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Adaptive Complexity in the Proto-Elamite Period: Networks, Administration, and Interregional Dynamics

پیچیدگی تطبیقی در دورهٔ آغازایلامی: شبکه‌ها، نظام اداری و پویایی بین‌منطقه‌ای

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ABSTRACT

This study examines the thematic classification of Proto-Elamite administrative and economic tablets as an analytical framework for identifying internal indicators of social complexity and transformation. Nine principal categories, ranging from ration disbursement, taxation, and animal husbandry records to household wealth inventories, labor allocation, agricultural accounts, decentralized administrative formats, minutes of collective decision making, and large-scale data texts, are evaluated for their capacity to reveal patterns of institutional organization, resource management, and power distribution. The findings underscore the multidimensional nature of complexity in the Proto-Elamite period, marked by polycentric, heterarchical, and flexible administrative arrangements. The evidence challenges unilinear and state-centric models, demonstrating that advanced bureaucratic, economic, and social systems could emerge through networked coordination, adaptive variability, and embedded distributive mechanisms rather than through centralized control alone.

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چکیده: این پژوهش، گونه‌بندی موضوعی الواح اداری و اقتصادی دورهٔ آغاز ایلامی را به‌عنوان چارچوبی تحلیلی برای شناسایی شاخص‌های درونی پیچیدگی و دگرگونی اجتماعی مورد بررسی قرار می‌دهد. در این مطالعه، نه دستهٔ اصلی از پرداخت جیره و مالیات‌ستانی و ثبت سوابق دامداری گرفته تا فهرست‌های دارایی خانوار، تخصیص نیروی کار، حساب‌های کشاورزی، قالب‌های اداری غیرمتمرکز و متون با مقادیر کمی بالا، بر اساس ظرفیت آن‌ها برای آشکار ساختن الگوهای سازمان نهادی، مدیریت منابع و توزیع قدرت ارزیابی شده‌اند. یافته‌ها بر چندبُعدی بودن ماهیت پیچیدگی در دورهٔ آغاز ایلامی تأکید دارند؛ پیچیدگی‌ای که با ترتیبات اداری چندمرکزی، هم‌رتبه‌ای و انعطاف‌پذیر مشخص می‌شود. شواهد فن مدیریت به نوعی به چالش کشیدن الگوهای خطی و دولت‌محور را نشان می‌دهند و بیان می‌کنند که نظام‌های پیشرفتهٔ بوروکراتیک، اقتصادی و اجتماعی می‌توانند از رهگذر هماهنگی شبکه‌ای، تنوع سازگار و سازوکارهای توزیعی درون‌ساختی پدید آیند و نه صرفاً از طریق کنترل متمرکز.

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1. Introduction

In contemporary approaches to social complexity, the concept of "complexity as an adaptive process[1]" has attained a prominent position, creating a significant divide between classical hierarchical theories and modern multilinear and adaptive perspectives. From this standpoint, complexity is not a static or linear condition, but rather a dynamic, responsive, and reactive process that societies continuously reproduce and recreate through interaction with their surrounding environment and in response to historical crises or opportunities (Earle, 1991). Some of the foremost proponents of this approach, such as Earle (1991), emphasize the issue of "adaptive efficiency[2]" and the potential for integrating or attenuating power structures as circumstances require. For these scholars, cultural–evolutionary mechanisms and social learning constitute the primary factors for understanding the dynamics, reproduction, and even contestation of complex structures; that is, societies possess an intrinsic capacity for ongoing adaptation to events and for responding to environmental pressures (Richerson and Boyd, 2001). James Scott, through the concept of the "art of not being governed[3]" or "state evasion[4]," highlights the role of agency and intentionality among social actors in choosing informal, networked, and decentralized forms of organization (Scott, 2009). In this view, many societies, not out of "backwardness" but as an adaptive strategy, refuse a fixed state form and centralized bureaucracy, and instead employ an array of compensatory patterns and mechanisms such as local contracts, consensus, kin-based alliances, or ritual networks to manage resources, resolve conflicts, and maintain social cohesion.

The adaptive process of social complexity assumes heightened significance in contexts where clear evidence exists for unstable political centrality, political fragmentation, and diversity in organizational patterns (McIntosh and McIntosh, 1984). In such societies, decision-making often oscillated fluidly and responsively between individual-oriented poles (such as local or familial authority) and collective-oriented poles (councils, consensus-based institutions), in correspondence with historical circumstances (Scott, 2009). Economic crises, external threats, or international opportunities, such as trade exchanges or technological innovations, could decisively influence the pace and trajectory of processes towards centralization or decentralization (Bandy, 2004). Such dynamic patterns reveal that political structures were not merely products of evolutionary inevitability but emerged from adaptive strategies, negotiated agency, and context-specific responses to shifting socio-ecological conditions.

Therefore, adaptive complexity entails a society's ability to "move between various levels of organization[5]", that is, to shift flexibly across

[1] "Complexity as an adaptive process" ; a theoretical perspective viewing social complexity not as a fixed stage of development, but as an ongoing capacity of societies to reorganize and transform their structure, institutions, and decision-making processes in response to environmental, demographic, or political pressures.

[2] "Adaptive efficiency"; the ability of a social, political, or economic system to adjust its organizational arrangements, redistribute authority, and reallocate resources in ways that maintain functionality and address emerging challenges or opportunities.

[3] "The Art of Not Being Governed" represents a critical departure from evolutionary models that equate political centralization with cultural advancement. His framework pivots on the proposition that many non-state communities are not merely residual forms awaiting integration into state structures, but are instead the active outcome of deliberate social, ecological, and political choices. In Scott's account, "state evasion" is not synonymous with isolation or regression; it is a repertoire of strategies aimed at minimizing exposure to central authority, taxation, conscription, and cultural assimilation. The highlands of Southeast Asia, "Zomia", become the conceptual archetype, characterized by geographical inaccessibility, mobile subsistence systems, linguistic diversity, and socially fluid structures that resist administrative capture. Three interrelated dimensions underpin Scott's theory: 1- "Spatiality"; The deliberate occupation of "non-state spaces" (mountains, swamps, forests, deserts) where terrain itself acts as a buffer against coercive state reach. 2- "Social Morphology"; Decentralized kinship networks, non-codified legal orders, and modes of subsistence (e.g., shifting cultivation, pastoralism) that are structurally incompatible with sedentary, tax-extractive regimes. 3- "Temporal Politics"; Episodes of temporary engagement with state economies followed by withdrawal, producing cyclical or oscillatory integration rather than linear absorption.

