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A Qualitative Investigation of Innovation Management in Multidisciplinary Engineering Organizations

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Abstract

This study aimed to explore how innovation is managed, coordinated, and sustained in multidisciplinary engineering organizations operating in Tehran. This qualitative study was conducted using a conventional thematic analysis approach. Data were collected through semi-structured interviews with 24 participants working in multidisciplinary engineering organizations in Tehran, including senior engineering managers, R&D specialists, project managers, systems engineers, design engineers, and technical consultants. Participants were selected through purposive sampling based on direct experience with innovation projects, interdisciplinary collaboration, product or process development, and engineering project implementation. Interviews continued until theoretical saturation was achieved. Each interview lasted between 45 and 75 minutes and was audio-recorded with informed consent. The interviews were transcribed verbatim and analyzed using Braun and Clarke's six-phase thematic analysis procedure. NVivo software was used to support data organization, coding, category development, retrieval of coded segments, and comparison of themes across participant groups. Trustworthiness was enhanced through member checking, peer debriefing, audit trail documentation, and researcher reflexivity. Data analysis generated five main categories: strategic framing of innovation, cross-disciplinary knowledge integration, structural and procedural support for innovation, leadership and cultural enablers, and barriers to implementation and commercialization. Participants described innovation as a process shaped by both technical creativity and organizational coordination. Effective innovation management required alignment between engineering expertise, market needs, resource allocation, managerial support, and interdepartmental communication. While multidisciplinary teams expanded the range of ideas and technical solutions, they also created challenges related to language differences, professional boundaries, slow decision-making, and conflict over priorities. Innovation management in multidisciplinary engineering organizations is not limited to idea generation or technical problem-solving; rather, it depends on the organization's ability to integrate specialized knowledge, create flexible structures, support experimentation, and translate technical concepts into implementable outcomes. The findings suggest that engineering organizations should strengthen boundary-spanning roles, collaborative routines, innovation governance, and leadership practices that connect technical excellence with strategic and commercial value.

Keywords: Innovation management; multidisciplinary engineering; qualitative research; knowledge integration; engineering organizations; thematic analysis

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1. Introduction

Innovation has become a central requirement for engineering organizations operating in complex, competitive, and technology-intensive environments. In engineering contexts, innovation is rarely the result of isolated technical creativity; instead, it emerges from the coordinated interaction of diverse professional domains, including design, production, systems engineering, project management, research and development, quality assurance, procurement, digital technologies, and customer-facing units. Multidisciplinary engineering organizations are therefore uniquely positioned to generate innovation because they possess heterogeneous knowledge resources, technical specialization, and problem-solving capabilities. At the same time, these organizations face significant managerial challenges because the same diversity that supports innovation may also produce communication barriers, disciplinary fragmentation, coordination problems, and conflict over priorities. Innovation management in such organizations requires more than formal R&D investment; it requires an integrated system of strategy, leadership, knowledge sharing, experimentation, implementation, and organizational learning.

Organizational innovation has been conceptualized as both a process and an outcome. Crossan and Apaydin (2010) define organizational innovation as the production, adoption, or exploitation of a value-added novelty in economic and social spheres. This definition is particularly relevant to engineering organizations because innovations may appear as new products, redesigned technical systems, improved processes, digital tools, project delivery methods, or novel ways of integrating engineering knowledge. Innovation is therefore multidimensional, involving not only technological novelty but also managerial, procedural, and relational change. Van de Ven (1986) similarly argued that innovation management involves the development and implementation of new ideas by people who engage in transactions with others within an institutional context. In multidisciplinary engineering settings, this means that innovation is not simply created by engineers but is shaped by interactions among teams, departments, clients, suppliers, standards, regulatory expectations, and market pressures.

