

Scientific Professionalism Among Iranian Scientific Associations: Beyond Sociology and Liberal Academic Contexts

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Abstract

This article examines how scientific professionalism is organized under institutional constraints and structural pressures. It extends Burawoy's fourfold typology—professional, critical, policy, and public—beyond sociology to other sciences, focusing on Iranian scientific associations. Professional work concerns intra-disciplinary standards; critical work reflects scientific assumptions and practices; policy work addresses institutional problem-solving and decision-making; and public work connects expert knowledge to wider publics. Drawing on survey data from 100 active Iranian scientific associations, the article shows that all four forms of professionalism can be identified beyond sociology, but not as clearly distinct roles. Scientific professionalism in Iran is weighted toward the professional dimension: critical reflection remains largely embedded in professional standards, while public and policy engagement overlap through semi-formal or institutional channels. In summary, typologies developed within liberal academic environments require reinterpretation when applied to non-liberal contexts characterized by centralized governance and oversight, metric-driven evaluation, limited public visibility, and political influence.

Keywords

Scientific professionalism, scientific associations, intra-academic professionalism, extra-academic professionalism, non-liberal context, institutional ecology, Iran

Introduction

Professions are not simply occupations governed by socially valued norms; they are also organized around specialized knowledge, institutionalized credentials, jurisdictional boundaries, and forms of labor-market shelter that distinguish them from other forms of work (Abbott, 1988; Freidson, 2001). At the same time, professions are commonly associated with claims to autonomy, public service, and socially valued responsibility (Sullivan, 2005). Professions have played a pivotal role in modernity: on the one hand, by linking social cohesion to the moral consequences of the division of labor (Durkheim, 2014); and on the other, by articulating the moral foundations of rational capitalism (Weber, 2001). Building on these classical foundations, subsequent theoretical traditions—from Parsons (1968) to Abbott (1988) and Freidson (2001)—have elaborated the institutional, structural, and power-laden dimensions of professional life, thereby deepening our understanding of professions as key institutions of modern social order. Within this tradition, the academic profession has been understood as a “key profession” (Perkin, 1969, p. 227), while academic work has been described as “the most pure professional work” (Abbott, 1988, p. 118), both as a body of knowledge and as a professional institution. This perspective draws on studies such as Merton’s (1973) ethos of science, Ben-David’s (1972) organizational analyses, and Mitroff’s (1974) discussion of counter-norms, highlighting features such as epistemic autonomy, collective self-governance, and peer-mediated quality control (Mieg, 2022). Although most research—particularly in the Global North—has focused on the internal characteristics of science, the definition of scientific professionalism (SP) and its relationship to the external environment remain contested, with notable exceptions such as Burawoy’s (2004) framework, which extends professionalism beyond purely disciplinary concerns. This contestation becomes especially significant when attention shifts from individual scientists to scientific associations as collective professional actors. Scientific associations are often regarded as “representatives of the profession” (Bird, 1998, p. 316), insofar as they help define standards, articulate disciplinary interests, and serve as organized arenas in which expert knowledge may be connected to broader social concerns and institutional expectations. In this respect, they offer a particularly useful site for examining the collective and multidimensional character of scientific professionalism.

In response to these debates, this study draws on Burawoy’s typology of sociology (Burawoy, 2005, pp. 9–11) and extends its analytical logic beyond sociology to the broader field of scientific professionalism in Iranian scientific associations. Although Burawoy’s framework has been influential and widely debated (Abbott, 2007; Holmwood, 2007; Turner, 2005; Wallerstein, 2007), this study examines whether Iranian scientific associations exhibit forms

of scientific professionalism beyond narrowly disciplinary and positivist orientations, particularly in their critical and extra-academic dimensions. Over the past two decades, Iran has experienced substantial scientific growth¹, and scientometric indicators show a steady increase in the country's scientific output, placing Iran prominently in global rankings (Islamic World Science Citation Center [ISC], 2024; Yaminfirooz et al., 2024). At the same time, structural challenges such as centralized control, metric-based evaluation, and political restrictions on professional activity have persisted (Heshmati & Dibaji, 2019; Mirzaie & Qarakhani, 2014; Nasiri et al., 2015; Tarikhi, 2020). Complementing this structural emphasis, previous studies have examined how institutional structures and scientific actors jointly shape professional practices (Mirzaie & Qarakhani, 2014; Qarakhani & Mirzaie, 2014, 2016). Iranian scientific associations have also been identified in Iranian policy and research sources as intermediary actors linking the scientific community to policy-making and national decision-making processes (Farasatkah, 2007; Khalifeh Soltani et al., 2012). Despite their expansion and the significant functions expected during this period, these associations have faced serious challenges in maintaining professional autonomy and sustaining their activities (Ghaneirad, 2006; Ghaneirad et al., 2019; Khosrokhavar et al., 2007; Qarakhani & Mirzaie, 2022). Drawing on survey data from active Iranian scientific associations, this study examines how scientific professionalism is configured in a setting where centralized licensing, metric-based evaluation, and politically mediated visibility redefine the boundaries of public engagement. Rather than proposing a universal alternative to Burawoy's typology, this study operationalizes and empirically tests its dimensions and examines how they are reconfigured within a non-liberal scientific environment.

Burawoy's typology of sociological professionalism

Over the past two decades, Burawoy's model of professionalism in sociology has been widely discussed, with numerous studies and reviews highlighting its significance (e.g., Burawoy, 2004, 2005, 2007, 2021). Inspired by Mills's *The Sociological Imagination* (1959), which critiques conventional American sociology and emphasizes its scientific and ethical dimensions, Burawoy highlights the persistent gap between sociological knowledge and the public sphere. Developed in response to the depoliticization and commercialization of academia, Burawoy's (2004, 2005) model of professionalism seeks to restore the critical and public dimensions of scientific practice. In his 2004 ASA presidential address², entitled "For Public Sociology", Burawoy advocates public engagement as a means for sociology to confront its relevance crisis. He centers the framework on the questions of for whom and for what sociology is pursued and emphasizes the interdependence of the four forms of sociological work (Burawoy, 2005).

In his model of the "division of sociological labor," Michael Burawoy (2005, p. 4; 2021, p. 36) identifies four types of sociological knowledge—professional, critical, policy, and public—each representing a distinct form of professionalism within the discipline. Professional sociology, as the core of the discipline, represents the mainstream of sociological knowledge. It "includes research conducted within research programs that define assumptions, theories,

concepts, questions, and puzzles” (Burawoy, 2005, p. 12) and is considered the “sine qua non” of policy, public, and critical sociologies (Burawoy, 2005, p. 10). Critical sociology involves “critical debates of the discipline within and between research programs” (Burawoy, 2005, p. 12). It entails the scrutiny and evaluation of concepts, normative and descriptive hypotheses, and professional practices across the discipline. Critical professionalism raises two central questions: Why do professionals pursue their work, and who benefits from it? Policy sociology involves “defense of sociological research, human subjects, funding, congressional briefings” (Burawoy, 2005, p. 12). Burawoy defines it as “sociology in the service of a goal specified by a client. Policy sociology’s *raison d’être* is to provide solutions to problems presented to us, or to legitimate solutions that have already been reached” (Burawoy, 2005, p. 9). Public sociology “brings sociology into a conversation with the public, understood as people who are themselves involved in the conversation” (Burawoy, 2005, p. 7). Public sociology emphasizes the responsibility of science and scholars to address urgent issues such as climate change, human rights, refugee crises, and racism. In this form, the sociologist collaborates closely with a visible, engaged, and active local community to reveal the unseen and transform the private into public (Zussman & Misra, 2007).