[4] "State evasion" refers to the deliberate social, political, and spatial strategies employed by communities or groups to avoid incorporation into centralized state structures, administrative control, and formal taxation or labor regimes. These strategies are not merely symptoms of technological or social "underdevelopment", but rather intentional forms of political self-determination. They exploit geographic remoteness, mobility, flexible kinship systems, oral histories, dispersed settlement patterns, ritual or religious frameworks, and decentralized economic practices to maintain autonomy, resist bureaucratic surveillance, and preserve local governance arrangements.

[5] In political anthropology and archaeology, to "move between various levels of organization" refers to the capacity of a society to shift, either temporarily or structurally, between different scales of social, economic, and political integration. This can include transitions between: (A) Household/kin-based units and larger communal or regional decision-making assemblies. (B) Decentralized, network-based structures and more centralized, hierarchical arrangements in response to strategic needs or environmental pressures. (C) Co-existing formal institutions (councils, religious hierarchies, legal codes) and informal governance mechanisms (kin alliances, ritual obligations, ad hoc coalitions). Such mobility is often "reversible" and "non-linear", reflecting the adaptive and historically contingent nature of complex systems.

different scales of integration, from localized kin-based units to regional confederations, and from informal networks to formalized institutions, depending on ecological, economic, or political imperatives (Bandy, 2004). These transitions allow societies to draw simultaneously upon both formalized governance structures and informal community mechanisms, patterns that not only enhance resilience but also ensure flexibility and responsiveness to transformation. As such, complexity should be understood as an open, dynamic, and historically contingent process that does not necessarily culminate in the creation of a centralized state or bureaucratic apparatus, but can instead persist as a network of interacting forces and actors that is continuously reconstructed and redefined in response to shifting socio-ecological and cultural conditions (Scott, 2009).

2. Metrics of Complexity

Identifying reliable metrics for assessing social and institutional complexity remains one of the most debated and challenging domains in archaeological and anthropological research, as any given definition or criterion inevitably reflects the diversity of patterns, environmental and historical differences, and the theoretical and methodological choices of the researcher (Carballo *et al.*, 2014). There is, however, a broad consensus among most scholars on the necessity for such metrics to be multidimensional and context-specific. In other words, the metrics must accurately capture various dimensions: structural, functional, institutional, and cultural, within a defined historical and regional framework. Consequently, no single, universally applicable metric exists, and assessment tools must be redefined each time, according to the case at hand, within a comparative–critical perspective.

One of the oldest criteria for measuring complexity is the analysis of multi-tiered hierarchies, whether political (e.g., chief, leader, king), religious (priest, temple staff), or economic (overseers, stewards, laborers). This metric detects layered structures of decision-making and power distribution and is rooted in models such as Elman Service's four-stage framework (Service, 1962) or Henry Wright's institutional models (Wright, 2003). In more recent approaches, however, this metric has been critiqued, with increasing emphasis placed on identifying flexible and informal hierarchies.

The intensity and diversity of professional and economic specialization, including craft production, agriculture, and administrative or technical services, constitute another core metric of complexity. Flannery (2003) and Earle (1991) have shown that the emergence of groups such as producers, skilled artisans, accountants, agricultural experts, or architects is often associated with greater complexity in resource and organizational systems. Indicators in this area include the division of labor, the presence of specialized forms, and the flow of technical information.

Development and use of writing systems for administrative, economic, and legal documentation is considered a key metric. Gelb and Damerow have traced the trajectory of writing and accounting systems (from signs and tokens to complete texts), demonstrating that complexity in recording, calculating, and archiving information serves as a critical marker of institutional growth and organizational interaction. Reporting systems and archival infrastructures reveal levels of transparency and the capacity to control resources (Gelb, 1963; Damerow, 2006).

The existence of institutions or mechanisms for collective decision-making, such as councils, assemblies, arbitration boards, local gatherings, and diverse conflict-resolution tools, constitutes another indicator. This metric assesses intra-group dynamics, equitable access, and the variety of consensus-building or mediation forms, illustrating that complexity is not necessarily tied to centralized power and may arise through decentralized, networked, and consensual systems (Blanton *et al.*, 1996; Crumley, 1995; 2001).

Distribution of goods, information, and services within multilevel networks; whether conducted horizontally among peer units or vertically across hierarchical levels, such distribution functions as a fundamental metric for evaluating the adaptive capacity, flexibility, and continuity of a social system. As Knappett (2011) and Smith (2021) have shown, analyzing the circulation of goods, the movement of information, and the mobility of individuals within these networks can reveal levels of creativity, resilience, and dependence or autonomy among communities and sectors. Networks with multiple pathways and redundant links enable rapid reconstruction of connections, the emergence of innovation, and the mitigation of crises. Moreover, the free flow of information and services across different levels facilitates decision-making, diffuses legitimacy, and enhances institutional capabilities. As such, the structure and dynamics of these communication networks serve as a telling indicator of institutional stability, diversification of connections, and the minimization of risks associated with systemic collapse or the monopolization of power by a single group or institution.

Degree of social integration and institutional synergy is a key metric for analyzing the complexity of societies, reflecting the extent of coordination, interaction, and functional overlap between various economic, political, social, and ritual institutions and groups. The higher the level of integration, the more orderly, transparent, and rule-based the distribution of resources, power, and legitimacy among these actors becomes, enhancing the community's capacity for labor division, participation, conflict management, and resource allocation (Carballo *et al.*, 2014; Fargher, 2016). Such synergy fosters flexibility and systemic cohesion in the face of crises and internal or external threats (Feinman, 1995; Bowles and Gintis, 2011). In conditions of instability, social structures with integrated institutions can mobilize resources and maintain unity, thus improving survival prospects (Fargher, 2016). Conversely, reduced social integration often leads to fragmentation, destructive competition, or inefficiencies in resource management and governance, potentially resulting in collapse or structural instability (Carballo *et al*., 2014: 110–115). For this reason, analyzing this metric is fundamental for understanding a society's internal dynamics and transformative potential (Feinman, 1995).