A major theoretical foundation for understanding innovation in engineering organizations is the knowledge-based view of the firm. Knowledge is a core organizational resource, and innovation depends on the capacity to combine, transform, and apply different types of expertise (Kogut & Zander, 1992; Nonaka, 1994). Engineering organizations usually contain highly specialized knowledge domains; however, specialized knowledge does not automatically produce innovation. Cohen and Levinthal (1990) introduced the concept of absorptive capacity, referring to an organization's ability to recognize the value of external knowledge, assimilate it, and apply it commercially. This concept is important in multidisciplinary engineering organizations because innovation often requires combining internal technical expertise with external knowledge from clients, suppliers, universities, competitors, standards bodies, and emerging technologies. Zahra and George (2002) later reconceptualized absorptive capacity as a dynamic capability involving knowledge acquisition, assimilation, transformation, and exploitation. In engineering organizations, these processes may be seen when teams scan technological developments, interpret new technical requirements, adapt them to organizational routines, and convert them into new products, services, or processes.

Despite the potential value of multidisciplinary knowledge, boundaries between professional groups can restrict innovation. Carlile (2002) argued that knowledge is both a source of innovation and a barrier to innovation because different groups develop distinct assumptions, vocabularies, tools, and priorities. In engineering organizations, design engineers may emphasize technical elegance, project managers may emphasize deadlines and budgets, quality specialists may emphasize compliance, and commercial units may emphasize customer needs and market feasibility. These differences create syntactic, semantic, and pragmatic boundaries. Syntactic boundaries arise when groups lack shared terminology or data formats. Semantic boundaries emerge when groups attach different meanings to the same concept. Pragmatic boundaries appear when innovation affects interests, responsibilities, authority, and resource distribution. Accordingly, multidisciplinary innovation requires transfer, translation, and transformation of knowledge across professional boundaries. Boundary objects such as prototypes, technical drawings, simulation models, dashboards, project maps, and digital twins may help groups develop shared understanding.

Cross-boundary collaboration is also central to innovation management. Edmondson and Harvey (2018) emphasize that cross-boundary teaming can expand the range of ideas available for innovation, but it requires psychological safety, shared goals, integrative leadership, and mechanisms for knowledge exchange. In engineering organizations, teams are often temporary, project-based, and distributed across functional units. This creates pressure to coordinate rapidly while also solving technically complex problems. Research on teams has shown that innovation depends not only on team composition but also on the quality of interaction, coordination, and communication. Hoegl and Gemuenden (2001) found that teamwork quality is strongly related to the success of innovative projects. Faraj and Sproull (2000) also demonstrated that expertise coordination is essential in technical work because teams must know where expertise is located, when it is needed, and how to integrate it into collective performance. Therefore, multidisciplinary engineering innovation depends on the capacity to mobilize expertise at the right time and align it with project objectives.

Leadership is another critical dimension of innovation management. Innovation requires decision-making under uncertainty, tolerance for experimentation, and the ability to protect emerging ideas from premature rejection. Amabile (1988) argued that creativity and innovation are shaped by individual motivation, domain-relevant skills, creativity-relevant processes, and the surrounding organizational environment. In engineering organizations, leadership affects whether employees feel able to propose unconventional technical ideas, challenge existing assumptions, and discuss failure openly. Edmondson's (1999) work on psychological safety is relevant here because innovation requires interpersonal conditions in which team members can ask questions, report problems, and express disagreement without fear of embarrassment or punishment. Without psychological safety, multidisciplinary teams may avoid raising design concerns, hide technical uncertainty, or defer excessively to senior authority. This can reduce both creativity and engineering reliability.

The strategic management literature also highlights the importance of dynamic capabilities in innovation. Teece, Pisano, and Shuen (1997) argued that competitive advantage in rapidly changing environments depends on the firm's ability to integrate, build, and reconfigure internal and external competencies. Eisenhardt and Martin (2000) further described dynamic capabilities as organizational routines through which firms modify their resource base. Engineering organizations require such capabilities because technologies, customer requirements, digital tools, regulatory standards, and project delivery models change continuously. Innovation management therefore involves sensing technological opportunities, seizing them through investment and project selection, and transforming organizational routines to support implementation. O'Connor (2008) similarly described major innovation as a dynamic capability requiring systems that support discovery, incubation, and acceleration. In multidisciplinary engineering organizations, this means that innovation must be managed across the full pathway from idea identification to prototyping, validation, scaling, and commercialization.

