

# Improving Hospital Facilities Management through a Human-Centred Complexity Management Approach in Tehran

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## Abstract

Hospital facilities management (FM) operates within a complex socio-technical environment where infrastructure, organisational routines, professional roles and human decision-making continuously interact. In high-density metropolitan contexts such as Tehran, this complexity is intensified by increasing service demand, ageing infrastructure, financial constraints and fragmented governance. This exploratory mixed-methods study investigates human-centred drivers of operational complexity in hospital FM and proposes a Human-Centred Complexity Management Framework. Quantitative data were collected through structured questionnaires completed by 40 hospital FM professionals selected through purposive sampling. The instrument included 18 five-point Likert-scale items measuring communication effectiveness, interdepartmental coordination, leadership engagement, role clarity and cultural adaptability. Data were analysed descriptively in SPSS, and reliability testing produced a Cronbach's alpha of 0.82. Qualitative insights from semi-structured interviews and on-site observations were analysed thematically to contextualise the questionnaire findings. Results indicate that communication gaps recorded the highest perceived influence, followed by coordination failures, role ambiguity and cultural resistance. The proposed framework integrates structured communication, cross-functional coordination, role clarification, adaptive leadership and behavioural governance alignment. The study contributes to complexity-informed FM by showing that hospital resilience depends not only on technical maintenance capacity, but also on the alignment of human, organisational and governance mechanisms.

**Keywords:** Complexity Management, Facilities Management, Healthcare Infrastructure, Hospital Performance, Socio-Technical Systems

## 1. Introduction

Hospitals are among the most complex built environments in contemporary cities. They operate continuously, accommodate vulnerable users and depend on highly specialised technical systems, while also requiring coordination among clinical, administrative, maintenance, safety and support-service functions. Facilities management (FM) in hospitals therefore extends beyond routine maintenance; it includes infrastructure reliability, emergency preparedness, environmental performance, compliance governance and operational continuity.

In metropolitan contexts such as Tehran, hospital FM is further challenged by increasing service demand, ageing infrastructure, financial constraints and fragmented administrative oversight. These pressures mean that operational disruptions are rarely purely technical. A delayed maintenance report, unclear responsibility boundary or weak escalation pathway may generate wider disruption across the facility. Consequently, hospital FM should be viewed as a socio-technical coordination function in which technical systems and human-organisational behaviour are interdependent.

Hospitals are increasingly understood as complex adaptive systems because they involve uncertainty, non-linearity, distributed decision-making and emergent behaviour (Plsek & Greenhalgh, 2001; Greenhalgh & Papoutsi, 2018). Socio-technical systems theory similarly suggests that organisational performance depends on the joint optimisation of technical and social subsystems (Trist, 1981; Cherns, 1976). In hospital FM, this means that asset condition, maintenance processes and infrastructure performance are closely connected to communication quality, leadership engagement, role clarity and organisational culture.

Despite growing attention to healthcare complexity and infrastructure resilience, empirical research on human-centred complexity drivers in hospital FM remains limited, particularly in developing metropolitan settings. This study addresses that gap by examining communication effectiveness, interdepartmental coordination, leadership engagement, role clarity and cultural adaptability in Tehran hospitals. The aim is to identify key human-centred drivers of FM complexity and develop a practical framework for improving resilience and sustainable performance. The paper

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contributes by repositioning FM from a reactive maintenance service to a strategic coordination mechanism that supports hospital continuity and governance.

## 2. Literature Review

### 2.1. Hospitals as complex socio-technical systems

Complexity theory is relevant to healthcare because hospital outcomes emerge from interactions among clinical processes, technical systems, professional groups, governance structures and contextual pressures. In such environments, minor disruptions may escalate when feedback mechanisms are weak or delayed. Greenhalgh & Papoutsi (2018) argue that health systems research should recognise uncertainty, adaptation, contextual variation and emergent causality rather than relying only on linear explanations.

Socio-technical systems theory provides a complementary lens. The technical subsystem includes buildings, utilities, medical-support infrastructure, maintenance systems and safety technologies. The social subsystem includes communication routines, leadership practices, departmental relationships, role allocation and behavioural responses to change. Misalignment between these subsystems can undermine performance even when technical standards are formally in place. Thus, hospital FM performance depends on both asset reliability and organisational coordination.

### 2.2. Human-centred complexity drivers in hospital FM

Human-centred complexity drivers are the behavioural, organisational and governance-related factors that influence how FM teams identify, prioritise and resolve operational problems. Communication effectiveness is central because FM teams rely on timely information from clinical units, administrative departments, maintenance staff, technical supervisors and external service providers. Weak communication reduces feedback quality and can delay corrective action.