Burawoy (2005) organizes these four professionalisms along two axes: intra-academic (professional, critical) versus extra-academic (policy, public), and instrumental (professional, policy) versus reflexive (critical, public). In a comparative study, he outlines distinct priorities in national models of sociology: the U.S. combines professional and policy sociology; Soviet sociology was largely aligned with the party-state, while post-Soviet Russian sociology shifted toward market-driven policy research; South Africa emphasizes public engagement alongside critical sociology; and Norway balances public sociology with welfare-state collaboration (Burawoy, 2004).

Despite its influence, Burawoy’s typology has been the subject of wide-ranging critique on epistemological, institutional, and practical grounds. Scholars argue that it imposes overly rigid boundaries and neglects the hybrid and fluid character of sociological practice (Abbott, 2007; Brint, 2005; Holmwood, 2007; Patterson, 2007; Tittle, 2004; Turner, 2005; Wallerstein, 2007), a shortcoming made especially visible in non-Western contexts (Arribas Lozano, 2018; Quah, 2005, 2011; Webster, 2004). Conceptually, the instrumental-reflexive dichotomy is viewed as untenable (Abbott, 2007; Morrow, 2009; Powell, 2013; Wallerstein, 2007). Critics further contend that privileging critical or activist forms risks dogmatism, undermines objectivity, and politicizes professional associations (Deflem, 2005; Goldberg & van den Berg, 2009; Holmwood, 2007; Massey, 2007; Turner, 2005). Among the four types, public sociology has attracted the most substantial criticism. Patterson (2007) argues that it should also encompass policy work undertaken by sociologists for governments or private organizations. Others caution that privileging consensus over empirical rigor undermines scientific standards (Smith-Lovin, 2007; Stinchcombe, 2007; Tittle, 2004). Wallerstein (2007) goes further, rejecting the category altogether, insisting that all sociologists are, by definition, public sociologists.

Institutionally, critics highlight the model's Western bias and its failure to account for diverse organizational settings. Empirical studies document how neoliberal reforms, such as those in post-apartheid South Africa, redirected sociology toward policy-driven research while marginalizing public engagement (Webster, 2004). Meanwhile, Quah (2005, 2011) emphasizes the importance of context-sensitive professionalism. The typology is also criticized for neglecting disciplinary pluralism (Holmwood, 2007) and for overlooking interdisciplinary perspectives, including those in gender and race studies (Glenn, 2007). In response, several alternative frameworks have been proposed as correctives: Turner's (2005) distinction between humanistic and scientific sociology, Abbott's (2007) ethically grounded approach, Wallerstein's (2007) cognitive-ethical-political model, and Quah's (2005, 2011) dual mission that combines knowledge production with social engagement. Taken together, these critiques highlight recurring conceptual, institutional, and practical challenges in Burawoy's typology, underscoring the need for empirical research on how scientific professionalism is configured across different contexts, particularly in non-liberal settings.

Research design and methods

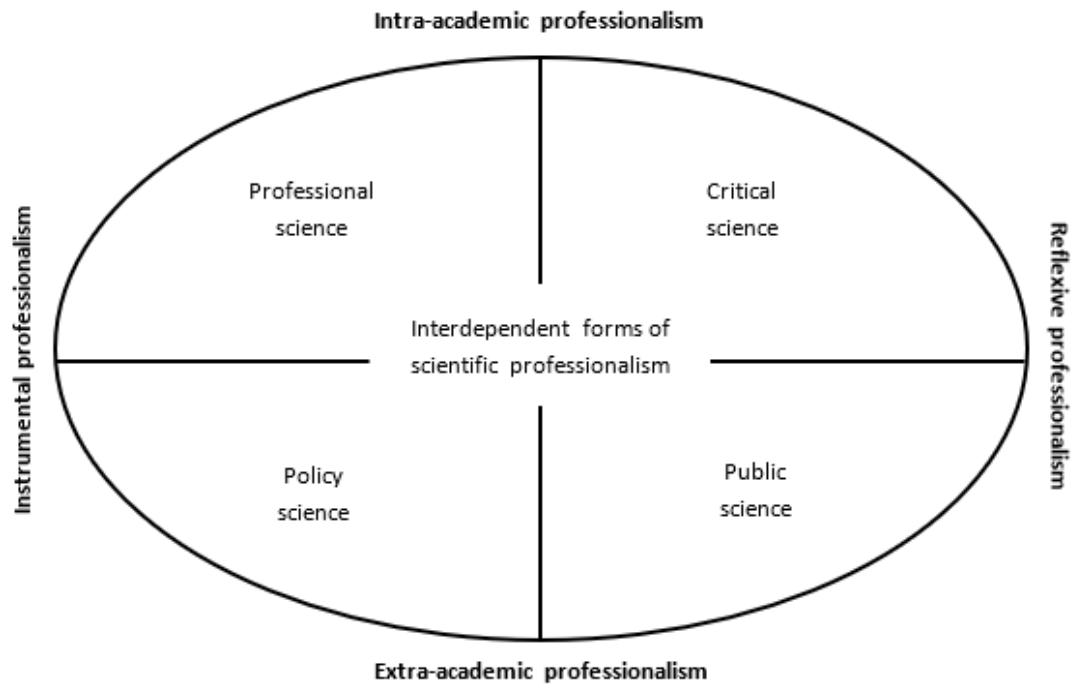
This study adopts a quantitative empirical approach to examine scientific professionalism and assess how Burawoy's typology can be extended beyond sociology to conceptualize, measure, and analyze it within Iranian scientific associations. The research design comprises three interconnected components: (1) the conceptual extension of the typology of scientific professionalism; (2) the design and validation of a dedicated scale to measure scientific professionalism in the Iranian context; and (3) the empirical assessment of scientific professionalism among active scientific associations in Iran at the time of data collection.

Toward a typology of scientific professionalism

This study builds on Burawoy's (2005) typology of sociology as a profession and, while considering the critiques directed at it, extends its analytical logic to the broader domain of science. Burawoy identifies four types of professionalism—professional (PRP), critical (CRP), policy (POP), and public (PUP)—and situates them along two cross-cutting dimensions: intra-academic versus extra-academic, and instrumental versus reflexive. In the present analysis, this fourfold typology is retained, while the two dimensions of intra-/extra-academic (IAP/EAP) and instrumental/reflexive (IP/RP) are employed as an analytical framework for systematically mapping the orientations of scientific professionalism. This perspective assumes that science is not confined to purely intra-disciplinary self-regulation, but extends into institutional, political, and civic arenas and engages heterogeneous audiences, stakeholders, and constituencies. Extending this framework beyond sociology requires attention, first, to the plural character of scientific practice across disciplines and, second, to the dynamic interaction between disciplinary professional norms and broader social demands. Accordingly, the typology presented here, and illustrated in Figure 1, should be understood not as a mechanical reproduction of Burawoy's model, but as an effort to apply its analytical logic to the broader field of scientific professionalism.

Figure 1

Types of scientific professionalism



Note. The authors' conceptualization of scientific professionalism extends and reconfigures Burawoy's (2005) typology of sociological work. The four forms are analytically distinct but interdependent. The model implies neither a fixed sequence nor equal, symmetrical, or causal relations among them; their interrelations may instead be reciprocal, differentiated, and context-dependent.

In Burawoy's original formulation, public sociology emphasizes dialogue through civil society and the media, whereas critical sociology carries a stronger normative orientation toward questioning disciplinary assumptions. In this study, public professionalism is operationalized as extra-academic civic engagement and critical professionalism as epistemic and methodological reflexivity. This re-specification is particularly relevant in Iran and in cross-disciplinary research, where channels of public engagement are more restricted and uneven, and not all fields engage society or express the normative dimension of critical professionalism in the same way. For this reason, the study emphasizes more general, measurable, and comparable indicators of public and critical engagement.