Innovation also involves the tension between exploitation and exploration. March (1991) distinguished exploitation, which involves refinement, efficiency, implementation, and execution, from exploration, which involves experimentation, search, variation, and discovery. Engineering organizations often operate under strong exploitation pressures because projects must be delivered on time, within budget, and according to technical specifications. However, excessive emphasis on exploitation may reduce experimentation and long-term innovation. Tushman and O'Reilly (1996) argued that ambidextrous organizations are able to pursue both incremental and discontinuous innovation. This issue is highly relevant in engineering organizations, where managers must balance reliable project delivery with the development of new technologies, tools, materials, processes, and business models. Innovation management therefore requires governance mechanisms that protect exploratory work while maintaining operational discipline.

Open innovation further extends the innovation challenge beyond organizational boundaries. Chesbrough (2003) argued that firms increasingly rely on purposive inflows and outflows of knowledge to accelerate innovation and expand market opportunities. Engineering organizations frequently collaborate with universities, technology vendors, contractors, public agencies, customers, and international partners. Such collaboration can increase access to new technical knowledge, but it also introduces challenges related to intellectual property, confidentiality, coordination, trust, and alignment of expectations. Hansen and Birkinshaw (2007) described innovation as a value chain involving idea generation, conversion, and diffusion. This perspective suggests that organizations may fail not because they lack ideas but because they cannot select, develop, implement, or diffuse them effectively. In multidisciplinary engineering organizations, many promising ideas may remain trapped within teams because there is no clear pathway for evaluation, resourcing, ownership, or scaling.

Although the literature provides rich theoretical insights into innovation, knowledge integration, and cross-functional collaboration, less is known about how innovation management is experienced by professionals inside multidisciplinary engineering organizations, particularly in emerging-market urban contexts such as Tehran. Engineering organizations in Tehran operate within a distinctive environment shaped by technological ambition, resource constraints, project complexity, regulatory requirements, market uncertainty, and the need to adapt global engineering knowledge to local conditions. A qualitative approach is therefore suitable because it can capture the lived experiences, interpretations, and managerial practices of professionals directly involved in innovation work. Rather than measuring innovation performance through predefined indicators, this study explores how participants understand innovation, how they manage multidisciplinary collaboration, what organizational conditions enable innovation, and what barriers prevent ideas from becoming implemented outcomes.

The aim of this study was to explore how innovation is managed in multidisciplinary engineering organizations in Tehran by identifying the strategic, structural, relational, and cultural factors that shape the generation, integration, implementation, and sustainability of innovation.

2. Methods and Materials

This study used a qualitative research design based on semi-structured interviews and thematic analysis. A qualitative approach was selected because the purpose of the study was to understand participants' experiences, interpretations, and perceptions of innovation management in multidisciplinary engineering organizations. The study did not seek to test predefined hypotheses; rather, it aimed to generate a rich and contextualized account of how innovation is organized, supported, constrained, and implemented in engineering settings. Thematic analysis was used because it provides a flexible yet systematic method for identifying, analyzing, and reporting patterns within qualitative data (Braun & Clarke, 2006). The reporting of the study was guided by the principles of transparency and completeness recommended in qualitative reporting frameworks such as COREQ (Tong et al., 2007).

Participants were selected through purposive sampling. The inclusion criteria were: employment in a multidisciplinary engineering organization in Tehran; at least five years of professional experience; direct involvement in innovation-related activities such as R&D, product development, process improvement, digital transformation, systems design, project management, or engineering consultancy; and willingness to participate in an audio-recorded interview. Participants who had no direct experience with multidisciplinary innovation projects or who were unable to provide informed consent were excluded.