Interdepartmental coordination is equally important because hospital FM problems often cross functional boundaries. A facilities issue may require cooperation between maintenance, procurement, clinical services, infection control, finance and senior management. If these actors operate in silos, decisions become slow and reactive. Leadership engagement also influences prioritisation, resource allocation and strategic integration of FM. Recent healthcare leadership literature highlights the need for leaders to navigate uncertainty, interdependence and complexity (Spanos et al., 2024).

Role clarity supports accountability and response speed, while cultural adaptability influences whether

staff accept new reporting systems, coordination routines and digital FM tools. Implementation research shows that organisational context, readiness for change and individual behaviour affect the success of new practices in healthcare settings (Damschroder et al., 2022). Teamwork and coordination also shape implementation outcomes in healthcare and human-service organisations (McGuier et al., 2024). These studies support the need for a human-centred complexity lens in hospital FM.

### 2.3. Research gap and conceptual position

The literature indicates that hospitals are complex socio-technical systems, yet FM research often gives greater attention to technical maintenance, asset management, sustainability and compliance than to the human-centred mechanisms that stabilise or destabilise operations. This paper therefore positions communication, coordination, leadership, role clarity and cultural adaptability as interconnected governance mechanisms that influence FM resilience. This conceptual position provides the basis for the empirical analysis and framework development presented below.

## 3. Research Methodology

### 3.1. Research design and context

An exploratory mixed-methods design was adopted because the study aimed to identify perceived complexity drivers quantitatively and interpret them through qualitative contextual evidence. Mixed methods are appropriate when quantitative patterns need to be understood alongside professional experience and contextual insight (Creswell & Plano Clark, 2018). The design was triangulation-oriented rather than intended for broad statistical generalisation.

The study was conducted in large hospitals in Tehran, where FM operations are shaped by high service demand, ageing infrastructure, resource constraints and fragmented governance. This context is appropriate for examining how technical FM responsibilities interact with organisational and behavioural factors in complex healthcare environments.

### 3.2. Sampling, instrument and analysis

Purposive sampling was used because the study required participants with direct familiarity with hospital FM operations, an approach suitable for exploratory studies involving information-rich professional cases (Palinkas et al., 2015; Etikan et al., 2016). The final valid quantitative sample consisted of 40 completed questionnaires from FM professionals involved in maintenance coordination, technical supervision, operational support and facilities-related decision-making. The study did not aim to compare occupational subgroups; instead, it examined shared human-centred complexity drivers across FM-related roles.

To strengthen sample transparency, the 40 valid questionnaires are treated as a purposive professional sample rather than a statistically representative population sample. Participants were drawn from FM management, technical supervision, maintenance coordination and operational support roles. Because the invitation pool was assembled through professional access points and only complete questionnaires were retained for analysis, a conventional population-based response rate is not reported; this is acknowledged as a methodological limitation. The occupational roles were analysed as one FM-professional group because the exploratory aim was to identify shared human-centred complexity drivers rather than compare role subgroups (Table 1).

### 3.3. Ethical considerations and limitations

Participation was treated as voluntary, and responses are reported in aggregated form to reduce the risk of individual identification. The study is limited to a single metropolitan context and a purposive sample of 40 valid responses. Therefore, the findings should be interpreted as exploratory and context-specific rather than statistically generalisable. A conventional response rate and detailed personal-demographic subgroup counts are not reported because the study used purposive professional access and analysed FM-related roles as one exploratory group. Future research should use larger samples, fuller demographic profiling, clearly disaggregated occupational categories, a defined sampling frame and advanced statistical modelling.

**Table 1:** Participant profile, role coverage and methodological transparency

| Sample reporting issue               | Clarification used in this study                                                                                                                                                                                                                  | Implication for interpretation                                                                                                   |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Sample size                          | Forty valid questionnaires from hospital FM professionals were analysed.                                                                                                                                                                          | Findings represent perceived patterns within an exploratory professional sample.                                                 |
| Role coverage                        | Participants were drawn from FM management, technical supervision, maintenance coordination and operational support roles.                                                                                                                        | The study captures cross-functional FM perspectives without claiming occupational subgroup comparison.                           |
| Sampling technique                   | Purposive sampling was used to reach information-rich professional cases.                                                                                                                                                                         | The sample is suitable for exploratory inquiry but not for statistical generalisation.                                           |
| Response rate                        | A conventional population-based response rate was not calculated because access was purposive and only complete questionnaires were retained.                                                                                                     | This is treated as a limitation and should be addressed in future studies with a defined sampling frame.                         |
| Qualitative saturation               | Recurring patterns were observed, but the qualitative component was used for triangulation rather than formal theory generation.                                                                                                                  | The study avoids making an unsupported claim of theoretical saturation.                                                          |
| Participant profile and demographics | Reporting focuses on professional role coverage relevant to hospital FM. Personal demographic variables are not disaggregated because the study used aggregated, anonymised professional responses and did not test demographic subgroup effects. | This improves participant-profile transparency while avoiding unsupported demographic claims or identifiable subgroup reporting. |

