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Identification of Criteria and Sub-Criteria for Urban Governance Pathology from the Perspective of Systems and Cybernetic Models: A Case Study of Hormozgan and Kerman Provinces

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Abstract

The present article was conducted with the aim of identifying the factors and components of environmentally ethical technology development. In terms of purpose, the research is applied; in terms of data, it is qualitative; and in terms of implementation method, it was conducted using the systematic grounded theory approach. The statistical population consisted of key informants in the field of research within the Tehran Province Department of Environment, and interviews were conducted with 11 individuals using the snowball sampling method until theoretical saturation was achieved. Data were collected through both library research (documents and records) and field research (semi-structured interviews). To assess the validity of the research instrument, three triangulation methods were used: methodological triangulation (71%), investigator triangulation (77%), and participant triangulation (83%), indicating that the instrument had acceptable validity. Data analysis was performed using theoretical coding (based on the paradigm model of grounded theory). The coding results showed that environmentally ethical technology development consisted of 133 open codes (indicators), 26 axial codes (components), and 6 selective codes (dimensions).

Keywords: Development, Technology, Environmental Ethics, Department of Environment.

1. Introduction

The accelerating pace of technological advancement in the twenty-first century has fundamentally reshaped human interaction with the environment, creating both unprecedented opportunities and severe ethical dilemmas. Emerging technologies have transformed industrial processes, communication systems, and societal infrastructures, but their environmental implications remain a pressing concern. As societies face escalating climate change, biodiversity loss, and resource depletion, integrating environmental ethics into the design, deployment, and governance of technologies has become a critical imperative (Randall, 2025). Ethical considerations are no longer peripheral to technological progress; instead, they are central to ensuring that innovation aligns with principles of sustainability, justice, and ecological stewardship (White, 2015). This paradigm shift requires rethinking traditional economic, social, and political frameworks to accommodate the moral responsibilities associated with technological systems (Bacon, 2016).

The ethical assessment of technology is inherently interdisciplinary, drawing on philosophy, engineering, environmental science, and social theory. Classical perspectives, such as those articulated in *The New Organon*, emphasize the systematic pursuit of knowledge while cautioning against the misuse of scientific discovery for harmful ends (Bacon, 2016). In contemporary discourse, scholars argue that technological artefacts are not neutral tools but embody moral values that influence human action (Van de Poel & Kroes, 2014; Verbeek, 2011). This view challenges the deterministic notion that technology evolves independently of human intention (Seghatoleslami et al., 2011) and instead frames technology as a product of deliberate design choices infused with ethical and cultural assumptions (Manders-Huits, 2011).

In the environmental domain, the interplay between technology and ethics becomes particularly salient. Technologies have the capacity to mitigate environmental harms through renewable energy systems, pollution control mechanisms, and resource-efficient production methods, yet they can also exacerbate ecological crises if guided solely by market incentives (Khaleghi, 2015). Ethical evaluation, therefore, must address not only the technical performance of innovations but also their broader societal and ecological consequences (Ahani amineh & Boorghani Farahani, 2015). Environmental ethics provides a normative framework for determining how human actions, mediated by technology, should respect the intrinsic value of nature (Fanaei & Behrouzi, 2017). Within this framework, principles such as intergenerational justice, precautionary responsibility, and respect for ecological integrity are pivotal (Haghkhah et al., 2017).

Environmental ethics has gained increasing prominence in both policy and academic discourse, reflecting a recognition that sustainable development cannot be achieved through technical efficiency alone (Carlsson & Rönnblom, 2022). Policy frameworks in regions such as the European Union have undergone transformations from focusing solely on technological innovation to incorporating ethical governance mechanisms that ensure alignment with societal values (Carlsson & Rönnblom, 2022). This evolution underscores the necessity of integrating moral reasoning into science and technology policy-making (Rasekh et al., 2016). Furthermore, ethical governance of technology requires active participation from diverse stakeholders, including governments, industries, academic institutions, and civil society organizations (Horst et al., 2007).