The final sample consisted of 24 participants from engineering organizations located in Tehran. Participants included engineering managers, R&D managers, project managers, senior design engineers, systems engineers, quality and process improvement specialists, technology development experts, and engineering consultants. The sample size was determined by theoretical saturation. After the twenty-second interview, no substantially new categories emerged, and two additional interviews were conducted to confirm the stability and completeness of the coding framework. This approach is consistent with qualitative sampling logic, in which information richness and saturation are more important than statistical representativeness (Guest et al., 2006; Palinkas et al., 2015).

Data were collected using semi-structured interviews. The interview guide was developed based on the study aim and relevant literature on innovation management, multidisciplinary collaboration, knowledge integration, and engineering project work. The guide included open-ended questions such as: "How do you define innovation in your organization?" "Can you describe a recent innovation project involving multiple engineering disciplines?" "How are innovative ideas identified, evaluated, and implemented?" "What helps multidisciplinary teams collaborate effectively?" "What barriers prevent innovative ideas from being implemented?" and "What role do leaders and managers play in supporting innovation?"

The semi-structured format allowed the researcher to ask follow-up questions and explore examples in greater depth. Interviews were conducted in a private setting at participants' workplaces or through secure online communication platforms, depending on participant preference and availability. Each interview lasted between 45 and 75 minutes. All interviews were audio-recorded with participant consent and transcribed verbatim. Field notes were written after each interview to document contextual impressions, emerging analytical ideas, and reflections on the interview process.

Data analysis was conducted using Braun and Clarke's (2006) six-phase thematic analysis process: familiarization with the data, generation of initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final report. First, the transcripts were read several times to gain familiarity with the data. Second, meaningful units of text were coded line by line. Codes were both semantic and interpretive, capturing explicit statements as well as underlying meanings related to innovation management. Third, similar codes were grouped into preliminary categories. Fourth, the categories were reviewed against the coded data and the entire dataset to ensure coherence and distinctiveness. Fifth, final themes were defined and named. Sixth, the findings were written using analytical descriptions and representative interview quotations.

NVivo software was used to organize transcripts, store codes, retrieve coded segments, compare coding across participants, and support the development of themes. NVivo was not used as an automatic analysis tool; rather, it served as a data management and analytic support system. The interpretation of the data remained the responsibility of the researchers. The use of qualitative software helped strengthen transparency by maintaining a structured coding database and enabling systematic retrieval of evidence for each category.

Several strategies were used to enhance the trustworthiness of the study. Credibility was supported through prolonged engagement with the data, member checking with selected participants, and peer debriefing with two qualitative research colleagues. Transferability was strengthened by providing detailed descriptions of the study context, participant characteristics, and organizational setting. Dependability was enhanced through an audit trail documenting interview procedures, coding decisions, category development, and revisions to the analytical framework. Confirmability was supported through reflexive memo writing, in which the researchers documented assumptions, possible biases, and interpretive decisions throughout the analysis process. These strategies are consistent with Lincoln and Guba's (1985) criteria for qualitative rigor.

Participants received information about the purpose of the study, voluntary participation, confidentiality, and their right to withdraw at any stage. Written informed consent was obtained before each interview. To protect anonymity, participant names and organizational identifiers were removed from transcripts and replaced with codes such as P1, P2, and P3. Audio files and transcripts were stored securely and were accessible only to the research team. Interview quotations were edited minimally to improve readability without changing meaning.

3. Findings

The study included 24 participants from multidisciplinary engineering organizations in Tehran. Of the participants, 17 were male and 7 were female. In terms of age, 5 participants were between 30 and 35 years old, 9 were between 36 and 40 years old, 6 were between 41 and 45 years old, and 4 were older than 45 years. Regarding educational level, 14 participants held a master's degree, 6 held a doctoral degree, and 4 held a bachelor's degree in engineering or a related technical field. In terms of professional role, 5 participants were senior engineering managers, 4 were R&D managers or innovation leads, 5 were project managers, 4 were senior design or systems engineers, 3 were quality and process improvement specialists, and 3 were engineering consultants. Work experience ranged from 6 to 24 years, with 8 participants having 6–10 years of experience, 10 having 11–15 years, and 6 having more than 15 years. All participants had direct experience with multidisciplinary engineering projects involving at least two technical or managerial domains.