Methodologically, this extended typology serves as a context-sensitive tool for analyzing scientific professionalism in Iranian scientific associations, which occupy a distinctive position within Iran's scientific ecosystem at the intersection of disciplinary life, state regulation, and

societal engagement. These associations operate under official state authorization, are supervised by the Commission of Scientific Associations of the Ministry of Science, Research and Technology, and are required to submit annual activity reports based on formally prescribed indicators. Given these characteristics, the present scale was developed to identify distinct forms of scientific professionalism, their relationships, and their potential roles in linking academic and extra-academic orientations under Iran's structural constraints and institutional requirements. Two main research questions guide the study:

1. To what extent can the proposed scale reliably and discriminatively assess the dimensions of scientific professionalism within Iranian scientific associations?
2. What configurations of scientific professionalism emerge among Iranian scientific associations, and how are these configurations shaped by structural and institutional constraints in a non-liberal context?

Sample selection and data collection

The survey was conducted among Iranian scientific associations to address the research questions and collect data. In recent decades, Iranian scientific associations have proliferated, and their activities are regularly evaluated and ranked using the "Performance Evaluation Indicators" by the Commission of Iranian Scientific Associations (CISA, 2016). According to the official list issued by CISA, which operates under Iran's Ministry of Science, Research and Technology (MSRT), 322 scientific associations were registered and licensed at the time of the study. Most of these associations are based in Tehran, with some located in other cities throughout Iran. They cover a range of academic fields, including Humanities and Social Sciences, Basic Sciences, Engineering and Technology, Agriculture, Interdisciplinary Studies and Art (CISA, 2021). Initially, we planned to survey all 322 associations listed by CISA, but we later focused on 164 active associations. According to CISA, about half of the associations were inactive at the time of the survey. Therefore, questionnaires were sent to all active scientific associations. The participants included presidents, vice presidents, or board members representing their scientific societies. After a four-month data collection period from May to August 2017, 105 questionnaires were returned, for a response rate of approximately 64% among active associations. After excluding incomplete responses and duplicate entries, 100 valid questionnaires remained (see Appendix A). These represent roughly 61% of active Iranian scientific associations and were included in the final analysis, as shown in Table 1.

Table 1*Disciplinary Distribution of Iranian Scientific Associations*

Disciplinary field	Population		Sample	
	Frequency	Percent	Frequency	Percent
Basic Sciences	14	8.5	13	13.0
Engineering and Technology	46	28.0	21	21.0
Agriculture	21	12.8	16	16.0
Humanities	27	16.5	15	15.0
Social Sciences	28	17.1	17	17.0
Interdisciplinary Studies	25	15.2	15	15.0
Art	3	1.8	3	3.0
Total	164	100%	100	100%

Note. Authors' calculations based on the CISA list of scientific associations (2021).

Measurement and analytical strategy

The SP scale was developed and evaluated through a multi-step analytical process. Descriptive statistics were computed to examine items and dimension distributions. Internal consistency was assessed using Cronbach's alpha and McDonald's omega, and construct validity was tested via exploratory factor analysis. Relationships among dimensions of scientific professionalism were examined using Spearman's rank-order correlations. To evaluate variation across groups, ANOVA was used, and cluster analysis was used to identify broader typological patterns in SP orientations. Overall, these analyses provided the foundation for assessing item performance, validating the scale, and understanding the empirical structure of scientific professionalism in the Iranian context.

Development and validation of the SP scale

Guided by the study's conceptual framework and expert input from the sociology of science, an initial pool of 40 items was developed. Content validation involved iterative expert review and cognitive pretesting with presidents of Iranian scientific associations to ensure clarity, relevance, and domain coverage. Responses were recorded on a five-point Likert scale from 1 (unimportant) to 5 (very important). Following item analysis in the main survey, the item pool was reduced to 23 items (see Appendix B). Items were eliminated for redundancy, low corrected item-total correlation, adverse effects on α/ω , low communality, weak or cross-loadings in factor analysis, or problematic distributions (e.g., ceiling or floor effects). The final 23-item instrument retained coverage of the four theorized dimensions—Professional, Critical, Policy, and Public. Internal consistency for the overall scale was excellent (Cronbach's $\alpha = .943$; McDonald's $\omega = .942$). Cronbach's alpha was calculated on complete cases after listwise deletion of item-level missing responses, and reliability estimates for the four subscales were also strong (Table 2). Overall, these results support the internal coherence of the SP scale and its usefulness for examining variation across Iranian scientific associations.

Table 2*Reliability Coefficients for SP Subscales*

SP subscale	Number of items	Cronbach's α	McDonald's ω
Policy	7	.916	.918
Public	5	.919	.918
Critical	4	.846	.853
Professional	7	.855	.857

Note. Authors' calculations based on collected data.

The reliability estimates ($\alpha = .846-.919$; $\omega = .853-.918$) and the retained four-factor structure indicate that the 23-item SP scale has satisfactory internal consistency and can be used to examine variation across scientific associations.

Structure of scientific professionalism

Sampling adequacy was satisfactory ($KMO = .873$), and Bartlett's test of sphericity was significant, $\chi^2(253) = 1614$, $p < .001$, indicating that the inter-item correlation matrix was suitable for factor analysis. To examine the dimensional structure of the 23-item SP scale, an exploratory factor analysis (EFA) was conducted using principal axis factoring (PAF) with Promax rotation. An oblique rotation was preferred because the four dimensions of scientific professionalism—public, policy, professional, and critical—were conceptually related and not expected to be orthogonal (Table 3). The initial unrestricted solution suggested a five-factor structure based on the Kaiser criterion (eigenvalues greater than 1). However, inspection of the scree plot indicated a clear leveling off after the fourth factor, supporting a more parsimonious four-factor solution. Closer inspection also showed that the fifth factor was weak and not theoretically interpretable (see Appendix C). Because it was supported by only a narrow cluster of items and did not represent a substantively distinct dimension, it was not retained. Instead, a four-factor solution was adopted, as it provided a more parsimonious and theoretically meaningful representation of the SP scale.

Table 3

Variance Explained by Scientific Professionalism Dimensions

Types of SP	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% Variance	% Cumulative	Total	% Variance	% Cumulative
Public	10.430	45.346	45.346	10.092	43.877	43.877
Policy	2.757	11.987	57.333	2.363	10.273	54.150
Professional	1.672	7.271	64.604	1.350	5.869	60.019
Critical	1.139	4.952	69.555	0.769	3.343	63.362

Note. Extraction method: principal axis factoring. Rotation method: Promax with Kaiser normalization. The rotation converged in 5 iterations.

Authors' calculations based on collected data.

The analysis supported a substantively interpretable four-factor solution broadly consistent with the theorized structure of the SP scale. The rotated pattern matrix was broadly consistent with the conceptualized four-dimensional structure of scientific professionalism (Table 4). The public dimension emerged most clearly through NGO-oriented and civic engagement; the policy dimension through collaboration with governmental and applied institutional actors; the professional dimension through disciplinary stewardship and internal professional regulation; and the critical dimension through critical reflection on established norms, reward structures, and theoretical or methodological frameworks.

Table 4*Factor Loadings Matrix for Scientific Professionalism Items*

Items of SP	Extra-academic		Intra-academic	
	Public	Policy	Professional	Critical
Joint publications with NGOs	.881			
Taking members from NGOs	.846			
Membership in NGOs	.837			
Research collaboration with NGOs	.791			
Applying knowledge to assist and support NGOs	.783			
Applying knowledge in government service		.978		
Research collaboration with government agencies		.819		
Research cooperation with the private sector		.780		
Applying knowledge in the private sector		.744		
Joint publication with government agencies		.722		
Taking members from governmental organizations		.472		
Joint publications with the private sector		.438		
Working with academic departments to protect knowledge			.751	
Validating knowledge dissemination			.857	
Sensitivity to the knowledge content and its quality			.736	
Recruiting specialists with professional competence			.594	
Challenging established knowledge			.505	
Critiquing existing research			.461	
Critique of teaching methods and knowledge transfer			.436	
Questioning established norms of the knowledge				.814
Critique of resource and reward allocation methods				.802
Criticizing theoretical and methodological frameworks				.580
Assessment of knowledge implementation procedures				.510
Number of items	5	7	7	4

Note. The items were originally written in Persian and are presented here in approximate English translation.