Redistributive systems and management of natural resources rank among the most important metrics of institutional complexity and organizational capability, since the ways in which resources such as water, land, agricultural produce, and raw materials are controlled, allocated, and redistributed determine not only economic and social equity but also the maturity and specialization of organizational structures (Earle, 1991; Feinman, 1995). The presence of precise measurement and accounting mechanisms such as registration systems, management records, role differentiation, and independent regulatory institutions signals accumulated administrative experience and the formation of equitable or strategic distribution models (Pfeiffer, 2012; Smith, 2021). Such systems are often accompanied by collective planning, quota schemes, market regulation, or oversight of consumption and storage (Feinman, 1995). The more advanced and efficient these mechanisms are, the greater the community's capacity to respond to environmental fluctuations, crises, and the equitable distribution of benefits (Fargher, 2016: 275–278). At higher levels, formalized algorithms and codified rules for resource redistribution may be established, traceable through documents, accounting systems, and complex administrative frameworks (Earle, 1991).

Institutional flexibility and resilience to crises and environmental change is among the most critical components of the long-term survival of complex societies. A mature and advanced institutional system must not only be capable of managing routine affairs but also possess the ability to restructure and adopt alternative solutions in the face of sudden crises or environmental shifts such as drought, migration, war, or economic fluctuations (Richerson and Boyd, 2001; Scott, 2009). Scholars have emphasized that mechanisms like decentralization, rotation or temporal limitation of key roles, delegation of authority to local units, and reliance on non-hierarchical networks foster flexibility, repairability, and systemic durability (Ostrom, 1990: 182–185; Fargher, 2016: 275–280). These features enable the testing and adoption of diverse strategies, rapid adaptation to changing conditions, and mitigation of the negative impacts of shocks or external pressures (Richerson and Boyd, 2001). The greater the institutional diversity, multilayered structure, and capacity for role reallocation, the higher the society's survival, recovery, and adaptation potential in the face of environmental and social threats (Scott, 2009: 40–45; Carballo *et al.*, 2014: 112–115).

3. The Necessity of Contextualization and Interdependence of Metrics

Alongside these traditional metrics, there is a growing inclination toward qualitative and analytical tools that prioritize the depth of cooperation, the multi-scalar nature of decision-making processes, and, in particular, the analysis of social, relational, and semantic networks (Carballo *et al.*, 2014). These new approaches examine not only material structures (such as architecture or artifacts) but also actions, interactions, information pathways, and social trust as criteria of complexity, thereby effecting a fundamental shift in the study of pre-state and state-forming societies.

In the assessment and analysis of social complexity, the importance of "contextualization[6]" and the "interdependence of metrics[7]" has emerged as a key strategic and methodological principle in

[6] "Contextualization" refers to the analytical process of situating each metric or indicator within the broader historical, socio-political, ecological, and cultural framework of the society under study, recognizing that the significance of any single datum emerges only in relation to its surrounding conditions.

[7] "Interdependence of metrics" denotes the principle that analytical variables, such as political hierarchy, economic specialization, or network connectivity are functionally linked, mutually influencing one another, and must therefore be evaluated in relation to the entire systemic matrix rather than as isolated phenomena.

archaeological and socio-anthropological research. Unlike earlier reductionist or one-dimensional approaches which relied on a limited set of indicators, such as the number of institutional levels or the existence of a strong political center, to make overarching judgments about a community's complexity, it is now recognized that no single metric, in isolation from the networked context of social, economic, cultural, and environmental relationships, carries adequate meaning or validity (Feinman, 1995; Blanton *et al.* 1996; Smith, 2021).

Complexity is the emergent outcome of the multi-layered interaction and reflection of multiple metrics (Feinman, 1995; Fargher, 2016). The presence of institutional hierarchies or political elites is undoubtedly important, yet without being coupled with the expansion of economic specialization, managerial innovations in accounting, or advanced mechanisms for conflict resolution, it cannot, by itself, determine the quality of social organization (Carballo *et al.*, 2014: 110–112). Similarly, the interaction between writing and accounting systems and the growth of redistributive networks for resources, such as grain, livestock, or manufactured goods, plays a crucial role in revealing the internal logic of administrative organization and a society's internal complexity (Earle, 1991; Algaze, 2008). The application of recording and writing technologies is both a consequence of and a contributor to the expansion of administrative and exchange networks; these two metrics operate within a mutually reinforcing, interdependent process (Michalowski, 1994).

At the higher levels of complexity, one observes that the development of accounting, documentation, and archival systems coincides with the growth of distributive institutions and resource allocation systems, in which each reinforces the other (Smith, 2021). In other words, enhanced managerial capacity and administrative complexity are of limited effectiveness unless accompanied by the expansion of exchange infrastructure and intergroup networks (Feinman and Garraty, 2010). According to the analyses of Scott (2009), even when one or more expected metrics, such as the absence of monumental temples or rigid class structures, are lacking, complexity may still manifest through alternative metrics, such as trust-based networks, local councils, or specialized managerial and communicative skills (Blanton *et al.*, 1996). Absence of a particular metric, therefore, does not necessarily indicate the absence of complexity, but may instead point to dynamic substitution, organizational transformation, or the adoption of alternative developmental trajectories (Feinman, 1995).

A networked, interaction-focused perspective requires the researcher to trace patterns of "interdependence[8]" rather than to focus exclusively on individual metrics (Feinman, 1995: 203–205; Blanton *et al.*, 1996: 1–5). This perspective enables a more accurate identification of the structure and depth of a society's social, economic, and institutional dynamics (Carballo *et al.*, 2014: 110–113; Smith, 2021: 14–16). The diversity of pathways through which complexity emerges, the use of composite indicators, and the study of relationships among metrics, such as the link between economic specialization and institutional flexibility, or the connection between administrative structures and conflict-resolution mechanisms, collectively define the contemporary approach (Scott, 2009; Fargher, 2016).

Above all, complexity is inherently a "context-dependent**"** concept, and its criteria cannot be meaningfully examined apart from the historical, geographical, and environmental framework. What functions as an indicator of complexity in one culture may arise from entirely different logic and functionality in another. This emphasis on contextualization necessitates both a critical reading of metrics and the development of analytical tools designed not through homogenization, but in accordance with the distinctive characteristics of each community. In sum, evaluating complexity without considering the network of interdependencies and the historical–cultural context yields an incomplete account of the organization and transformation of societies. Achieving a comprehensive and effective understanding of complexity requires the application of interactive, systematic models.