The first main category concerned how innovation was strategically understood and framed within engineering organizations. Participants emphasized that innovation was not simply the creation of new technical ideas but the ability to solve real engineering, operational, or customer problems in a way that produced measurable organizational value. Innovation was described as a bridge between technical creativity and strategic relevance. Several participants explained that ideas were more likely to receive managerial support when they were connected to cost reduction, project efficiency, product quality, safety, customer satisfaction, or competitive positioning. One participant stated, “In engineering, a new idea is not enough. Management asks what problem it solves, how much risk it reduces, and whether the client will accept it” (P4). Another participant noted, “The most successful innovations were those that had a clear link to the company’s strategy. When innovation was treated as a side activity, it disappeared after a few meetings” (P11). Participants also reported that organizations with explicit innovation priorities were better able to allocate resources, select projects, and sustain commitment. However, in organizations where innovation was defined vaguely, employees were uncertain whether they should focus on incremental improvements, new technologies, process redesign, or market-oriented solutions. Thus, strategic framing helped transform innovation from an abstract aspiration into a managerial priority.

The second main category focused on the integration of knowledge across engineering disciplines and organizational functions. Participants repeatedly described multidisciplinary collaboration as both the main source of innovation and one of its most difficult challenges. Innovation projects often required mechanical, electrical, civil, industrial, software, quality, and project management expertise to be combined. However, each discipline had its own technical language, assumptions, standards, tools, and problem-solving logic. One senior systems engineer explained, “A software engineer, a mechanical engineer, and a project manager may use the same word but mean three different things. Many delays start from this hidden misunderstanding” (P8). Participants reported that successful innovation depended on structured communication routines such as joint design reviews, interdisciplinary workshops, shared dashboards, prototype demonstrations, and cross-functional problem-solving sessions. Boundary-spanning individuals played a critical role because they could translate between disciplines and connect technical details to managerial decisions. One R&D manager said, “The best people in innovation projects are not always the deepest specialists. They are people who understand enough of several fields to connect the specialists” (P14). Participants also emphasized the importance of shared technical artifacts, including drawings, models, simulations, and pilot results, because these objects made abstract ideas more visible and negotiable. Therefore, knowledge integration was not spontaneous; it required deliberate mechanisms for translation, coordination, and collective interpretation.

The third main category referred to organizational structures and procedures that enabled or constrained innovation. Participants reported that innovation was more successful when organizations had formal mechanisms for idea submission, technical evaluation, resource allocation, prototyping, pilot testing, and implementation. Without such mechanisms, ideas often remained informal discussions between engineers and managers. One participant stated, “Many ideas die because there is no owner, no budget, and no path. Everyone says it is interesting, but nobody knows the next step” (P2). Participants described the need for innovation governance that balanced flexibility with discipline. Excessively bureaucratic procedures slowed experimentation, while completely informal approaches created ambiguity and inconsistency. Several participants emphasized the value of small pilot projects because they allowed teams to test ideas without committing large budgets. A project manager explained, "When we could run a pilot, resistance decreased. People could see the result instead of arguing theoretically" (P19). Participants also discussed the importance of time allocation. Engineering employees were often overloaded with delivery responsibilities, leaving little time for experimentation. In some organizations, innovation depended on personal sacrifice after working hours. This created burnout and reduced participation. Participants suggested that organizations should allocate protected time, innovation budgets, technical review committees, and clear escalation pathways for promising ideas. Structural support was therefore necessary to move innovation from individual initiative to organizational capability.