The questionnaire consisted of 18 five-point Likert-scale items measuring communication effectiveness, interdepartmental coordination, leadership engagement, role clarity and cultural adaptability. Quantitative data were analysed descriptively in SPSS using mean values and standard deviation, with the results reported as aggregated patterns. Reliability analysis yielded a Cronbach's alpha of 0.82, indicating acceptable internal consistency for exploratory analysis.

Qualitative evidence was collected through semi-structured interviews and on-site observations and analysed thematically following Braun & Clarke (2006). The qualitative component was used to contextualise and triangulate the questionnaire findings rather than to claim broad theoretical saturation. This cautious interpretation is consistent with the exploratory scope of the study.

## 4. Findings and Discussion

### 4.1. Descriptive results

The descriptive findings indicate that human-centred organisational factors strongly influence hospital FM complexity. Communication gaps recorded the highest mean score, followed by coordination failures, role ambiguity and cultural resistance. These results suggest that operational disruption is not driven only by technical deficiencies, but also by weaknesses in information flow, interdepartmental alignment, accountability and behavioural adaptation.

Given the exploratory purposive design, the descriptive statistics are used to identify perceived priority drivers rather than to infer population-level causal effects. This analytical scope is consistent with the study aim and supports cautious interpretation of the mean-score ranking (Table 2).

**Table 2:** Descriptive results of key human-centred complexity drivers

| Human-centred complexity driver | Mean score | Interpretation                |
|---------------------------------|------------|-------------------------------|
| Communication gaps              | 4.32       | Very high perceived influence |
| Coordination failures           | 4.18       | High perceived influence      |
| Role ambiguity                  | 3.95       | High perceived influence      |
| Cultural resistance             | 3.88       | High perceived influence      |

#### 4.2. Interpretation of findings

Communication gaps were the strongest driver. In hospital FM, communication functions as an operational feedback system through which problems are detected, prioritised, escalated and resolved. Fragmented reporting channels can delay maintenance response and weaken service continuity. This aligns with complexity-informed healthcare research, which emphasises feedback, adaptation and contextual responsiveness (Greenhalgh & Papoutsi, 2018).

Coordination failures also received a high score. Hospital FM issues frequently require cooperation between technical teams, clinical departments, procurement units, safety officers and senior management. When these actors operate in silos, FM decisions become reactive and infrastructure risks may be addressed late. This finding supports the socio-technical argument that technical performance depends on organisational alignment.

Role ambiguity weakens accountability and response speed. During urgent maintenance events, unclear responsibility for reporting, approval, escalation or resolution can produce delay and duplication. Cultural resistance further limits improvement because new

reporting systems, cross-functional routines and digital FM tools require behavioural adaptation. Implementation literature therefore supports treating FM improvement as an organisational change process, not only a technical intervention (Damschroder et al., 2022).

#### 4.3. Qualitative triangulation

The qualitative component helped explain how the main drivers appear in daily FM practice. Interview and observation insights pointed to delayed information flow, fragmented routines, unclear task ownership, resistance to procedural change and limited strategic integration of FM (Table 3).

#### 4.4. Human-Centred Complexity Management Framework

Based on the findings, a Human-Centred Complexity Management Framework is proposed. The framework translates the identified drivers into governance mechanisms for improving FM responsiveness, accountability and resilience. It does not replace technical maintenance systems; rather, it complements them by aligning technical activities with communication, coordination, leadership and behavioural governance (Table 4).