Extraction method: principal axis factoring. Rotation method: Promax with Kaiser normalization. Factor loadings below .40 were suppressed. The rotation converged in 5 iterations.

Authors' calculations based on collected data.

As shown in Table 4, the four dimensions are empirically distinguishable but not fully separate in practice. Several items expected to load on Critical loaded more strongly on the professional dimension, suggesting that, in the Iranian context, some critical practices remain embedded within routine professional standards rather than institutionalized as a fully separate sphere. Likewise, the proximity between the public and policy dimensions indicates that extra-academic engagement often combines civic, governmental, and applied forms of action. Overall, Table 4 supports a coherent four-dimensional structure while also highlighting meaningful overlaps among adjacent dimensions.

Correlational patterns of scientific professionalism

The correlation matrix shows a structured yet uneven layout of scientific professionalism. The strongest within-domain connection occurs in the extra-academic sphere, where policy engagement and public participation are closely linked (policy-public, $\rho = .71$). This indicates that organizations active in the policy field are often also involved in the public realm. Inside the intra-academic area, the professional and critical dimensions exhibit a strong correlation ($\rho = .66$), suggesting that critical reflexivity typically remains part of professional standards rather than evolving into a fully independent sphere. Cross-domain correlations are somewhat higher for critical than for professional, but the overall pattern is better understood not as evidence of critical being the main organizing principle, but rather as a sign of overlap and uneven differentiation among the four dimensions.

Table 5

Correlation Matrix for SP Dimensions

SP	Professional	Critical	Policy	Public
Professional	-	.66**	.47**	.50**
Critical		-	.57**	.57**
Policy			-	.71**
Public				-

Note. Values are Spearman's ρ ; all coefficients are significant at $p < .01$ (two-tailed). Pearson r replicates the same ordering and comparable magnitudes.

Authors' calculations based on collected data.

Taken together, the matrix supports an interpretation in which the intra-/extra-academic divide is more pronounced than the instrumental/reflexive contrast. In this configuration, the professional dimension remains the core and most stable, while extra-academic engagement is expressed most clearly in the close pairing of Policy and Public. Overall, the correlational pattern suggests that scientific professionalism in the Iranian case is organized less around sharply differentiated, separate roles and more around a shared professional core that extends unevenly into extra-academic domains.

Disciplinary variation in scientific professionalism

Among the four dimensions, the professional dimension had the highest mean score ($M = 4.25$, $SD = .64$), indicating that internal professional regulation and knowledge stewardship were the most strongly endorsed forms of scientific professionalism. Policy ($M = 3.84$, $SD = .91$) and critical ($M = 3.73$, $SD = .86$) ranked in the middle, whereas the public dimension had the lowest mean score ($M = 3.65$, $SD = 1.02$), suggesting a comparatively weaker orientation

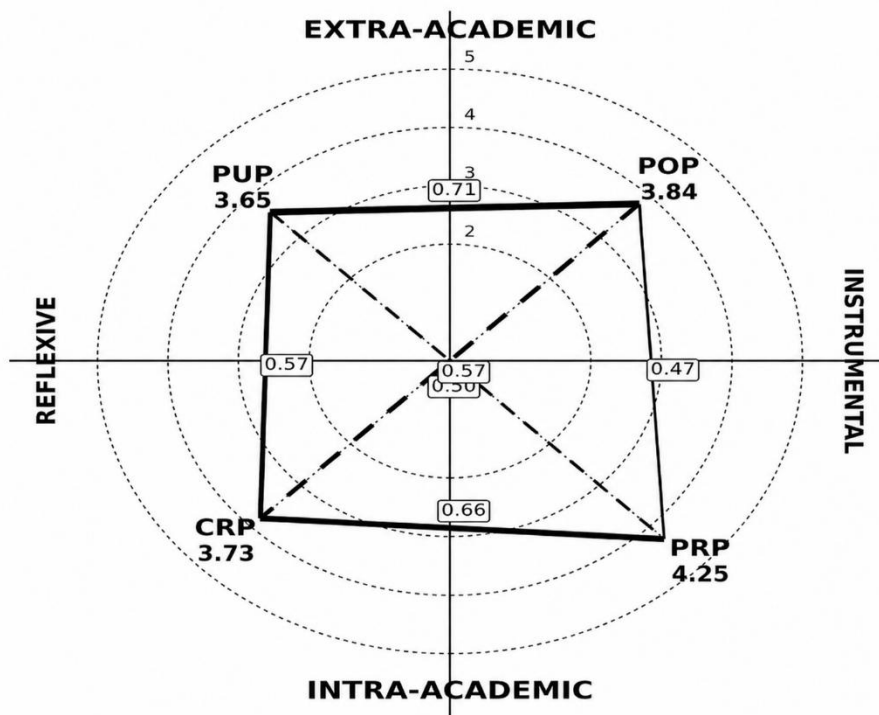
toward civic and NGO-related engagement. The professional dimension also had the lowest dispersion, while the public dimension showed the highest variability across associations.

The professional dimension was highest in Agriculture and the Humanities and lowest in Social Sciences, whereas critical professionalism was highest in Interdisciplinary Studies and the Humanities and lowest in Engineering and Technology. Public showed its highest mean in Interdisciplinary Studies, whereas policy varied little across fields (see Appendix D).

Figure 2 maps the four dimensions of scientific professionalism across the intra- and extra-academic and the instrumental/reflexive quadrants, combining mean scores (node positions) with rank-based correlations (edge weights).

Figure 2

Configuration of Scientific Professionalism



Note. The position of each dimension is determined by its mean score; a greater distance from the center indicates a stronger orientation toward that form of scientific professionalism. Line thickness is proportional to Spearman's ρ , dashed diagonal lines denote cross-domain correlations, and mean scores are displayed next to each dimension.

The configuration highlights two main patterns. First, the intra-/extra-academic divide is more pronounced than the instrumental-reflexive contrast, as reflected in the alignment of the pro-

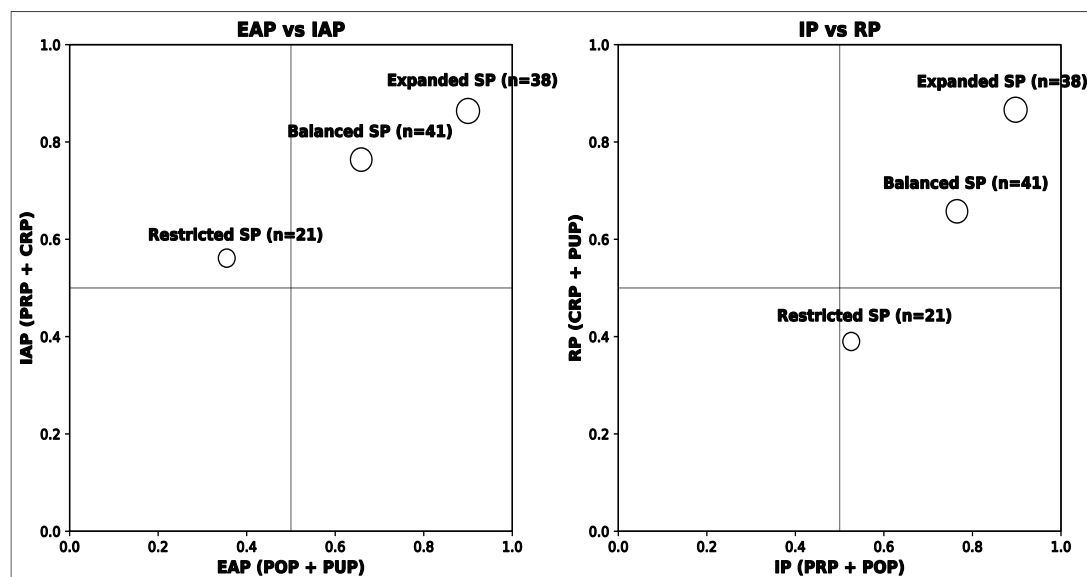
professional and critical dimensions within the intra-academic domain and of the policy and public dimensions within the extra-academic domain. Second, the main variation among associations lies not in a shift from instrumental to reflexive professionalism, but in the uneven extension of a shared professional core into extra-academic domains. The professional dimension remains the strongest dimension across the configurations, while the strong pairing of the policy and public dimensions suggests that policy-oriented associations are often publicly engaged as well. Overall, the four dimensions are organized across two broad domains—intra-academic and extra-academic activity—whereas the instrumental-reflexive distinction operates less as an autonomous axis than as a secondary gradient.