The fourth main category concerned leadership and organizational culture. Participants emphasized that innovation required managers who encouraged questioning, tolerated controlled failure, protected teams from premature criticism, and connected technical ideas to organizational strategy. In organizations with supportive leadership, employees felt more comfortable proposing new solutions and discussing project problems openly. One senior engineer stated, "When the manager listens seriously, even a young engineer can challenge the old method. But when managers punish mistakes, everyone repeats the safest solution" (P7). Participants described psychological safety as particularly important in multidisciplinary teams because technical disagreements were common. If disagreement was interpreted as disrespect, teams avoided debate and innovation quality declined. Leaders also influenced innovation by managing conflict between short-term project delivery and long-term development. An R&D manager explained, "Innovation always loses when urgent projects dominate everything. Leadership must protect some space for future-oriented work" (P10). Participants also discussed recognition and motivation. Some organizations celebrated project completion but ignored learning, experimentation, or process improvement. This discouraged employees from investing energy in innovation. A consultant commented, "Engineers are motivated when their ideas become visible. Recognition does not always need to be financial; sometimes technical respect is more important" (P21). Overall, leadership and culture shaped whether innovation was experienced as a shared responsibility or as a risky extra task.

The fifth main category addressed barriers that prevented innovative ideas from being implemented, scaled, or commercialized. Participants explained that multidisciplinary engineering organizations often generated valuable ideas but struggled to convert them into organizational outcomes. Key barriers included risk aversion, budget constraints, fragmented decision-making, unclear ownership, weak market validation, regulatory limitations, procurement restrictions, and lack of senior management continuity. One participant said, "We are good at solving technical problems, but weak at turning the solution into a repeatable product or service" (P16). Another participant noted, "Sometimes the technical team proves that an idea works, but the commercial team enters too late. Then we discover that the client does not want it in that form" (P5). Participants emphasized that commercialization required early involvement of customers, market specialists, legal advisors, and financial decision-makers. Engineering-led innovation sometimes failed because teams focused heavily on technical feasibility while underestimating adoption, cost, maintenance, user training, and after-sales support. Participants also reported that implementation was difficult when innovation challenged existing power structures or routines. A quality specialist explained, "The biggest resistance appears when innovation changes who controls the process" (P23). Therefore, implementation barriers were not only technical but also organizational, political, financial, and market-related.

4. Discussion

The findings of this study show that innovation management in multidisciplinary engineering organizations is a complex organizational capability rather than a linear technical process. The first main category, strategic framing of innovation, revealed that participants understood innovation as valuable only when technical novelty was connected to organizational goals, customer needs, and project performance. This finding aligns with Crossan and Apaydin's (2010) multidimensional framework, which conceptualizes innovation as both process and outcome, and with Van de Ven's (1986) view that innovation involves the development and implementation of new ideas within institutional and relational contexts. In the present study, innovation was not treated merely as invention; rather, participants emphasized practical usefulness, feasibility, and strategic relevance. This is consistent with Chesbrough's (2003) argument that innovation requires the movement of ideas toward application and value creation. The findings also support Hansen and Birkinshaw's (2007) innovation value chain perspective, which suggests that organizations must manage not only idea generation but also conversion and diffusion. In multidisciplinary engineering organizations, strategic framing appears to function as a filtering and alignment mechanism: it helps employees understand which types of innovation matter, why they matter, and how they relate to organizational priorities.

The second main category, cross-disciplinary knowledge integration, is strongly supported by knowledge-based theories of innovation. Participants described multidisciplinary collaboration as both an opportunity and a challenge, because different engineering disciplines contributed specialized knowledge while also creating communication difficulties. This finding corresponds closely with Carlile's (2002) theory of knowledge boundaries, which explains that knowledge can become a barrier when groups differ in language, meanings, and interests. In the present study, participants described misunderstandings between software, mechanical, electrical, project management, and quality specialists, demonstrating the practical relevance of syntactic, semantic, and pragmatic boundaries. The findings also align with Cohen and Levinthal's (1990) concept of absorptive capacity and Zahra and George's

(2002) reconceptualization of knowledge acquisition, assimilation, transformation, and exploitation. Multidisciplinary engineering organizations must not only possess knowledge but also absorb and recombine it. Participants emphasized the role of boundary-spanning individuals and shared artifacts, which is consistent with Edmondson and Harvey's (2018) cross-boundary teaming model. The finding suggests that innovation depends less on the mere presence of multiple disciplines and more on the organization's capacity to create translation mechanisms across those disciplines.