In the Iranian context, the institutionalization of environmental ethics in technological development faces distinct challenges and opportunities. Studies indicate that environmental ethics among various professional groups, including agricultural students (Bandari et al., 2019) and rural communities (Mahboobi & Ramazani, 2011), are shaped by a combination of cultural norms, educational exposure, and economic conditions. Engineering education in Iran has been criticized for insufficient integration of environmental ethics into curricula (Hosseinloo, 2020; Mohammad Oghli Reyhan & Alizadeh, 2018), despite the acknowledged role of engineering decisions in shaping environmental outcomes (Mena, 2019). The absence of comprehensive ethical training in engineering fields can lead to a narrow focus on technical problem-solving without adequate consideration of ecological consequences (Mokhtari, 2019).

Addressing environmental ethics in technology requires an understanding of both micro-level behavioral factors and macro-level structural influences. At the individual level, moral awareness, value orientation, and cultural background significantly influence ethical decision-making (Hasanpour et al., 2017). At the organizational level, leadership commitment to ethical principles, institutional policies, and competitive value frameworks play crucial roles in embedding environmental ethics within operational practices (Haghkhah et al., 2017). Moreover, systemic challenges—such as weak regulatory enforcement, limited public awareness, and insufficient stakeholder collaboration—can undermine efforts to develop environmentally responsible technologies (Hemmati & Shobeiri, 2016).

Globally, the emergence of artificial intelligence (AI), biotechnology, and other transformative innovations has prompted renewed attention to ethical governance (Kazim & Soares Koshiyam, 2021). Scholars emphasize that AI ethics, for example, must extend beyond issues of bias and privacy to address environmental impacts, such as energy consumption in data centers and e-waste generation (Kazim & Soares Koshiyam, 2021). Similarly, the convergence of science and technology in areas like nanotechnology and genetic engineering raises complex ethical questions about unintended ecological effects (Khanahmadi et al., 2016). In this context, environmental ethics serves as a guiding framework to anticipate, assess, and manage the risks associated with novel technological applications (Rahimi et al., 2021).

From a philosophical standpoint, environmental ethics intersects with theories of responsibility and justice. Act utilitarian perspectives advocate for actions that maximize environmental well-being while minimizing harm (White, 2015), whereas deontological approaches stress the inherent duty to protect nature regardless of economic cost (Ahani amineh & Boorghani Farahani, 2015). The challenge lies in operationalizing these ethical commitments within the technological innovation process, where economic, political, and social pressures often compete with ecological priorities (Saleh Ahmadi, 2011). Integrating ethics into technology design requires explicit articulation of moral values during the early stages of innovation (Manders-Huits, 2011) and continuous reflection on their implications as technologies evolve (Verbeek, 2011).

Practical strategies for embedding environmental ethics into technology development include regulatory frameworks, market-based incentives, stakeholder engagement, and educational reform (Dashtaki et al., 2021). Regulatory measures, when effectively enforced, can set minimum environmental performance standards and deter harmful practices (Seghatoleslami et al., 2011). Economic instruments, such as green taxation and subsidies for sustainable technologies, can align financial incentives with ethical objectives (Khaleghi, 2015). Public participation mechanisms enhance the legitimacy and responsiveness of technological governance, ensuring that diverse perspectives inform decision-making (Horst et al., 2007).

Educational initiatives are equally essential in fostering a culture of environmental responsibility among future technologists. Curricula that integrate environmental ethics, sustainability principles, and interdisciplinary problem-solving skills can equip students to address complex socio-ecological challenges (Hosseinloo, 2020; Mohammad Oghli Reyhan & Alizadeh, 2018). Ethical competence in technology professionals not only improves individual decision-making but also strengthens institutional capacity to pursue sustainable innovation (Mena, 2019). Research indicates that promoting environmental values and norms within educational and professional settings positively correlates with ethical behavior in environmental contexts (Dehghan et al., 2018).

Despite these advances, significant gaps remain in the literature and practice of environmentally ethical technology development. Many existing studies focus on specific sectors or technologies, lacking comprehensive models that integrate causal, contextual, and intervening factors influencing ethical outcomes (Dashtaki et al., 2021; Rahimi et al., 2021). Additionally, there is a need for empirical frameworks that capture the complex interactions between cultural, regulatory, technological, and economic variables (Bandari et al., 2019). This complexity is heightened in developing countries, where resource constraints, policy instability, and competing development priorities can hinder ethical integration (Hemmati & Shobeiri, 2016).