4. Analytical Metrics in the Study of the Proto-Elamite Complexity

Analysis of data from the Proto-Elamite period reveals a society characterized by a diverse range of organizational patterns, spanning from the household and micro-level units to administrative and economic tiers (Dahl, 2005; 2009; Dahl *et al.*, 2013; Desset, 2016; Hessari and Yousefi, 2023). This diversity is reflected not only in more traditional

[8] "Interdependence" refers to the condition in which individual metrics or variables such as political hierarchy, economic specialization, or network connectivity are functionally linked so that changes in one influence, and are influenced by, others; it emphasizes reciprocal causality within the broader systemic matrix, rather than the independence of discrete indicators.

structures such as chiefdom-based and family units, but also in the organization of productive economies, the distribution of resources, and the management of labor forces (Dahl *et al.*, 2018; Etemadifar and Yousefi, 2024). From the perspective of decision-making and division of labor, administrative evidence and recovered documentation indicate that the circulation of information and the organization of processes were not confined to a single central core, but were often based on networked, non-hierarchical models (Born and Kelley, 2021). This implies the simultaneous operation of multiple loci of authority and responsibility transfer, each exerting influence and exercising agency within its respective domain (Paladre, 2022; Yousefi *et al.*, 2025b).

This reality invites us to conceive the power structure and social organization of Proto-Elamite society not as a closed, authority-centered pyramid, but as a polycentric and heterarchical system in which decision-making and resource allocation could occur within independent spheres that were nonetheless interlinked (Alden, 1982; Yousefi *et al.*, 2025c). Within such networks, economic, administrative, and even ritual institutions operated not solely as vertically stratified hierarchies but also as interconnected webs of agents and actors exhibiting varying degrees of autonomy and mutual cooperation. This networked, co-equal configuration increased the efficiency of information distribution, enhanced task mobility, and improved the capacity to manage crises. It also allowed different actors, according to temporal and spatial exigencies, to share or even exchange roles and executive authority (Pittman, 1997).

The data from the Proto-Elamite period thus confirm not only the complexity and multidimensionality of its social and administrative structures but also their striking affinity with contemporary theories on "heterarchy[9]" and polycentricity of power; a situation that contrasts markedly with purely hierarchical interpretations and underscores the necessity of re-evaluating early society models (Crumley, 1995).

The administrative tablets of this period attest to the division of labor across multiple levels (household, workshop, local overseer), the use of multiple accounting systems, and even the participation of women and children in the labor organization (Etemadifar and Yousefi, 2024). This reality challenges state-centered, chiefly models and highlights the importance of assessing and explaining complexity through a dynamic, multi-layered, network-oriented approach. In a comparative sense, analysis of the structure and content of these texts including ration distribution, evidence of resource-control systems, and indicators of personal identity (signatures, marks), provides valuable evidence for evaluating multiple metrics of complexity, demonstrating that participatory and flexible management, consistent with heterarchical organization, formed the foundation of Proto-Elamite social and economic structures (Dahl *et al.*, 2018).

Archaeological and textual evidence from the Proto-Elamite period thus opens new horizons for understanding the diversity and dynamism of complexity. According to interpretations derived from the analysis of Proto-Elamite tablets, the organization of society and economy relied primarily upon a network of coequal, and at times competing, institutions (Yousefi *et al.*, in Press). Decision-making, resource allocation, and the regulation of economic flows were not necessarily undertaken by a single, centralized authority but through distributed and parallel structures (Alden, 1987). The layout of records and accounting systems in these texts clearly reflects multiple layers of interaction between households, labor groups, local administrators, and specialized entities.

For instance, the contents of certain tablets not only record the identification and tracking of individual household members or production groups but also indicate role flexibility and variability within administrative cycles. Responsibilities for auditing, ration management, or even oversight of production could, within short intervals, be transferred between individuals or units. Such a fluid and polycentric structure is itself evidence of societal capacity to adapt to external pressures and risks (such as climatic fluctuations or resource

[9] "Heterarchy**"** is a form of social organization in which elements are "unranked" or can be ranked in multiple, non-linear ways, allowing for simultaneous, overlapping systems of authority and coordination rather than a single, top-down hierarchy. In such systems, decision-making power and organizational control are distributed across individuals, groups, or institutions, with authority contingent on context rather than fixed structural dominance. Heterarchy is thus not the absence of structure, but rather an arrangement in which different nodes (actors, offices, or communities) maintain the capacity to influence or lead in varying domains, often through negotiation, reciprocity, and network interdependence rather than coercive command. In archaeological and anthropological theory, the concept was notably articulated by Crumley (1995) as an analytic framework for recognizing complex societies that integrate both hierarchical and non-hierarchical linkages. It challenges unilinear evolution models by showing that complexity can emerge without rigid stratification, and that governance, economic exchange, and social relations may operate in polycentric or multipath modes.

crises) and to meet the complex requirements of economic coordination.

5. Proto-Elamite Texts as Metrics of Complexity

Among the various classes of data available for assessing complexity in the earliest proto-urban societies, Proto-Elamite administrative tablets occupy a uniquely significant position. These documents not only record the everyday mechanisms of resource management, labor allocation, and information processing, but also capture, in direct form, the symbolic systems and institutional agendas of their time (Paladre, 2022; Kelley, 2024). Unlike architectural remains or settlement distribution patterns, which often yield generalized and sometimes indirect images of social structures, textual records enable the tracing of fine-grained details regarding accounting systems, sequences of operations, role assignments, and the communicative forms linking economic and administrative actors (Dahl *et al.*, 2018; Yousefi *et al.*, 2025c).

Moreover, analysis of the standardized and varied formats in which information was recorded allows researchers to decode the degree of flexibility and specialization within administrative affairs as reflected in the structure of the documents themselves. Consequently, the study and analysis of these tablets not only complement conventional archaeological approaches but also serve as an essential tool for uncovering the otherwise hidden, internal layers of complexity within Proto-Elamite societies, layers that, without a textual and content-focused approach, would remain largely obscured.

Undoubtedly, the content-based and structural analysis of Proto-Elamite tablets is significant not merely as a means of retrieving data related to economy and administration, but as a mirror reflecting the logic of organizational complexity and revealing the social and political dynamics of these communities. The study of Proto-Elamite tablets discloses a repository of internal metrics and indicators that illuminate the hidden yet foundational dimensions of the economic, administrative, and political institutions of Proto-Elamite society.