**Table 3:** Qualitative triangulation of human-centred complexity drivers

| Qualitative theme                   | Related driver                      | Operational meaning                                  |
|-------------------------------------|-------------------------------------|------------------------------------------------------|
| Delayed information flow            | Communication gaps                  | Maintenance issues may be reported or escalated late |
| Fragmented departmental routines    | Coordination failures               | FM decisions become reactive and less integrated     |
| Unclear task ownership              | Role ambiguity                      | Accountability and response speed are weakened       |
| Resistance to procedural change     | Cultural resistance                 | Improvement initiatives become harder to implement   |
| Limited strategic integration of FM | Leadership and governance alignment | Facilities risks may be underrepresented in planning |

**Table 4:** Human-Centred Complexity Management Framework for hospital FM

| Component                        | Problem addressed                   | Practical FM action                                          | Expected benefit                                       |
|----------------------------------|-------------------------------------|--------------------------------------------------------------|--------------------------------------------------------|
| Structured communication system  | Delayed reporting and weak feedback | Standardised reporting channels and escalation protocols     | Faster issue identification and clearer prioritisation |
| Interdepartmental coordination   | Departmental silos                  | Cross-functional FM coordination meetings                    | Improved collaboration across hospital units           |
| Role clarification               | Unclear task ownership              | Responsibility matrix for reporting, approval and resolution | Clearer accountability and reduced duplication         |
| Adaptive leadership engagement   | Reactive FM decision-making         | FM involvement in planning and risk review                   | Better anticipation of infrastructure risks            |
| Behavioural governance alignment | Resistance to procedural change     | Training, participation and feedback routines                | Higher acceptance of FM improvements                   |

Figure 1 summarises how the identified human-centred drivers are converted into behavioural governance alignment and, ultimately, improved FM resilience and operational performance. The visual logic clarifies the practical sequence from complexity drivers to governance mechanisms and performance outcomes.

The theoretical contribution lies in applying complexity-informed and socio-technical thinking to hospital FM. The practical contribution is the Human-Centred Complexity Management Framework, which offers hospital administrators and FM managers a structured way to strengthen feedback, coordination,

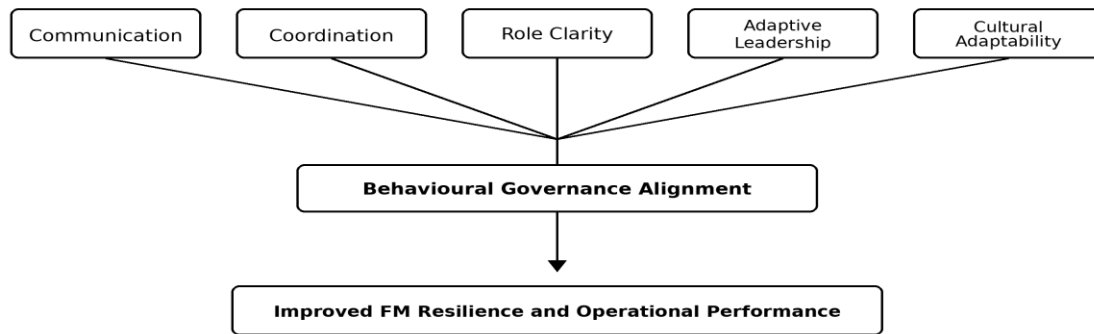


**Figure 1:** Conceptual logic of the Human-Centred Complexity Management Framework

#### 4.5. Managerial recommendations

The findings can be translated into practical actions for hospital administrators and FM managers. Table 5 summarises concise recommendations that can be implemented without relying solely on major capital investment.

accountability, adaptive leadership and behavioural alignment. The results suggest that hospital FM should be positioned as a strategic coordination function rather than a purely reactive maintenance service.

The study remains exploratory and context-specific. Future research should involve larger samples, multiple

**Table 5:** Managerial recommendations for improving hospital FM complexity management

| Identified problem         | Managerial recommendation                              | Responsible level                         | Expected benefit                           |
|----------------------------|--------------------------------------------------------|-------------------------------------------|--------------------------------------------|
| Communication gaps         | Introduce a standardised FM reporting channel          | FM manager and operations team            | Faster reporting and fewer response delays |
| Coordination failures      | Hold regular cross-functional FM coordination meetings | Hospital administration and FM leadership | Better interdepartmental alignment         |
| Role ambiguity             | Develop a responsibility matrix for FM issues          | FM leadership and department heads        | Clearer accountability                     |
| Cultural resistance        | Use training, feedback and staff participation         | FM leadership and HR/training units       | Greater acceptance of change               |
| Weak strategic integration | Include FM in risk review and planning discussions     | Senior management                         | More proactive infrastructure governance   |

## 5. Conclusion and Further Research

This study examined human-centred drivers of operational complexity in hospital FM in Tehran. The findings indicate that FM complexity is shaped not only by technical infrastructure conditions, but also by communication, coordination, role clarity, leadership engagement and cultural adaptability. Communication gaps were the most influential driver, followed by coordination failures, role ambiguity and cultural resistance.