Configurations of scientific professionalism

A one-way ANOVA showed no statistically significant disciplinary differences across the four dimensions of scientific professionalism ($N = 97$; Art excluded due to its small sample size), with F values ranging from 0.06 to 2.05 and all $p \geq .080$. Accordingly, mean differences across disciplinary fields are interpreted descriptively rather than inferentially. To uncover latent patterns in the data and explore alternative typologies of scientific professionalism, a k -means cluster analysis was conducted using the four SP dimensions. The three-cluster solution yielded conceptually clear, interpretable configurations, with reasonably balanced cluster sizes and meaningful separation across the four dimensions.

Figure 3

Three-cluster map of Scientific Professionalism Among Iranian Scientific Associations



Note. Coordinates are based on the mean cluster centers and rescaled to a 0-1 range for visual comparison.

Cluster labels indicate the number of associations in each group.

Figure 3 shows that the three configurations are differentiated primarily along the intra-/extra-academic axis. In the left panel, the expanded configuration lies closest to the extra-academic pole, indicating the strongest extension of the professional core into the public and policy domains. The restricted configuration lies closer to the intra-academic pole, suggesting a stronger concentration around the internal academic core, whereas the balanced configuration occupies an intermediate position. This pattern aligns with the cluster centers: the expanded cluster scores highest across all four dimensions, the balanced cluster remains relatively high but more moderate, and the restricted cluster has the lowest overall profile. Across all three clusters, the professional dimension remains the strongest, indicating that the key difference among associations lies not in the presence of professionalism itself, but in the extent to which the professional core extends beyond academia.

By contrast, the right panel shows much weaker differences among clusters along the instrumental/reflexive axis. This suggests that variation among associations is better understood not as a clear shift from instrumental to reflexive professionalism, but as an uneven expansion of a shared professional core into the public, policy, and critical domains. Taken together, the two panels indicate that the Iranian case is best understood as a field in which scientific professionalism varies mainly in the extent to which it moves from an intra-academic professional core toward extra-academic engagement. This interpretation is also consistent with the article's broader findings, including strong within-domain correlations between policy and public and between professional and critical dimensions, which point to overlap and uneven differentiation. A chi-square test also found no statistically significant association between disciplinary category and cluster membership (Pearson $\chi^2(10) = 8.44$, $p = .586$), suggesting that the distribution of the three configurations cannot be explained by disciplinary grouping alone.

Discussion and conclusion

The empirical findings gain further significance when considered in relation to Burawoy's typology and the institutional and political context in which Iranian scientific associations operate. Among these associations, the professional dimension is more strongly expressed than the other dimensions of scientific professionalism, while critical reflection remains largely embedded in professional self-regulation and public engagement often proceeds through policy-oriented and semi-formal institutional channels. This configuration suggests that scientific professionalism is shaped not only by disciplinary norms but also by the institutional and political conditions under which associations operate.

Recalibrating Burawoy's typology in the Iranian context

The findings of this study show that extending Burawoy's typology beyond sociology is both empirically feasible and analytically illuminating; however, it requires conceptual recalibration. In Iranian scientific associations, all four dimensions of scientific professionalism—professional, critical, policy, and public—were identifiable in the data, yet their empirical config-

uration appeared more compressed, overlapping, and asymmetrical than in Burawoy's original formulation. More specifically, the intra-/extra-academic axis—a relatively positional and institutionally observable distinction—appeared more robust than the epistemic-normative instrumental/reflexive axis. As a result, the four analytically distinguishable forms tended to be organized around two dominant domains: a professional-centered intra-academic domain, within which critical reflexivity remained largely embedded, and a policy-centered extra-academic domain, through which much public engagement was channeled. The k-means clustering pattern reinforces this interpretation: the three identified configurations—expanded, balanced, and restricted—were differentiated primarily along the intra-academic/extra-academic axis rather than the instrumental/reflexive one. Across all clusters, the professional dimension remained the strongest, and the main difference among associations lay in the extent to which this professional core extended into extra-academic spheres. The absence of significant disciplinary differences across the four dimensions, together with the non-significant association between disciplinary category and cluster membership, suggests that the observed configurations are better understood in terms of levels of engagement than disciplinary boundaries.

From this perspective, the Iranian case is better understood as a field in which scientific professionalism varies primarily with the extent to which it moves from an intra-academic core toward extra-academic engagement, rather than as a complete shift from instrumental to reflexive orientations. The theoretical significance of this finding lies in showing that, in a non-liberal context, the main issue is not the absence of Burawoy's dimensions but rather shifts in their weight, interrelationships, and modes of expression. Here, the professional dimension appears not merely as one of four dimensions but as the most stable and institutionally consequential anchor around which the others are organized. The critical dimension also appears to remain largely embedded within this core, while public engagement seems to proceed less through an autonomous public sphere and more through policy-related and semi-formal channels.

These findings support critiques that regard the boundaries of Burawoy's typology as overly rigid and the instrumental/reflexive distinction as conceptually unstable or imposed (Abbott, 2007; Brint, 2005; Holmwood, 2007; Morrow, 2009; Patterson, 2007; Powell, 2013; Tittle, 2004; Turner, 2005; Wallerstein, 2007). At the same time, the present results do not imply abandoning Burawoy's framework. Rather, they show that the framework's value lies primarily in its heuristic capacity to reveal contextual differences in the intensity, overlap, and orientation of the dimensions of scientific professionalism. Burawoy's model should therefore be understood not as a fixed and universal map but as a flexible framework for understanding context-dependent configurations of scientific professionalism.

Institutional and political context of scientific professionalism in Iran

The observed configuration of scientific professionalism cannot be adequately understood without attention to Iran's institutional and political context. Although scientific and academic associations in Iran are formally regarded as civil and professional bodies, in practice they operate within a scientific field that is centralized, regulated, and institutionally unequal. These associations require formal authorization to operate, are overseen by the CISA under the Ministry of Science, Research and Technology, and are monitored through annual reporting and formal performance evaluations. Official indicators also show that a substantial proportion of evaluative criteria is oriented toward the professional and policy functions of associations (CISA, 2016). Scientific associations are described as intermediary institutions that link the scientific community and the policymaking system and are expected to play a stronger role in policy decision-making (Farasatkah, 2007; Khalifeh Soltani et al., 2012). Taken together, these features point to an institutional environment in which associations are largely understood as producers of science, organizers of scientific activities, and providers of services or advice to state bodies. Under such conditions, the professional dimension is reinforced both formally and structurally, becoming the basis for other forms of scientific professionalism, since the continuity and legitimacy of associations depend, in part, on conformity with official evaluative frameworks.