6. Indicators of Administrative and Bureaucratic Structuring in Proto-Elamite Data

One of the most salient characteristics of Proto-Elamite administrative records is their display of a high degree of formal and substantive stability (Yousefi Zoshk, 2010). The use of orderly tables, precise horizontal and vertical divisions, and the systematic arrangement of rows and columns all point to the establishment of fixed administrative procedures and instructions in this period (Damerow and Englund, 1989; Englund, 1998). Such structural consistency, in turn, presupposes the existence of formal training systems, in-service instruction, and the transgenerational transfer of supra-organizational knowledge (Dahl, 2005; 2009). This structural coherence not only enhanced administrative efficiency but also reinforced organizational stability and facilitated the transmission of managerial experience (Fig. 1).

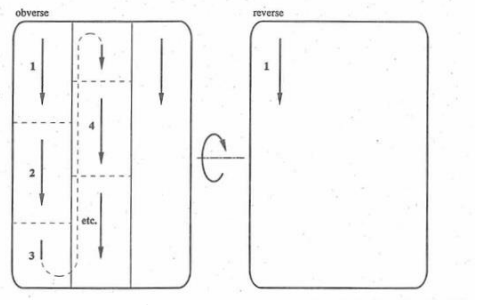


Figure 1. The layout of a Proto-Elamite tablet, illustrating those entries in Proto-Elamite texts, may extend across multiple lines Proto Elamite tablet organization. The numbers 1, 2, 3, indicate the heading (1) and individual text entries (2,3,4, etc) (After Damerow and Englund 1989)

Furthermore, the extensive application of standardized signs, specialized terminology, and conventionalized markers for classifying materials, goods, occupations, or centers reflects the deepening of bureaucratic processes and the differentiation of professional and administrative roles (Dahl, 2009). This phenomenon embodies both the "division of office labor" and the gradual formation of what can be termed "institutional memory[10]," the embedding of experience, knowledge, and operational rules not

[10] In theoretical terms, "institutional memory**"** refers to the collectively stored knowledge, experiences, practices, and rules of an institution that persist beyond the tenure of any single individual. It is an organization's long-term "cognitive infrastructure," embodied not only in written records, archives, and formal policies, but also in standardized routines, shared norms, and established procedures. Scholars in organizational studies consider institutional memory crucial for continuity, learning, and adaptive capacity, as it preserves solutions to past problems, codified expertise, and collective values (Walsh and Ungson, 1991: 57–61). In archaeology and ancient administration, it can manifest as persistent "bureaucratic habits," serialization of signs, or consistent classifying systems, mechanisms by which knowledge is stored and transmitted structurally, making the organization less dependent on specific personnel.

solely in individuals but within the procedural and structural frameworks of the organization itself (Walsh and Ungson, 1991). Equally significant is the utilization of multiple and context-specific numerical systems in the Proto-Elamite period, applied to distinct categories of goods, accounting headings, and transactional contexts (Yousefi *et al.*, 2025c). These systems encompassed varying numerical signs, metrological units, and recording conventions, each tailored for commodities such as livestock, grain, textiles, or labor obligations (Fig. 2). Such numerical diversity was not merely a reflection of practical counting needs but a sophisticated administrative strategy to enhance accuracy, prevent ambiguity, and streamline auditing processes (Dahl, 2009). The deliberate choice of specific numeration systems for different operational domains demonstrates a high degree of cognitive and institutional organization, underscoring the adaptability and specialization of early bureaucratic practice on the Iranian Plateau (Potts, 2016: 74–76).

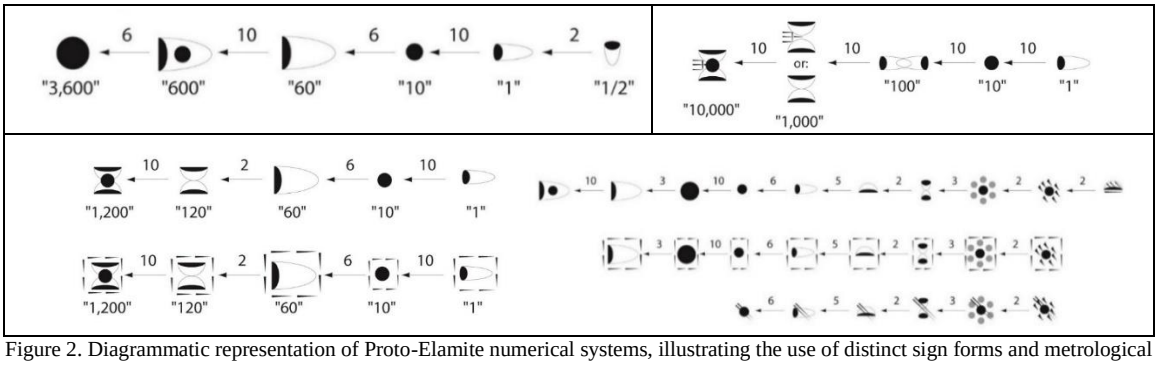


Figure 2. Diagrammatic representation of Proto-Elamite numerical systems, illustrating the use of distinct sign forms and metrological conventions for recording different categories of commodities and labor in administrative contexts (After Yousefi *et al.*, 2025c).

The explicit mention of personal names, references to officials, professional ranks, and administrative titles in texts and transactions demonstrates the mechanisms of responsibility delegation, oversight, and administrative control, indicating the existence of functional hierarchies and the systematic flow of task division within the Proto-Elamite administrative apparatus (Fig. 3). Such structured relationships and task allocations signal a movement toward more complex and multi-layered administrative configurations, serving as a prelude to the emergence of a bureaucratic order (Afshari, 2019; Etemadifar and Ahmadi Afzadi, 2022).