Given these challenges, grounded theory offers a suitable methodological approach to systematically identify and categorize the factors shaping environmentally ethical technology development. By engaging with diverse stakeholders and analyzing their perspectives, such an approach can reveal underlying patterns, contextual dependencies, and strategic pathways for embedding environmental ethics into technology systems (Randall, 2025). The current study applies grounded theory to identify causal conditions, contextual influences, intervening variables, strategies, and outcomes associated with environmentally ethical technology development, with the aim of contributing both to theoretical understanding and practical policy-making.

2. Methods and Materials

This research employed a qualitative study design aimed at identifying and analyzing the criteria and sub-criteria of urban governance pathology within the frameworks of systems theory and cybernetic models. The study population consisted of 16 experts drawn from various key organizations involved in urban governance, including municipal administrations, governorates, city councils, water and electricity departments, and agricultural jihad organizations. All participants had a minimum of ten years of professional experience and held positions at the level of deputy director, director, or senior expert. Additionally, perspectives from academic scholars with specialized knowledge in urban governance systems and cybernetics were incorporated to enhance the analytical depth of the study. Participants were selected through purposive sampling, with the process continuing until theoretical saturation was reached. Geographically, the sample was drawn from two main areas:

the city of Bandar Abbas in Hormozgan Province and the Khabar district in Baft County, Kerman Province. In these regions, convenience sampling was also employed to facilitate access to participants who met the inclusion criteria.

The primary tool for data collection was in-depth, semi-structured interviews conducted with the selected experts. The interview protocol was designed to elicit comprehensive insights into the challenges, deficiencies, and system-level dynamics influencing urban governance in the study areas. The questions were structured to explore both general governance issues and specific aspects related to systems and cybernetic models. Interview validity was ensured through face validation by academic advisors and expert review, confirming the appropriateness and clarity of the questions. The trustworthiness of the data was further reinforced through member checking, whereby interview transcripts and preliminary interpretations were reviewed by participants to confirm accuracy and alignment with their intended meaning.

The recorded interviews were transcribed verbatim and subjected to qualitative content analysis. The reliability of the coding process was assessed through intra-topic agreement between coders. Specifically, the supervisory and advisory academic members independently coded two interview transcripts, and the degree of coding similarity reached 78 percent, indicating an acceptable level of reliability. Data analysis followed a thematic approach to extract key themes, sub-themes, and relationships among identified criteria and sub-criteria for urban governance pathology. The process involved iterative reading, coding, categorization, and synthesis of data to develop a conceptual model grounded in systems and cybernetic perspectives.

3. Findings and Results

The analysis of interviews with experts from municipal administrations, governorates, city councils, utility departments, agricultural organizations, and academia led to the identification of six main criteria and multiple sub-criteria that define the pathology of urban governance from the perspective of systems and cybernetic models. These criteria capture the social, economic, political, legal, scientific–technical, and individual dimensions that influence the effectiveness, sustainability, and adaptability of urban governance in the case study areas. The results reflect both structural and functional deficiencies, indicating a complex interplay between systemic weaknesses, resource allocation challenges, policy gaps, and citizen engagement barriers. The identified sub-criteria reveal that the shortcomings are multidimensional and often interconnected, requiring integrated solutions rooted in systemic and cybernetic thinking.

Table 1. Main Criteria and Sub-Criteria of Urban Governance Pathology from a Systems and Cybernetic Perspective