metropolitan regions, fuller demographic data and advanced statistical techniques such as regression analysis or structural equation modelling. Longitudinal research could also test whether the proposed framework improves FM resilience, response speed and operational performance over time

## References

- A'aqoulah, A.A., El-Metwally, A.A., Al Khateeb, B., Alammari, D., Alshahrani, A., Aldubikhi, A., Alsulami, A., Innab, N. & Fatani, F. (2025), 'Challenges and opportunities of complexity theory in health care systems', *Journal of Taibah University Medical Sciences*. <https://doi.org/10.1016/j.jtumed.2025.06.006>
- Braun, V. & Clarke, V. (2006), 'Using thematic analysis in psychology', *Qualitative Research in Psychology*, Vol. 3 No. 2, pp. 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Cherns, A. (1976), 'The principles of sociotechnical design', *Human Relations*, Vol. 29 No. 8, pp. 783-792. <https://doi.org/10.1177/001872677602900806>
- Creswell, J.W. & Plano Clark, V.L. (2018), *Designing and Conducting Mixed Methods Research*. 3rd edn. Thousand Oaks, CA: SAGE Publications.
- Damschroder, L.J., Reardon, C.M., Opra Widerquist, M.A. & Lowery, J. (2022), 'The updated Consolidated Framework for Implementation Research based on user feedback', *Implementation Science*, Vol. 17, 75. <https://doi.org/10.1186/s13012-022-01245-0>
- Etikan, I., Musa, S.A. & Alkassim, R.S. (2016), 'Comparison of convenience sampling and purposive sampling', *American Journal of Theoretical and Applied Statistics*, Vol. 5 No. 1, pp. 1-4. <https://doi.org/10.11648/j.ajtas.20160501.11>
- Greenhalgh, T. & Papoutsi, C. (2018), 'Studying complexity in health services research: desperately seeking an overdue paradigm shift', *BMC Medicine*, Vol. 16 No. 1, 95. <https://doi.org/10.1186/s12916-018-1089-4>
- McGuier, E.A., Kolko, G.A., Aarons, G.A., Schachter, A.A., Klem, M.L., Diabes, M.A., Weingart, E., Salas, E. & Wolk, C.B. (2024), 'Teamwork and implementation of innovations in healthcare and human service settings: a systematic review', *Implementation Science*, Vol. 19. <https://doi.org/10.1186/s13012-024-01381-9>
- Palinkas, L.A., Horwitz, S.M., Green, C.A., Wisdom, J.P., Duan, N. & Hoagwood, K. (2015), 'Purposeful sampling for qualitative data collection and analysis in mixed method implementation research', *Administration and Policy in Mental Health and Mental Health Services Research*, Vol. 42 No. 5, pp. 533-544. <https://doi.org/10.1007/s10488-013-0528-y>
- Plsek, P.E. & Greenhalgh, T. (2001), 'The challenge of complexity in health care', *BMJ*, Vol. 323 No. 7313, pp. 625-628. <https://doi.org/10.1136/bmj.323.7313.625>
- Spanos, S., Leask, E., Patel, R., Dwyer, M., Loh, E. & Braithwaite, J. (2024), 'Healthcare leaders navigating complexity: a scoping review of key competencies and roles', *BMC Medical Education*, Vol. 24. <https://doi.org/10.1186/s12909-024-05689-4>
- Trist, E.L. (1981), 'The evolution of socio-technical systems: a conceptual framework and an action research program', *Occasional Paper No. 2*. Toronto: Ontario Quality of Working Life Centre.

## Appendix A. Questionnaire Structure and Items

The questionnaire consisted of 18 five-point Likert-scale items covering the five dimensions below. The appendix is included to clarify the structure of the instrument without adding unsupported statistical claims.

Table A1. Questionnaire structure

| Dimension                      | Items covered                                                                                                                                                        |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Communication effectiveness    | Clear interdepartmental communication; consistent maintenance reporting; timely escalation of FM issues; clarity of information flow                                 |
| Interdepartmental coordination | Coordination with clinical, administrative and technical units; cross-functional problem-solving; avoidance of departmental silos; joint prioritisation of FM issues |
| Leadership engagement          | FM involvement in operational decisions; leadership support for infrastructure risk review; proactive resource prioritisation                                        |
| Role clarity                   | Clarity of reporting duties; clarity of approval responsibilities; clarity of escalation pathways; avoidance of duplicated responsibilities                          |

| Dimension             | Items covered                                                                                            |
|-----------------------|----------------------------------------------------------------------------------------------------------|
| Cultural adaptability | Readiness to accept new FM routines; willingness to use reporting systems; openness to procedural change |