7. Internal Indicators Based on the Thematic Classification of Proto-Elamite Tablets

From the perspective of thematic and content classification, the Proto-Elamite tablets preserve a rich array of indicators for social complexity and transformation. These classifications not only make it possible to outline with greater precision the economic, administrative, and managerial structures of society but also serve as a window into the dynamics of social life, power relations, cultural approaches, and patterns of collective action during this formative period. Careful analysis of such categories, by highlighting multiple indicators of complexity, allows us to move beyond conventional and purely hierarchical descriptions toward an understanding of the dynamic, multi-layered processes centered around resource management, the distribution of power, institutional roles, and large-scale data practices. Accordingly, the classification of administrative and economic records yielding key complexity metrics can be summarized as follows:

7.1. Ration Disbursement Texts

Evidence from ration disbursement records clearly demonstrates the existence of standardized mechanisms for allocating resources to individuals, households, and various officials. These reveal not only an active and efficient administrative apparatus with the capacity to categorize and prioritize recipients by measurable criteria such as social standing, occupational role, or assigned duties, but also open avenues for studying the organization of social life at the micro-level. The method of disbursement, whether to a household head or to individuals, provides valuable information on household structure and small-scale resource allocation patterns, while disparities in ration quantities reflect embedded social and economic hierarchies. The very standardization of ration disbursement may be considered an indicator of social transformation, marking a gradual shift from

informal, personal-relationship-based systems toward rule-bound, organized practices that deepened and stabilized Proto-Elamite administrative, economic, and social structures (Fig. 4).

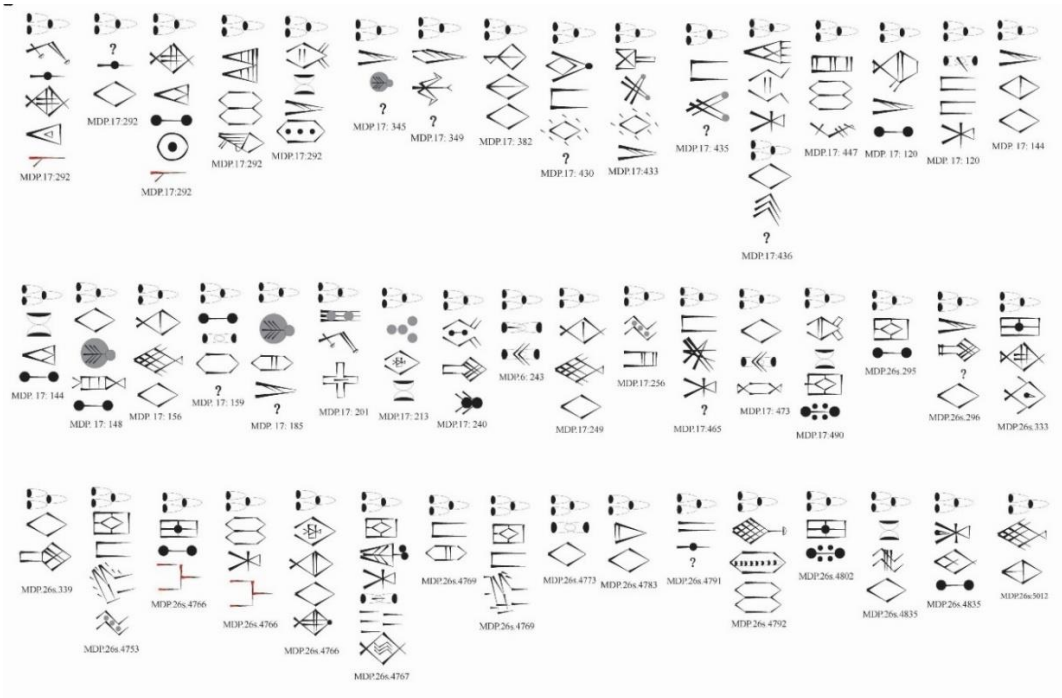
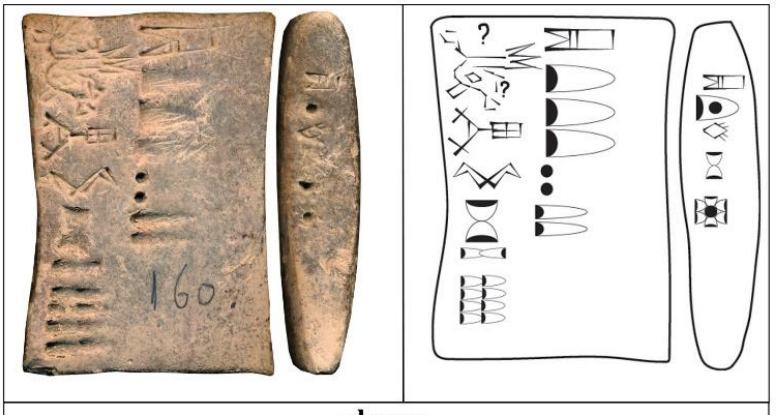


Figure 3. Example of Proto-Elamite personal names, references to officials, professional ranks, and administrative titles, providing evidence for hierarchical structures and role specialization within early bureaucratic systems (After Afshari, 2019).

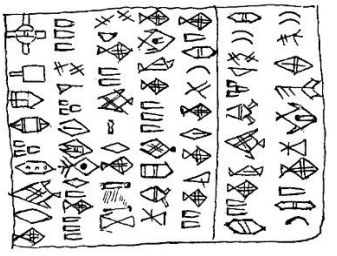


obverse	
1.	x ,
2.	M210~f M054 , 1(N51) 1(N23) 8(N01)
3.	M288 , 3(N34) 2(N14) 2(N01)
4.	M288 , 1(N48)
5.	x , 1(N24) 2(N30C)

Figure 4. Proto-Elamite ration disbursement tablet recording the allocation of food or goods to named individuals or work groups, illustrating the use of standardized numerical systems and administrative notation in the management of labor and resources (After Yousefi *et al.*, 2025c).