Simultaneously, this scientific field is shaped not only by its institutional logic but also by broader political and structural pressures. Internal restrictions, quantitatively driven scientific production, metric-driven evaluation, and centralized control have created conditions in which the extra-academic aspects of professionalism develop unevenly (Heshmati & Dibaji, 2019; Nasiri et al., 2015; Tarikhi, 2020). Complementing this structural emphasis, previous studies have shown that institutional structures and the agency of scientific actors shape one another (Mirzaie & Qarakhani, 2014; Qarakhani & Mirzaie, 2014, 2016). Scientific associations are not exempt from this dynamic: despite their semi-autonomous position, their required compliance with formal institutional requirements may itself help reproduce the institutional ecology in which they operate (Ghaneirad et al., 2019; Qarakhani & Mirzaie, 2022). In such an environment, public professionalism is expressed less through an autonomous public sphere and open dialogue with society than through policy-related, semi-formal, and institutionalized channels, helping to explain the strong overlap between the policy and public dimensions. The comparatively low mean but high variability of public professionalism further suggests that public engagement is not uniformly absent or weak across associations, but unevenly distributed and, where it is more strongly expressed, closely connected to policy-oriented forms of engagement. Although the critical dimension is less prominent than the professional dimension, it is by no means absent; rather, it remains largely embedded in intra-academic activity, particularly within the professional core, where it takes the form of epistemic and methodological reflexivity.

Under these conditions, dimensions of professionalism that are institutionally enabled and practically attainable become more salient, while others remain constrained or compressed. The three configurations identified in this study—expanded, balanced, and restricted—do not merely reflect disciplinary differences. Rather, they indicate variation in the extent to which associations extend their professional core beyond the academic sphere, given shared constraints. The Iranian case thus suggests that these configurations reflect different ways of navigating a common institutional environment, rather than distinct disciplinary models of scientific professionalism (Ghaneirad, 2006; Ghaneirad et al., 2019; Khosrokhavar et al., 2007; Qarakhani & Mirzaie, 2022).

Implications, limitations, and future directions

The main contribution of this article lies not in rejecting Burawoy's typology but in reconstructing it for context. Four implications follow from the findings. First, levels of engagement—or the extent to which the professional core extends beyond the academic sphere—emerge as an analytically important axis of variation in scientific professionalism. Second, in the Iranian case, the intra-academic/extra-academic divide appears more robust than the instrumental/reflexive axis. Third, structural pressures and institutional ecology must be explicitly incorporated into analyses of scientific professionalism. Fourth, overlap and hybridity among the dimensions should be understood not as anomalies but as part of the logic of scientific professionalism in constrained and regulated environments. In this sense, Iran is not merely a peripheral or exceptional case but an illuminating one for the comparative study of scientific professionalism in non-liberal contexts. Beyond these theoretical implications, the study also makes a methodological contribution by providing an empirically grounded 23-item measure of scientific professionalism that operationalizes Burawoy's four dimensions beyond sociology and provides a basis for further validation and comparative research across disciplines and institutional contexts.

This study also has limitations. The data rely on the self-reports of association leaders and may therefore be affected by institutional optimism or situational factors. In addition, applying Burawoy's framework across diverse disciplines may obscure field-specific differences. Moreover, the evidence in this study is cross-sectional and is therefore better suited to identifying configurational patterns and relationships among dimensions than to demonstrating long-term causal change. These limitations also point to directions for future research. Mixed methods designs, longitudinal studies, and cross-national comparisons can clarify the conditions under which scientific professionalism moves toward greater autonomy, broader public engagement, or deeper institutional compression. From this perspective, Iran can serve as a productive comparative case for examining how scientific professionalism is shaped simultaneously by institutional arrangements, national regulatory systems, and global regimes of metric-driven evaluation.

Overall, the article's main contribution is not to reject Burawoy's typology, but to operationalize and empirically assess its dimensions and to re-specify their relationships in context. More broadly, models of professionalism developed in liberal academic settings should not be treated as fixed typologies when applied to non-liberal environments. Rather, they can serve as flexible analytical tools for showing how professional roles are compressed, redirected, or institutionally reshaped under conditions of centralized regulation, political constraint, and unequal access to public autonomy.

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Conflict of interest

The authors declare that they have no competing interests.

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Endnotes

¹According to the official report published by the Islamic World Science Citation Center (ISC) in May 2024, Iran ranked 19th globally in scientific production in 2023 based on the Web of Science database, with 68,982 articles and a 2.03% share of global output. In Scopus, Iran ranked 14th worldwide, producing 74,420 articles and accounting for 1.95% of the global share. These achievements, together with H-index scores of 474 in Web of Science and 490 in Scopus, underscore Iran's established scientific position internationally and demonstrate significant scientific growth over the past two decades, particularly in engineering, medicine, and materials science (ISC, 2024).

²As Burawoy reflected in his final interview, he never regarded himself simply as a public sociologist but rather as an "evangelist for public sociology" (Burawoy & Benson, 2025). This distinction is revealing: his model of professionalism was not insulated from the world but grounded in a reflexive orientation toward publics. The trajectory that began with his 2004 ASA presidential address and was amplified during his presidency of the International Sociological Association (2010–2014) established a privileged platform for advancing this model. Teaching, writing, and activism were, for him, inseparable practices animated by the conviction that sociology should "start with the world" and foster living conversations among students, the public, and scholars (Burawoy & Benson, 2025, para. 14). His professional life has also been systematically charted in a recent bibliometric study, which highlights four core orientations in his scholarly trajectory: methodological reflexivity, engagement with the Global South, critiques of marketization, and a call for public sociology, thereby reinforcing the interpretive account offered here (Raj & Sinha, 2024).

Appendix A

Table A1

Scientific Associations Included in the Survey

1. Association of Desert Management and Control (Anjoman-e Elmi-ye Modiriyat va Kontrol-e Manateghe-e Biabani-ye Iran)
2. Association of Cognitive Sciences and Technologies (Anjoman-e Oloom va Fanavari-ha-ye Shenakhti-ye Iran)
3. Association of Control and Instrumentation Engineers (Anjoman-e Mohandesan-e Kontrol va Abzar-e Daghigh-e Iran)
4. Association of Energy Consumption Management (Anjoman-e Elmi-ye Modiriyat-e Masraf-e Enerzhi-ye Iran)
5. Astronomical Society of Iran (Anjoman-e Nojoom-e Iran)
6. Genetics Society of Iran (Anjoman-e Zhenetik-e Iran)
7. Informatics Society of Iran (Anjoman-e Informatik-e Iran)
8. Iranian Anthropological Association (Anjoman-e Ensanshenasi-ye Iran)
9. Iranian Aquaculture Association (Anjoman-e Abziparvari-ye Iran)
10. Iranian Association for English Language and Literature Education (Anjoman-e Amoozesh-e Zaban va Adabiyat-e Engelisi-ye Iran)
11. Iranian Association for Population Development (Anjoman-e Jamiyat-e Tosee-ye Iran)
12. Iranian Association for Radiation Protection (Anjoman-e Hefazat dar Barabar-e Ashaeh-ye Iran)
13. Iranian Association for the Promotion of Persian Language and Literature (Anjoman-e Tarvij-e Zaban va Adab-e Farsi-ye Iran)
14. Iranian Association of Agronomy and Plant Breeding (Anjoman-e Oloom-e Zeraat va Eslah-e Nabatat-e Iran)
15. Iranian Association of Economic Law (Anjoman-e Hoghough-e Eghtesadi-ye Iran)
16. Iranian Association of Environmental Specialists (Anjoman-e Motakhasesan-e Mohit-e Zist-e Iran)
17. Iranian Association of Fiction Literature (Anjoman-e Adabiyat-e Dastani-ye Iran)
18. Iranian Association of Food Science and Technology (Anjoman-e Oloom va Sanaye-ye Ghazaei-ye Iran)
19. Iranian Association of Geography and Border Regions Planning (Anjoman-e Joghrafia va Barnamehrizi-ye Manateghe-e Marzi-ye Iran)
20. Iranian Association of Geography and Urban Planning (Anjoman-e Joghrafia va Barnamehrizi-ye Shahri-ye Iran)
21. Iranian Association of Irrigation and Drainage (Anjoman-e Abiyari va Zehkeshi-ye Iran)
22. Iranian Association of Islamic Economics (Anjoman-e Eghtesad-e Eslami-ye Iran)
23. Iranian Association of Islamic Studies (Anjoman-e Maaref-e Eslami-ye Iran)
24. Iranian Association of Management Sciences (Anjoman-e Oloom-e Modiriyat-e Iran)
25. Iranian Association of Microbial Science and Technology (Anjoman-e Oloom va Fanavari-ye Mikrobi-ye Iran)
26. Iranian Association of Plant Cell and Tissue Culture (Anjoman-e Kesht-e Solul va Bafat-e Giyahi-ye Iran)
27. Iranian Association of Qur'anic Sciences and Hadith (Anjoman-e Oloom-e Qorani va Hadith-e Iran)
28. Iranian Association of Qur'anic Studies and Islamic Culture (Anjoman-e Irani-ye Motaleat-e Qorani va Farhang-e Eslami)
29. Iranian Association of Rainwater Catchment Surface Systems (Anjoman-e Sistem-ha-ye Sotooh-e Abgir-e Baran-e Iran)
30. Iranian Association of Remote Sensing and GIS (Anjoman-e Sanjesh az Doori va GIS-e Iran)
31. Iranian Association of Textile Engineering Science and Technology (Anjoman-e Oloom va Fanavari-ye Mohandesi-ye Nasaji-ye Iran)
32. Iranian Bioengineering Association (Anjoman-e Mohandesi-ye Hayat)

