounting of a substantial workforce and the distribution of rations. The tablet employs both the decimal and capacity systems, illustrating a degree of complexity in tracking both personnel and resources. The presence of entries organized by worker groups and ration containers, combined with the sheer number of workers (1108), suggests a centralized administrative system capable of managing significant labor demands, likely for a major construction, agricultural, or public works project. This implies a complex economic structure with a capacity for surplus production and a stratified social organization in Proto-Urban Susa. Together, these tablets illustrate a society with a centralized authority capable of organizing and

controlling the production, storage, and distribution of grain. The detailed accounting practices, as evidenced by the tablets' numerical precision and standardized measures, reflect the need to manage a growing population and ensure the efficient distribution of resources. These findings align with broader understandings of early urban centers in the Near East, where the development of writing and complex accounting systems played a crucial role in supporting social and economic complexity.

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Observation Contribution

The first author was responsible for the writing and analysis of the proto-Elamite tablets in this study. The second author contributed to the design and drafting of the texts, while the third author prepared the relevant research literature.

Conflict of Interest

The Authors, while observing publication ethics in referencing, declare the absence of conflict of interest.

Endnote

1. Approximately 1,646 Proto-Elamite texts are currently known, with the bulk of the published material originating from the works of Scheil (1905; 1923; 1935), de Mecquenem and Rutten (1949), de Mecquenem (1956), and Vallat (1971). In addition, 129 previously unpublished tablets and fragments housed in the Louvre were published by Jacob Dahl (Dahl, 2019), and 89 fragments have been recently released from the storage facilities of the National Museum of Iran on the CDLI website.

2. Here is the calculation the total rations and rations per worker: Total rations = Line 3 + Line 4 + Line 5 Total rations = 3N34 + 2N12 + 2N1 + 6N1 + 10 N1 + 10/3 N1 To simplify this, we need to convert N34 to N1 10N34 = 1N48 3N45 = 1N34 10 * 3N45 = 10N34 30 N45 = 10N34 10N14 = 1N45 30 * 10N14 = 30N45 300 N14 = 10N34 300 * 6N1 = 10N34 1800 N1 = 10N34 180 N1 = 1N34 So, Total rations = 3 * 180 N1 + 2N12 + 2N1 + 6N1 + 10 N1 + 10/3 N1 Total rations = 540 N1 + 2N12 + 18 + 10/3 N1. To convert N12 to N1, we use 6N1 = 1N14 and 10N14 = 1N45 and 3N45 = N34 and 10 N34 = N48 N12 = 2N14 = 12 N1 Total rations = 540 N1 + 12 N1 + 18 N1 + 10/3 N1 Total rations = 570 + 3.33 Total rations = 2355.33 N1. Rations per worker = Total rations / Number of workers Rations per worker = 2355.33 N1 / 1108 workers Rations per worker = 2.126 N1.

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مطالعه‌ای بر مقیاس حسابداری: تحلیل محتوایی گِل‌نبشته‌های آغازایلامی شوش با ارزش عددی بالا موجود در موزهٔ ملی ایران

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چکیده

این پژوهش به تحلیل عمیق چهار گِل‌نبشتهٔ آغازایلامی موجود در موزهٔ ملی ایران می‌پردازد که به‌دلیل برخورداری از حجم قابل‌توجه داده‌های عددی برگزیده شده‌اند. انتخاب این لوح‌ها فرصتی کم‌نظیر برای مطالعهٔ مقیاس حسابداری کالا در نیمهٔ دوم هزارهٔ چهارم پیش‌ازمیلاد در شوش، محوطه‌ای با جایگاه راهبردی در بررسی جوامع پیچیده، فراهم می‌آورد. تمرکز پژوهش بر شناسایی و تبیین نشانه‌ها و نظام‌های عددی پیچیده‌ای است که کاتبان آغازایلامی برای ثبت این داده‌های گسترده به‌کار گرفته‌اند، با تأکید ویژه بر نحوهٔ کاربرد و تعامل نظام‌های شمارش شصت‌گانی، دَه‌دهی، دوشصت‌گانی و حجمی. بررسی این متون پرده از سازوکارهای یک دستگاه اداری کارآمد برمی‌دارد که نه‌تنها توانایی مدیریت، بلکه قابلیت ثبت دقیق مقادیر کلان کالا را دارا بوده است. کالاهای ثبت‌شده طیف وسیعی از منابع موردنیاز جامعه، از انواع غلات و حسابداری نیروی کار انسانی و دامی تا میزان دستمزد را دربر می‌گرفته و بیانگر نظامی سازمان‌یافته برای توزیع و تخصیص منابع بوده است. گستردگی داده‌های عددی این لوح‌ها، شواهد ارزشمندی از پویایی اقتصادی شوش در این دوره به‌دست می‌دهد و بر مقیاس وسیع مدیریت منابع، وجود شبکه‌های منظم توزیع، و امکان برقراری ارتباطات تجاری فراتر از محوطه‌های پیرامونی شوش تأکید می‌کند. هرچند نشانه‌های عددی آغازایلامی در مقایسه با همتایان بین‌النهرینی خود، سبکی بصری متمایز و برخاسته از سنت فرهنگی و کتابتی، ویژه را بازتاب می‌دهند، اما تمرکز مشترک بر کمی‌سازی کلان‌مقیاس، نشانگر دغدغه یکسان برای تدوین شیوه‌های حسابداری دقیق و کارآمد است. چنین دقت و نظمی در ثبت و ضبط داده‌ها، عنصری حیاتی برای مدیریت مازاد تولید، سازماندهی نیروی کار، و حفظ ثبات اقتصادی یک مرکز درحال توسعه به‌شمار می‌رفت. یافته‌های این مطالعه علاوه بر تأکید بر ضرورت تحلیل موشکافانهٔ داده‌های عددی موجود، به فهم بهتر سازوکارهایی یاری می‌رساند که بستر رشد و پیچیدگی جوامع آغاز شهرنشینی در ایران را ترسیم می‌کنند.

کلیدواژگان: آغازایلامی، شوش، گِل‌نبشته، مقادیر کمّی بالا، مرکز تجاری.

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