Main Criteria	Sub-Criteria
Social Factors	Lack of accurate understanding of existing conditions; Limited knowledge of urban governance; Misconceptions about system-based urban governance; Limited knowledge of cybernetic and systems-based urban governance; Lack of necessary social infrastructure for developing urban governance; Neglect of citizen education and absence of future-oriented planning for urban governance; Sloganeering and promotional approaches in planning for cybernetic governance
Economic Factors	Insufficient allocation of urban and rural budgets for implementing and developing cybernetic governance; Public perception of high costs in cybernetic governance leading to low participation; High cost of providing infrastructure for urban governance; Lack of national-level budget allocation for cybernetic cities; Improper allocation of financial resources
Political Factors	Weakness or absence of comprehensive and integrated laws for cybernetic urban governance; Lack of consensus among experts; Absence of political will to implement cybernetic urban governance; Lack of interaction between system and environment in urban governance; Lack of coordination between political sectors in developing cybernetic governance programs; Lack of systemic thinking in urban governance
Legal Factors	Ambiguities and overlaps in the legal mandates of governorates, municipalities, rural and district administrations; Dependence on centralized institutions and neglect of public institutions; Weakness in data management and outputs in traditional urban governance; Lack of transparency, accountability, public information, and personal identification codes; Fragmented and partial laws in urban governance; Lack of a cybernetic platform for integrated visibility of urban governance laws; Reliance on traditional legislation and unstable, rent-seeking revenue for urban services; Legal gaps and lack of enforcement guarantees; Top-down policymaking instead of bottom-up approaches; Lack of laws aligned with systemic and cybernetic governance
Scientific–Technical Factors	Absence of a strategic program for training individuals; Lack of necessary training for using electronic platforms; Informational and legal restrictions on conducting fundamental research; Lack of comprehensive research on deficiencies hindering cybernetic systems; Absence of suitable facilities and infrastructure for benefiting from scientific advances
Individual Factors	Lack of public demand for establishing cybernetic governance; Lack of public awareness about cybernetic urban governance; Public distrust toward cybernetic governance; Absence of public expectations for cybernetic governance; Limited public participation

Social Factors: The social dimension revealed that deficiencies in public understanding and awareness significantly hinder the adoption of systems and cybernetic governance. Many stakeholders, including both officials and citizens, possess only limited knowledge of the principles and practices of modern urban governance models. Misconceptions persist regarding the nature and benefits of systemic approaches, which are often perceived as abstract or impractical. Furthermore, the lack of a

supportive social infrastructure, coupled with minimal investment in citizen education and a lack of foresight in governance planning, has created a fragmented social foundation. In some cases, planning is reduced to slogans and promotional campaigns rather than substantive strategic initiatives, undermining the credibility and sustainability of reforms.

Economic Factors: Economic constraints emerged as a major obstacle to the advancement of cybernetic urban governance. Experts highlighted insufficient budget allocations at both urban and rural levels, with no dedicated funds for implementing systemic governance reforms. The perception among citizens that cybernetic governance entails high costs further discourages participation. Additionally, the substantial financial requirements for developing infrastructure, combined with the absence of targeted national-level funding, exacerbate the resource gap. Mismanagement and improper allocation of the available resources further weaken the economic foundation necessary for successful governance transformation.

Political Factors: The political context was found to be characterized by fragmented strategies and limited institutional commitment. The absence of comprehensive, integrated legislation for cybernetic urban governance prevents cohesive policy-making. Disagreements among experts and the lack of political will to adopt systemic reforms contribute to inertia. Furthermore, insufficient interaction between the governance system and its external environment results in missed opportunities for adaptive and responsive decision-making. Political sectors operate in silos, without the necessary coordination to create unified development programs, and systemic thinking remains absent from the political culture of urban governance.

Legal Factors: Legal shortcomings present some of the most critical challenges in achieving systemic and cybernetic governance. Ambiguities and overlaps in jurisdiction between different administrative bodies cause inefficiencies and conflicts. Over-reliance on centralized institutions neglects the potential of local and public bodies. Traditional governance suffers from inadequate data management, lack of transparency, weak accountability mechanisms, and the absence of personal identification systems for citizens. The existing laws are fragmented, partial, and often outdated, with no unified cybernetic platform to make them accessible and integrated. Additionally, revenue generation for urban services relies heavily on unstable and rent-seeking practices, legal enforcement mechanisms are weak, and policymaking is predominantly top-down, ignoring the participatory approaches required for systemic governance.

Scientific–Technical Factors: From a scientific and technical standpoint, the absence of a strategic training plan severely limits capacity-building. Public officials and citizens alike lack the necessary skills to use modern electronic and digital governance platforms effectively. Restrictions on information access and legal barriers to conducting fundamental research further stifle innovation. Comprehensive studies on the barriers to establishing cybernetic systems are lacking, and the infrastructure to apply scientific findings is either underdeveloped or absent. This technical gap prevents the translation of theoretical models into practical, operational governance frameworks.