33. Iranian Comparative Education Association (Anjoman-e Amoozesh va Parvaresh-e Tatbighi-ye Iran)
34. Iranian Counseling Association (Anjoman-e Moshavereh-ye Iran)
35. Iranian Association for Cultural Studies and Communications (Anjoman-e Irani-ye Motaleat-e Farhangi va Ertebatat)
36. Iranian Educational Management Association (Anjoman-e Modiriyat-e Amoozeshi-ye Iran)
37. Iranian Engineering Education Association (Anjoman-e Amoozesh-e Mohandesi-ye Iran)
38. Iranian Environmental Assessment Association (Anjoman-e Arzyabi-ye Mohit-e Zist-e Iran)
39. Iranian Environmental Education and Sustainable Development Association (Anjoman-e Elmi-ye Amoozesh-e Mohit-e Zist va Tosee-ye Paydar-e Iran)
40. Iranian Geographical Association (Anjoman-e Joghrafiyai-ye Iran)
41. Iranian Higher Education Association (Anjoman-e Amoozesh-e Aali-ye Iran)
42. Iranian Hydrogen and Fuel Cell Association (Anjoman-e Hidrojen va Pil-e Sokhti-ye Iran)
43. Iranian Hydrology Association (Anjoman-e Hidrologi-ye Iran)
44. Iranian Literary Criticism Association (Anjoman-e Naqd-e Adabi-ye Iran)
45. Iranian Management Association (Anjoman-e Modiriyat-e Iran)
46. Iranian Marine Engineering Association (Anjoman-e Mohandesi-ye Daryaei-ye Iran)
47. Iranian Nematology Association (Anjoman-e Nematodshenasi-ye Iran)
48. Iranian Operations Research Association (Anjoman-e Irani-ye Tahqiq dar Amaliyat)
49. Iranian Philosophy of Education Association (Anjoman-e Elmi-ye Falsafeh-ye Talim va Tarbiyat-e Iran)
50. Iranian Psychological Association (Anjoman-e Ravanshenasi-ye Iran)
51. Iranian Quaternary Association (Anjoman-e Koaternari-ye Iran)
52. Iranian River Engineering Association (Anjoman-e Mohandesi-ye Roodkhane-ye Iran)
53. Iranian Scientific Association for Peace Studies (Anjoman-e Elmi-ye Motaleat-e Solh-e Iran)
54. Iranian Scientific Association for Quality (Anjoman-e Elmi-ye Keyfiyat-e Iran)
55. Iranian Scientific Association of Acarology (Anjoman-e Elmi-ye Keneshshenasi-ye Iran)
56. Iranian Scientific Association of Archaeology (Anjoman-e Elmi-ye Bastanshenasi-ye Iran)
57. Iranian Scientific Association of Architecture and Urban Planning (Anjoman-e Elmi-ye Memari va Shahrsazi-ye Iran)
58. Iranian Scientific Association of Biosafety (Anjoman-e Elmi-ye Imeni-ye Zisti-ye Iran)
59. Iranian Scientific Association of Chemical Engineering (Anjoman-e Elmi-ye Mohandesi-ye Shimi-ye Iran)
60. Iranian Scientific Association of E-Learning (Anjoman-e Elmi-ye Yadgiri-ye Elektroniki-ye Iran / YADA)
61. Iranian Scientific Association of Electronic Commerce (Anjoman-e Elmi-ye Tejarat-e Elektroniki-ye Iran)
62. Iranian Scientific Association of Energetic Materials (Anjoman-e Elmi-ye Mavad-e Porenerzhi-ye Iran)
63. Iranian Scientific Association of Foresight (Anjoman-e Elmi-ye Ayandehnegari-ye Iran)
64. Iranian Scientific Association of Foundry (Anjoman-e Elmi-ye Rikhtehgari-ye Iran)
65. Iranian Scientific Association of Gas Engineering (Anjoman-e Elmi-ye Mohandesi-ye Gaz-e Iran)
66. Iranian Scientific Association of Geography and Rural Planning (Anjoman-e Elmi-ye Joghrafia va Barnamehrizi-ye Roostaei-ye Iran)
67. Iranian Scientific Association of Internal Diseases of Large Animals (Anjoman-e Elmi-ye Bimari-ha-ye Dakheli-ye Dam-ha-ye Bozorg-e Iran)
68. Iranian Scientific Association of Management Accounting (Anjoman-e Elmi-ye Hesabdari-ye Modiriyat-e Iran)
69. Iranian Scientific Association of Mycology (Anjoman-e Elmi-ye Gharchshenasi-ye Iran)
70. Iranian Scientific Association of Oceanography (Anjoman-e Elmi-ye Oqyanusshenasi-ye Iran)
71. Iranian Scientific Association of Passive Defense (Anjoman-e Elmi-ye Pedafand-e Gheyr-e Amel-e Iran)
72. Iranian Scientific Association of Probiotics and Functional Foods (Anjoman-e Elmi-ye Probiotik va Ghaza-ha-ye Farasoodmand-e Iran)
73. Iranian Scientific Association of Professors of Persian Language and Literature (Anjoman-e Elmi-ye Ostadan-e Zaban va Adabiyat-e Farsi-ye Iran)