7.2. Taxation and Tribute Texts

Records of taxation and tribute offer direct evidence for the establishment of a complex system of authority capable of defining, assessing, and collecting various forms of taxes, whether in goods, services, or possibly currency, from different production units and individuals. These documents testify to the existence of a coherent framework for managing and safeguarding collected resources, along with the implementation of mechanisms for their assessment and collection. They reveal the intricacy of relationships between administrative bodies and productive groups such as farmers, pastoralists, and artisans, a network bound by reciprocal obligations and mutual legitimacy between state and society. The diversity of taxes and levies indicates an evolved and varied fiscal system intended to fund administrative costs, defense needs, and public projects, while simultaneously reflecting the institutional differentiation and expanded fiscal-administrative capacity that facilitated a transition toward more complex forms of socio-economic organization (Fig. 5).



obverse

1. M327~d, (*header)* 2. M157~a M292~i M305 M388 M301 M259 M218 M263, 3(N01) 3. M048~k M033 M388 M219 |M218+M288| M250~ba M218 M386~a? M263~a, 3(N01) 4. M048~k x M263~a, 2(N01) 5. M259 M390# M218 M263~a M373#? x M101 M263~a M281~f M329? M263~a, 3(N01) 6a. M255 M293~c M242~d M096 M263~a, 1(N01)

6b. M297, 1(N39B) 7a. M048~k#? M263~a M219 M263~a M106 M263~a, 2(N01) 7b. M297, 2(N39B) 8a. M048~k M033 M388 M242~d M259 M329? M263~a, 2(N01) 8b. M297, 2(N39B) 9a. M048~c M223~b M251~c3 M281~f M096 M263~a, 1(N01) 9b. M297, 1(N39B)

reverse

column 1

1. [...], 1(N01) 1(N39B) 2. M297, 1(N01) 1(N39B)

Figure 5. Proto-Elamite tax or tribute payment tablet documenting the delivery of commodities to central authorities, reflecting the integration of numerical systems and administrative titles in the regulation of fiscal obligations (After CDLI).

7.3. Animal-Husbandry Texts

Livestock records, detailing numbers, species, ages, and sexes of animals as well as feed allocations, offer unequivocal proof of advanced accounting and management systems in this sector, systematically monitoring and organizing animal husbandry as a central economic pillar. They reflect comprehensive oversight aimed at multi-purpose exploitation, milk, meat, wool, and the economic valuation of livestock. Such monitoring was essential to sustaining a more complex economic order within the Proto-Elamite social framework. The statistical precision and regular recordkeeping also signal a gradual shift from subsistence-based herding toward a larger-scale, organized system integrated into the communal economy and management processes (Fig. 6).

7.4. Household Wealth

Inventories of the assets and resources of prominent households reflect a social structure in which power and wealth were distributed through decentralized, kin-based networks. Each household functioned as a self-contained economic and social unit, pivotal in accumulating, managing, and transmitting wealth. These documents highlight the foundational role of family structure in organizing production and resource distribution, while illustrating the deep entanglement between kinship ties, economic relations, and social legitimacy. Within these familial networks, production, cooperation, competition, and even inter-family alliances took shape. Analysis of these records illuminates patterns of competition and collaboration, showing that Proto-Elamite balances of wealth and power rested on fluid, multi-directional interactions among household-economic units (Fig. 7).

obverse
1. M157~a, (*header)* 2. M343 M388 M004 |M218+M101|? M371 M346, 2(N14) 2(N01) *en: 22 female sheep belonging to x* 3. M139# M004 |M218+M101? |# M371, 9(N01) *en: 9 belonging to x* 4. M352~c M346, 1(N14) 8(N01) # *en: 18 female sheep belonging to x* 5. M057~a1 M346, 1(N14) 6(N01) *en: 16 female sheep belonging to x*
reverse
1. M346, 6(N14) 5(N01) e*n: (total) 65 female sheep* **top**1. M139,

Figure 6. Proto-Elamite animal husbandry tablet recording the enumeration, classification, and allocation of livestock, illustrating the use of specialized numerical systems and administrative terminology in pastoral management (After CDLI).

obverse
1. M157, (*header)* 2. M387~c M384~d M054 M387~l M263~b1, 1(N01) 3. |M036+1(N30D) |, 5(N01) 4. M388 M265~f, 5(N01) 5. M354, 5(N01) 6. M122~6 M265~f, 4(N01) 7. M354, 4(N01)
8. M103 M111~a M323# M354, 3(N01) #
reverse
column 1
1. M297, 2(N39B) 2(N30C) 1(N30D) 1(N39C) **top** 1. 1(N34)

Figure 7. Proto-Elamite household wealth tablet documenting the possession and distribution of goods within a domestic unit, reflecting the role of numerical systems and administrative notation in tracking property, assets, and resource allocation (After CDLI).

7.5. Labor and Workforce Allocation Texts

Labor records meticulously list individual names, task types, and associated payments, providing clear evidence for the specialized division of labor and the increasing professionalization of occupations. These suggest the need for precise management and organization of human resources for specific projects or tasks, as well as systematic oversight of performance through continuous monitoring of work and remuneration, ensuring productivity, quality control, and cost management. The quantity and variety of such records point to fundamental shifts in labor markets and employment practices, progressively moving beyond purely household-based or slave-based systems toward new forms of contractual and waged work, themselves indicators of growing social and economic complexity (Fig. 8).

7.6. Agricultural and Horticultural Texts

These documents detail a wide variety of crops, the use of diverse measurement units (area, weight, volume) for land and produce, and descriptions of different management practices for fields and gardens. They reflect elevated levels of specialization in agriculture and the adaptive flexibility of accounting systems to the multiple requirements of this sector. Beyond recording technical skill and administrative adaptability, they reveal the implementation of strategic resource management—particularly of land and water—that underpinned survival, resilience, and development. Crop diversity and innovative management practices affirm that the Proto-Elamite economy was both innovative and adaptable, capable of meeting changing environmental conditions and growing subsistence needs (Fig. 9).