Individual Factors: At the individual level, low public demand and engagement represent a fundamental barrier to cybernetic urban governance. The general public remains largely unaware of the concept, scope, and potential benefits of such governance models. Distrust toward governance initiatives is widespread, and there are no clearly articulated public expectations that could drive reform. Participation in governance processes is limited, reflecting both a lack of awareness and a lack of motivation to engage in systemic governance initiatives.

4. Discussion and Conclusion

The present study aimed to identify the criteria and sub-criteria for urban governance pathology from the perspective of systems and cybernetic models, focusing on the provinces of Hormozgan and Kerman. The findings revealed six main categories of pathology—social, economic, political, legal, scientific–technical, and individual factors—each containing multiple sub-criteria that collectively outline the systemic challenges facing the adoption of cybernetic governance. These results indicate that urban governance in the studied regions is hindered by both structural weaknesses and functional inefficiencies, with significant implications for transparency, accountability, and long-term sustainability.

The analysis of social factors highlighted the central role of public understanding, awareness, and cultural readiness in the success of systemic and cybernetic governance reforms. The lack of accurate knowledge about current governance conditions, limited awareness of systems and cybernetic models, and prevalence of misconceptions align with previous research demonstrating that governance transformation requires a strong social foundation supported by citizen education and participatory culture (Agu et al., 2024; Rahmani Zadeh Dehkordi, 2022). Studies on governance pathologies in other

contexts have similarly emphasized that without deliberate investment in societal awareness and the creation of enabling environments, systemic reforms are likely to be perceived as abstract or inaccessible, reducing public engagement (Ali et al., 2018; Mansouri, 2020). Moreover, the finding that urban governance strategies in some cases rely on promotional or slogan-driven approaches echoes earlier analyses of Iranian governmental systems, where rhetorical commitments to reform have not always been matched by actionable strategies (Sardarnaba, 2016).

Economic factors emerged as a decisive barrier to cybernetic governance implementation. Inadequate budget allocations at both urban and rural levels, coupled with public perceptions of high operational costs, not only limit the feasibility of reforms but also reinforce citizen reluctance to participate. This is consistent with the view that economic constraints, particularly in infrastructure-intensive initiatives like cybernetic urban governance, require sustained national-level funding commitments (Ferdowsi, 2014; Mulai & Lotfi, 2020). Similar budgetary limitations have been reported in the pathology of public sector decision-making, where misaligned resource allocation undermines reform implementation (Agharazi et al., 2023; Pourasad et al., 2020). Furthermore, the improper allocation of existing financial resources reflects a governance gap that previous studies have linked to insufficient transparency and oversight mechanisms (Al-Faryan, 2024; Utami & Barokah, 2024).

The political dimension of the pathology is characterized by fragmented legislative support, absence of consensus among stakeholders, and insufficient political will to implement cybernetic reforms. The lack of coordination between political sectors and weak interaction between the governance system and its environment indicate a deficiency in systemic thinking at the policymaking level. This aligns with research indicating that governance modernization requires cohesive political frameworks that bridge institutional silos (Javani et al., 2023; Rahmanizadeh Dehkordi, 2022). In the context of Iran, studies have shown that without strong political alignment, initiatives for governance reform remain vulnerable to inconsistency and fragmentation (Mansouri, 2020; Taghva et al., 2023). These findings also resonate with international research on governance and anti-corruption, which underscores that political will is a non-negotiable prerequisite for implementing systemic reforms effectively (Agu et al., 2024; Ibrahimy et al., 2023).

Legal challenges represent one of the most complex barriers identified in this study. Overlapping and ambiguous jurisdictions, reliance on centralized governance, and absence of integrated cybernetic platforms for legal transparency have been observed in similar studies examining structural inefficiencies in public sector organizations (Ghoraishi et al., 2018; Mirzaei Ahranjani, 1998). The lack of comprehensive laws tailored to systems and cybernetic governance reflects a gap that has been documented in the broader pathology of governmental and administrative law evolution (Mulai & Lotfi, 2020). In addition, the reliance on unstable revenue generation methods for urban services is consistent with previous critiques of unsustainable financing mechanisms in Iranian municipal systems (Ferdowsi, 2014; Shahbazi Ghiasi & Torabi Far, 2016). Importantly, the absence of bottom-up policymaking contradicts the participatory principles necessary for cybernetic governance, echoing concerns raised by governance researchers about the risks of top-down decision-making approaches (Sardarnaba, 2016; Taghva et al., 2023).