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74. Iranian Scientific Association of Science and Technology Parks and Incubators (Anjoman-e Elmi-ye Park-ha-ye Elm va Fanavari va Marakez-e Roshd-e Iran)
75. Iranian Scientific Association of Sedimentology (Anjoman-e Elmi-ye Rasobshenasi-ye Iran)
76. Iranian Scientific Association of Solar Energy (Anjoman-e Elmi-ye Enerzhi-ye Khorshidi-ye Iran)
77. Iranian Scientific Association of Urban Economics (Anjoman-e Elmi-ye Eghtesad-e Shahri-ye Iran)
78. Iranian Scientific Association of Visual Arts (Anjoman-e Elmi-ye Honar-ha-ye Tajassomi-ye Iran)
79. Iranian Scientific Association of Waste Engineering and Management (Anjoman-e Elmi-ye Mohandesi va Modiriyat-e Pasmamand-e Iran)
80. Iranian Scientific Association of Wind Energy (Anjoman-e Elmi-ye Enerzhi-ye Badi-ye Iran)
81. Iranian Scientific Camel Association (Anjoman-e Elmi-ye Shotor-e Iran)
82. Iranian Scientific Carpet Association (Anjoman-e Elmi-ye Farsh-e Iran)
83. Iranian Scientific Composite Association (Anjoman-e Elmi-ye Kompozit-e Iran)
84. Iranian Scientific Concrete Association (Anjoman-e Elmi-ye Beton-e Iran)
85. Iranian Scientific Peptide Association (Anjoman-e Elmi-ye Peptid-e Iran)
86. Iranian Scientific Society for Suicide Prevention (Jamiyat-e Elmi-ye Pishgiri az Khodkoshi-ye Iran)
87. Iranian Social Welfare Association (Anjoman-e Elmi-ye Refah-e Ejtemaei-ye Iran)
88. Iranian Society for the History of Islam (Anjoman-e Irani-ye Tarikh-e Eslam)
89. Iranian Society of Education (Anjoman-e Irani-ye Talim va Tarbiyat)
90. Iranian Society of World Studies (Anjoman-e Irani-ye Motaleat-e Jahan)
91. Iranian Sociological Association (Anjoman-e Jamee-shenasi-ye Iran)
92. Iranian Sociology of Education Association (Anjoman-e Jamee-shenasi-ye Amoozesh va Parvareh-e Iran)
93. Iranian Watershed Management Association (Anjoman-e Abkhizdari-ye Iran)
94. Iranian Weed Science Association (Anjoman-e Oloom-e Alaf-ha-ye Harz-e Iran)
95. Linguistic Society of Iran (Anjoman-e Zabanshenasi-ye Iran)
96. Physical Society of Iran (Anjoman-e Fizik-e Iran)
97. Scientific Association of Health, Safety and Environment Management and Engineering (Anjoman-e Elmi-ye Modiriyat va Mohandesi-ye Behdasht, Imeni va Mohit-e Zist)
98. Scientific Association of Light Steel Buildings (Anjoman-e Elmi-ye Sakhteman-ha-ye Fooladi-ye Sabok)
99. Scientific Association of Packaging (Anjoman-e Elmi-ye Basteh-bandi)
100. Scientific Association of Police Research (Anjoman-e Elmi-ye Pazhohesh-ha-ye Entezami)

Note. Authors' final analytic sample, matched against the Commission of Iranian Scientific Associations (CISA) roster.

Appendix B

Table B1

Descriptive Statistics for SP Scale Items

Item allocation follows the final four-factor solution reported in Table 4: Professional (7 items), Critical (4), Policy (7), and Public (5).

Dimension	SP scale item	M	SD
Professional	Working with academic departments to protect knowledge	4.13	.90
	Validating knowledge dissemination	4.26	1.04
	Sensitivity to the knowledge content and its quality	4.57	.73
	Recruiting specialists with professional competence	4.48	.73
	Challenging established knowledge	4.04	.92
	Critiquing existing research	4.05	.90
	Critique of teaching methods and knowledge transfer	4.14	.91
Critical	Questioning established norms of the knowledge	3.93	.98
	Critique of resource and reward allocation methods	3.41	1.25
	Criticizing theoretical and methodological frameworks	3.57	1.11
	Assessment of knowledge implementation procedures	3.95	.91
Policy	Applying knowledge in government service	3.90	1.12
	Research collaboration with government agencies	3.96	1.21
	Research cooperation with the private sector	3.89	1.17
	Applying knowledge in the private sector	3.92	1.17
	Joint publication with government agencies	3.79	1.08
	Taking members from governmental organizations	3.57	1.27
	Joint publications with the private sector	3.66	1.10
Public	Joint publications with NGOs	3.42	1.31
	Taking members from NGOs	3.68	1.18
	Membership in NGOs	3.62	1.14
	Research collaboration with NGOs	3.74	1.20
	Applying knowledge to assist and support NGOs	3.74	1.11

Note. Items were originally written in Persian and are presented here in approximate English translation.

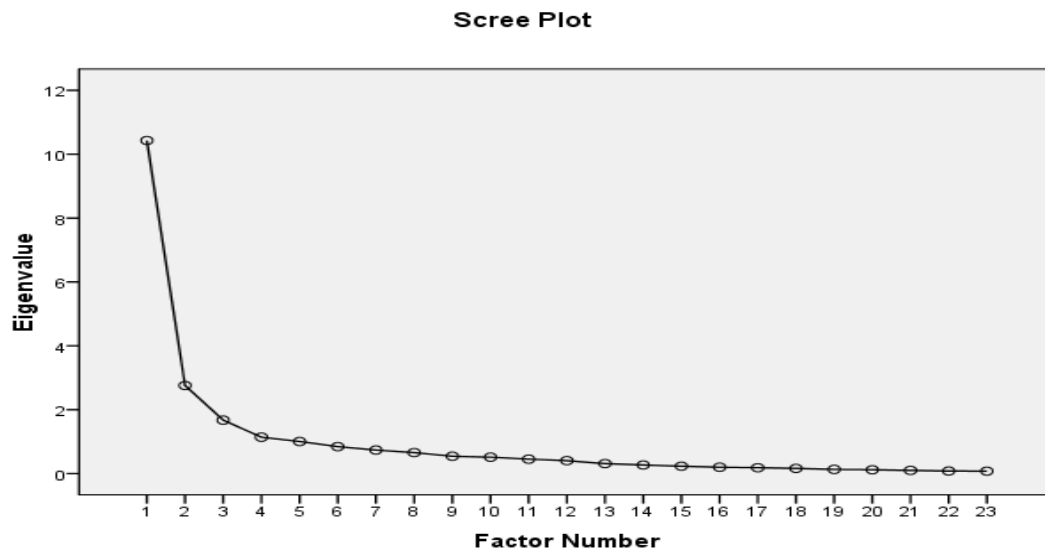
Responses were rated on a five-point scale ranging from 1 (unimportant) to 5 (very important), with higher scores indicating greater perceived importance.

Authors' calculations based on collected data.

Appendix C

Figure C1

Scree Plot for the Exploratory Factor Analysis of the Scientific Professionalism (SP) Scale



Note. The scree plot shows a clear levelling off after the fourth factor, supporting retention of the four-factor solution over the weaker five-factor alternative.

Authors' analysis based on collected data.

Appendix D

Table D1

Disciplinary Profiles of Scientific Professionalism

This appendix reports descriptive profiles of the four observed dimensions and four derived axes across the seven disciplinary fields in Table 1, using the final 23-item allocation reported in Table 4.

Discipline	N	PRP	CRP	POP	PUP	IAP	EAP	IP	RP
Basic Sciences	13	4.37	3.90	3.85	3.80	4.14	3.82	4.11	3.85
Engineering and Technology	21	4.14	3.37	3.76	3.55	3.75	3.65	3.95	3.46
Agriculture	16	4.46	3.64	3.84	3.44	4.05	3.64	4.15	3.54
Humanities	15	4.39	3.98	3.87	3.62	4.18	3.74	4.13	3.80
Social Sciences	17	3.87	3.63	3.91	3.51	3.75	3.71	3.89	3.57
Interdisciplinary Studies	15	4.30	4.00	3.87	4.20	4.15	4.03	4.09	4.10
Art	3	4.48	4.00	3.67	3.00	4.24	3.33	4.07	3.50
Total sample	100	4.25 (0.64)	3.73 (0.86)	3.84 (0.91)	3.65 (1.02)	3.99	3.74	4.04	3.69

Note. Values are mean scores. For the total sample, standard deviations are shown in parentheses only for the four observed dimensions. The final item allocation is PRP = 7 items, CRP = 4 items, POP = 7 items, and PUP = 5 items, consistent with Table 4. Science professionalism comprises four dimensions: PRP (professional), CRP (critical), POP (policy), and PUP (public). The derived axes are arithmetic means calculated from the unrounded dimension scores: $IAP = (PRP + CRP) / 2$; $EAP = (POP + PUP) / 2$; $IP = (PRP + POP) / 2$; and $RP = (CRP + PUP) / 2$.

Authors' calculations based on the final analytic dataset.