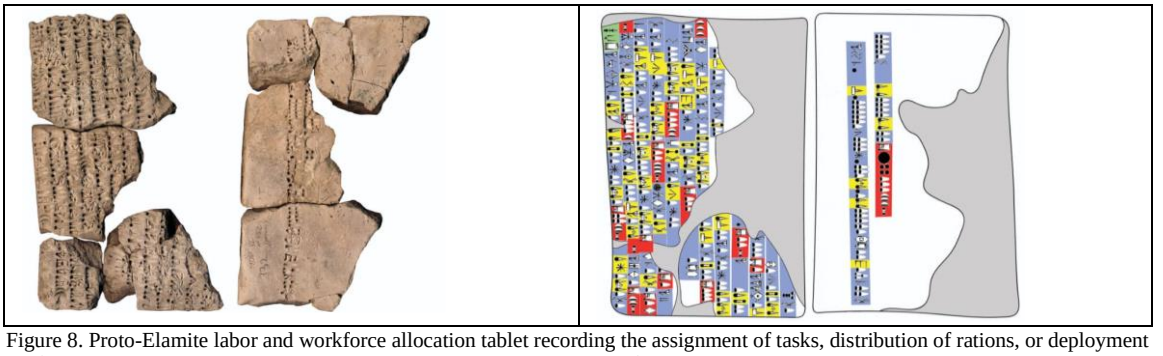
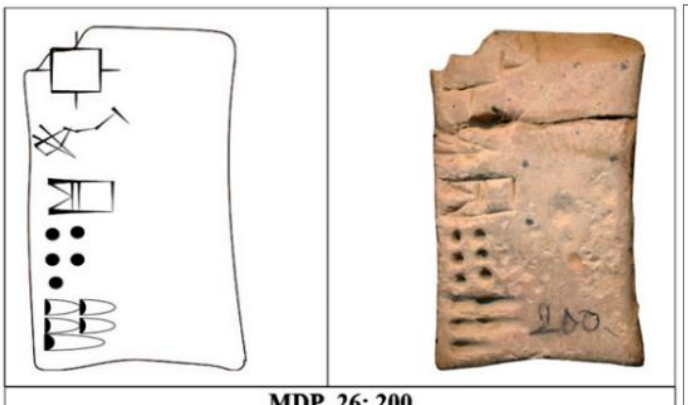
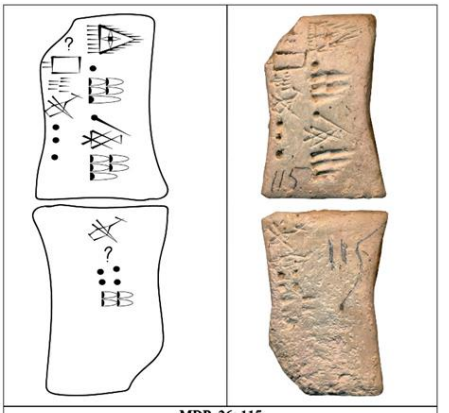


Figure 8. Proto-Elamite labor and workforce allocation tablet recording the assignment of tasks, distribution of rations, or deployment of personnel across various work units, demonstrating the integration of numerical systems and administrative terminology in the organization of labor within early bureaucratic structures (After Etemadifar and Yousefi, 2024).



MDP. 26: 200			
obverse			
1.	M195, *(header)*	2.	M056~f M288, 5(N14) 5(N01)
Reverse	(*blank space*)		

Figure 9. Proto-Elamite agricultural and horticultural tablet documenting the cultivation, harvesting, and allocation of crops or garden produce, reflecting the application of specialized numerical systems and administrative notation in the management of agrarian resources (After Yousefi *et al.*, 2025a).



MDP. 26: 115			
obverse			
1.	X, *(header)*	2.	M157 M010~2 M056~f, 3(N14)
3.	|M136+M365|, 1(N14) 5(N01)		X M471, 5(N01) 1(N14)
reverse			
1.	M056~f X, 4(N14) 4(N01)		

Figure 10. Proto-Elamite administrative tablet exhibiting decentralized organizational structures, where record-keeping reflects the distribution of authority across multiple local administrative units, illustrating the flexible application of numerical systems and administrative conventions outside a fully centralized bureaucracy (After Yousefi *et al.*, 2025a).

7.7. Administrative Texts with Decentralized Structures

The presence of records with varied headings and formats clearly indicates a multi-layered, decentralized administrative system in which distinct units, each enjoying a degree of autonomy, undertook their own documentation and reporting. This diversity evidences both the presence and competition of local and regional powers with differing organizational patterns and a form of coexistence and interaction among them. Variation in documentation styles points to a high degree of administrative flexibility, enabling the system to adapt to environmental and social changes while supporting multi-level and responsive governance within the Proto-Elamite political-administrative framework (Fig. 10).

7.8. Large-Scale Data Texts

"Macro-data" records from the Proto-Elamite period—documenting massive quantities of stored grain, livestock numbers, and other aggregated resources—attest to societal capacity for large-scale resource management in response to demographic, military, and economic demands. They further reflect a high degree of informational sophistication, precise counting tools, and advanced data-organization methods enabling the systematic collection and processing of such data. This level of informational and administrative maturity provided a foundation for planning and forecasting in production, distribution, and allocation, paving the way for sustainable development and effective decision-making in Proto-Elamite socio-economic and political structures.

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)		

Figure 11. Proto-Elamite large-scale data tablet consolidating extensive records of commodities, personnel, and transactions across multiple administrative sectors, illustrating the capacity of early numerical systems and notation conventions to manage complex datasets within expansive bureaucratic networks (After Yousefi *et al.*, 2025c).

8. Conclusion

The assessment of the thematic range and structural features of Proto-Elamite administrative and economic tablets illuminates the intricate and adaptive nature of early complex societies in the Iranian Plateau. The diversity of record types, from granular accounts of livestock herding and ration allocation to high-order compendia of aggregated economic data, reveals an administrative tradition that was both methodologically sophisticated and operationally flexible. Rather than adhering to a monolithic chain of bureaucratic command, Proto-Elamite governance structures appear to have relied on a constellation of polycentric nodes, each equipped to manage specific domains of production, distribution, and decision-making.

This multi-sited and often heterarchical organization facilitated the simultaneous operation of local autonomy and supra-regional integration, enabling communities to

adapt to varied ecological conditions, resource bases, and socio-political contingencies. The coexistence of standardized accounting systems with regionally nuanced administrative practices underscores the balance between institutional consistency and contextual responsiveness, a balance that may have been central to the system's longevity and reach. By embedding distributive and managerial mechanisms within a dense web of interdependent actors, the Proto-Elamite system demonstrated that complexity could be generated and sustained without reliance on rigid centralization.

These findings contribute to a growing body of archaeological and anthropological research that re-evaluates the pathways by which complexity emerges, challenging unilinear evolutionist and state-centric paradigms. The Proto-Elamite case underscores the analytical value of heterarchy, polycentricity, and adaptive governance as explanatory models, not as anomalies but as intentionally engineered modes of societal coordination. In doing so, it reframes our understanding of early bureaucratic systems as dynamic, network-based constructions capable of maintaining high levels of economic integration, institutional resilience, and social cohesion in the absence of an omnipresent central authority.

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Conflict of Interest Statement

In adherence to ethical publication standards, the authors affirm that there are no conflicts of interest, either personal or financial, that could have influenced the content or conclusions presented in this research.

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