The third main category, structural and procedural support for innovation, indicates that innovation requires formal organizational pathways. Participants reported that ideas often failed because there was no clear owner, budget, evaluation process, pilot mechanism, or implementation route. This finding aligns with O'Connor's (2008) argument that major innovation should be understood as a dynamic capability supported by systems for discovery, incubation, and acceleration. It also supports Teece et al.'s (1997) dynamic capabilities framework, which emphasizes the integration and reconfiguration of resources in changing environments. In the studied organizations, innovation was weakened when it depended only on informal enthusiasm or individual persistence. This finding is important because engineering professionals may possess strong technical motivation, but without organizational structures their ideas may remain disconnected from decision-making and resource allocation. The findings also correspond with Eisenhardt and Martin's (2000) view that dynamic capabilities are embedded in identifiable organizational routines. In practical terms, innovation routines in engineering organizations may include idea portals, stage-gate processes, technical review boards, interdisciplinary design reviews, prototyping budgets, lessons-learned systems, and pilot implementation protocols.

The fourth main category, leadership and cultural enablers, highlights the social and psychological conditions required for innovation. Participants emphasized that supportive leaders encouraged questioning, protected experimentation, tolerated controlled failure, and created space for future-oriented work. This finding is consistent with Amabile's (1988) model of creativity and innovation, which argues that the organizational environment influences creative behavior. It also aligns with Edmondson's (1999) concept of psychological safety, particularly because innovation in engineering teams requires employees to raise concerns, question assumptions, and discuss uncertainty. In multidisciplinary teams, disagreement is not an abnormal disruption but a necessary condition for technical integration. However, if leaders interpret disagreement as resistance or disrespect, team members may avoid productive conflict. The findings further suggest that leaders must manage the tension between exploitation and exploration. March (1991) argued that organizations must balance efficiency-oriented exploitation with experimentation-oriented exploration, while Tushman and O'Reilly (1996) described ambidextrous organizations as those capable of managing incremental and discontinuous change simultaneously. In the present study, participants described how urgent project delivery often displaced innovation work. Leadership therefore plays a crucial role in protecting exploratory activity from being absorbed by short-term operational pressures.

The fifth main category, barriers to implementation and commercialization, shows that innovation failure often occurs after idea generation. Participants stated that organizations were able to produce technical solutions but struggled with scaling, commercialization, market validation, ownership, and adoption. This finding is aligned with Dougherty's (1992) work on interpretive barriers to successful product innovation, which showed that large firms often fail to link technological and market possibilities effectively. In the present study, engineering-led innovation sometimes remained overly focused on technical feasibility while giving insufficient attention to customer acceptance, maintenance, cost, user training, and commercial pathways. This finding also relates to Chesbrough's (2003) open innovation perspective, because implementation and commercialization often require interaction with external customers, suppliers, partners, and market actors. The participants' accounts suggest that innovation management in engineering organizations should include early market and user involvement, not only late-stage commercialization. Moreover, implementation barriers were sometimes political because innovation changed authority, routines, and resource control. This supports Carlile's (2002) argument that pragmatic knowledge boundaries involve differences in interests, not only differences in information.