Scientific–technical factors were found to be equally critical in shaping the feasibility of governance transformation. The absence of strategic training programs, inadequate digital literacy, and legal restrictions on research are significant barriers to building the necessary human capital for cybernetic systems. This mirrors previous findings in the pathology of employee training systems, which have emphasized the importance of aligning training initiatives with long-term governance objectives (Pourasad et al., 2020; Shakeri et al., 2023). The lack of comprehensive research on barriers to cybernetic governance is consistent with broader critiques of insufficient investment in applied and interdisciplinary research within Iranian governance structures (Ali et al., 2018; Niazi, 2023). Furthermore, the limited availability of suitable infrastructure to operationalize scientific findings underscores the importance of integrating technical capacity-building into governance reform agendas (Ibrahimy et al., 2023; Utami & Barokah, 2024).

Finally, individual factors such as low public demand, lack of awareness, distrust, and minimal participation directly impede the social legitimacy and sustainability of governance reforms. Public disengagement has been documented as a recurrent issue in the pathology of governance systems, particularly when reforms are perceived as elite-driven rather than citizen-centered (Agharazi et al., 2023; Rahmani Zadeh Dehkordi, 2022). Similar patterns have been observed in comparative studies of

governance reforms, where the absence of grassroots involvement has led to weak adoption rates and limited impact (Agu et al., 2024; Mansouri, 2020). These findings suggest that citizen engagement must be prioritized alongside structural and policy reforms to create a governance ecosystem that is both participatory and adaptive.

Taken together, the six categories of pathology identified in this study present a multifaceted challenge that requires integrated solutions. The findings align with the consensus in governance literature that successful systemic transformation depends on simultaneous progress in legal, political, economic, social, and technical domains (Al-Faryan, 2024; Taghva et al., 2023). Moreover, the emphasis on cybernetic governance resonates with global trends toward adaptive, feedback-oriented governance systems, as highlighted in studies on e-government and anti-corruption measures (Ibrahimy et al., 2023; Utami & Barokah, 2024). Addressing these pathologies will require not only structural reforms but also a cultural and institutional shift toward systemic thinking and collaborative policymaking (Niazi, 2023; Rahmanizadeh Dehkordi, 2022).

This study was conducted with a relatively small sample size of 16 experts, selected from two provinces, which may limit the generalizability of the findings to other regions with different socio-political and economic contexts. The use of purposive sampling, while appropriate for qualitative exploration, may have introduced selection bias by focusing on participants already engaged in governance-related roles. Additionally, the reliance on self-reported perspectives through interviews carries the risk of subjectivity, as participants may have emphasized certain pathologies based on personal experiences or institutional affiliations. Furthermore, the study's scope was limited to the perspectives of experts and did not include direct input from the general public, which could provide a broader understanding of governance challenges.

Future studies should expand the geographic scope to include multiple provinces with diverse socio-economic profiles, allowing for comparative analyses that can reveal region-specific governance challenges. Incorporating quantitative methods alongside qualitative interviews would enable researchers to validate findings through statistical analysis and increase the robustness of the conclusions. Including perspectives from citizens, civil society organizations, and private sector stakeholders could provide a more holistic view of governance pathologies. Moreover, longitudinal studies tracking the impact of specific governance reforms over time would be valuable for assessing the effectiveness of systemic and cybernetic approaches in practice.

Practical efforts to address urban governance pathologies should focus on integrating systemic thinking into policymaking, improving cross-sector coordination, and developing strategic training programs for both officials and citizens. Legal reforms must aim to eliminate overlaps in jurisdiction, enhance transparency, and provide clear, enforceable frameworks for cybernetic governance. Financial planning should ensure sustainable budget allocations for infrastructure and technical capacity-building. Finally, fostering citizen engagement through participatory governance mechanisms and awareness campaigns will be critical to building trust and ensuring the long-term viability of governance reforms.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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