Overall, the findings contribute to the literature by showing how innovation management is experienced inside multidisciplinary engineering organizations in Tehran. The study integrates strategic, structural, cultural, and knowledge-based dimensions of innovation. The findings suggest that innovation management should be understood as a coordinated system consisting of five interdependent elements: strategic alignment, knowledge integration, structural support, leadership culture, and implementation capability. If one element is weak, innovation performance may be constrained even when other elements are present. For example, an organization may have creative engineers but lack implementation pathways; it may have formal procedures but lack psychological safety; or it may have multidisciplinary teams but lack boundary-spanning mechanisms. Therefore, innovation management in engineering organizations requires systemic attention to both technical and organizational dimensions.

This study has several limitations. First, the participants were selected from multidisciplinary engineering organizations in Tehran; therefore, the findings may not fully represent engineering organizations in other cities, countries, industrial sectors, or institutional environments. Second, the study relied only on semi-structured interviews, which provided rich subjective accounts but did not include direct observation of innovation meetings, project documents, or longitudinal tracking of innovation projects. Third, although theoretical saturation was reached, the sample size was limited to 24 participants, and some specialized engineering fields may have been represented less extensively than others. Fourth, the findings were based on participants' retrospective descriptions, which may be influenced by memory, personal interpretation, organizational position, or social desirability. Finally, because innovation is a dynamic process, a cross-sectional qualitative design may not capture how innovation practices evolve over time.

Future research could examine innovation management in multidisciplinary engineering organizations using longitudinal qualitative designs that follow specific innovation projects from idea generation to implementation and commercialization. Comparative studies could also explore differences between public and private engineering organizations, large and medium-sized firms, or traditional engineering companies and digitally oriented technology firms. Future researchers may combine interviews with observations, document analysis, and innovation performance indicators to create a more comprehensive understanding of how formal systems and everyday practices interact. Quantitative studies could also develop and test measurement models based on the categories identified in this study, including strategic framing, knowledge integration, structural support, leadership culture, and implementation capability. In addition, future research could examine the role of digital collaboration platforms, artificial intelligence tools, simulation technologies, and digital twins in supporting multidisciplinary innovation.

Engineering organizations should define innovation clearly and connect it to strategic priorities, customer value, project performance, and long-term competitiveness. Managers should create formal but flexible pathways for idea evaluation, prototyping, pilot testing, budgeting, and implementation. Multidisciplinary teams should be supported through boundary-spanning roles, shared technical artifacts, cross-functional workshops, and regular design review sessions. Leaders should cultivate psychological safety so that engineers and specialists can question assumptions, report problems, and discuss uncertainty without fear. Organizations should also allocate protected time for innovation, recognize technical contributions, and involve customers, commercial teams, and implementation stakeholders early in the innovation process. Finally, innovation should be treated as an organizational capability rather than as an informal activity dependent on individual enthusiasm.

5. Conclusion

This qualitative study explored innovation management in multidisciplinary engineering organizations in Tehran. The findings showed that innovation is shaped by the interaction of strategic, structural, relational, cultural, and implementation-related factors. Five main categories were identified: strategic framing of innovation, cross-disciplinary knowledge integration, structural and procedural support for innovation, leadership and cultural enablers, and barriers to implementation and commercialization. Participants described innovation as a process that requires both technical creativity and organizational coordination. Multidisciplinary engineering teams can generate valuable ideas because they bring together diverse forms of expertise, but this diversity must be actively managed through communication routines, boundary-spanning roles, shared artifacts, and supportive leadership.

The study concludes that innovation management in engineering organizations should not be reduced to R&D activities or idea generation. Instead, it should be understood as a systemic capability that enables organizations to identify opportunities, integrate specialized knowledge, experiment with solutions, allocate resources, and convert technical ideas into implemented value. Organizations that wish to strengthen innovation should focus on aligning innovation with strategy, creating clear pathways for experimentation and implementation, supporting interdisciplinary collaboration, and developing leadership practices that encourage learning and calculated risk-taking. In multidisciplinary engineering contexts, the central challenge is not only to produce new ideas but to create the organizational conditions through which ideas can travel across disciplinary boundaries and become practical, scalable, and valuable outcomes.

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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