A Qualitative Exploration of Decision-Making Processes in Multidisciplinary Engineering Innovation

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Abstract

This study aimed to explore how multidisciplinary engineering teams make innovation-related decisions under conditions of technical uncertainty, disciplinary diversity, organizational constraint, and market-oriented pressure. This qualitative study was conducted using semi-structured interviews with 24 participants from Tehran-based engineering and technology-oriented organizations. Participants included senior engineers, project managers, R&D specialists, product development experts, innovation managers, and technical consultants who had direct experience in multidisciplinary engineering innovation projects. Purposeful sampling was used to recruit information-rich participants, and data collection continued until theoretical saturation was achieved after the twenty-first interview, followed by three additional interviews to confirm thematic stability. Interviews were conducted face-to-face or online, lasted 45–75 minutes, and focused on participants' experiences of innovation decision-making, cross-disciplinary coordination, technical evaluation, conflict resolution, risk assessment, and implementation choices. Audio-recorded interviews were transcribed verbatim and analyzed using thematic analysis with the support of NVivo software. Analysis produced five main categories: shared problem framing across disciplinary boundaries, evidence-based negotiation under uncertainty, distributed authority and decision ownership, iterative experimentation and risk balancing, and organizational alignment with innovation value. The findings showed that multidisciplinary engineering decisions were rarely linear or purely technical. Instead, participants described decision-making as an interactive process shaped by translation between disciplinary logics, negotiation over evidence, informal influence, prototype-based learning, and organizational expectations regarding cost, feasibility, timing, and market relevance. The study concludes that effective decision-making in multidisciplinary engineering innovation depends on the team's ability to create shared interpretive spaces, combine analytical and experiential knowledge, clarify decision authority, tolerate controlled experimentation, and align technical novelty with organizational value. These findings contribute to engineering innovation literature by showing how decision-making operates as a socio-technical and negotiated practice rather than a purely rational selection process.

Keywords: multidisciplinary engineering, innovation, decision-making, qualitative research, semi-structured interviews

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1. Introduction

Engineering innovation increasingly occurs in multidisciplinary environments where mechanical, electrical, software, industrial, civil, materials, and managerial expertise must be integrated to produce technically feasible and commercially meaningful outcomes. Contemporary engineering projects rarely depend on a single field of knowledge. Instead, they require the coordination of diverse technical specializations, stakeholder expectations, market constraints, safety requirements, digital tools, regulatory considerations, and organizational strategies. In this context, decision-making becomes a central process through which innovation is shaped, filtered, justified, delayed, accelerated, or abandoned. Although engineering is often associated with rational analysis, optimization, calculation, and technical problem-solving, decision-making in innovation projects is also social, interpretive, negotiated, and context-dependent. The present study therefore explores how multidisciplinary engineering teams experience and construct decision-making processes during innovation-oriented work.

Engineering design has long been understood as a complex activity involving problem formulation, solution generation, modeling, evaluation, iteration, and trade-off management. Simon (1996) conceptualized design as a science of the artificial, emphasizing that design is concerned not only with understanding existing realities but with transforming existing situations into preferred ones. This view is particularly relevant to innovation because engineering teams must make decisions before all variables are known and before the final consequences of a technical choice can be fully predicted. Similarly, Dym, Agogino, Eris, Frey, and Leifer (2005) argued that engineering design thinking involves divergent and convergent reasoning, systems thinking, experimentation, communication, and decision-making under constraint. In multidisciplinary innovation, these elements become even more complex because each discipline may define the problem differently, use different standards of evidence, and prioritize different dimensions of success.

Decision-making in engineering innovation is not simply a technical selection among predefined alternatives. It often begins with problem framing. Different specialists may interpret the same innovation challenge through different disciplinary assumptions. For example, a mechanical engineer may frame a product challenge in terms of material strength, manufacturability, or reliability, whereas a software engineer may focus on control logic, user interface, data architecture, or adaptability. A project manager may frame the same problem in relation to time, cost, resource allocation, and client expectations. Bucciarelli (1994) described engineering design as a social process involving different "object worlds," where engineers from different backgrounds participate in a shared project while maintaining distinct ways of seeing and reasoning. This perspective suggests that multidisciplinary engineering decision-making requires not only technical evaluation but also translation between professional worlds.

Knowledge integration is therefore a core challenge in multidisciplinary innovation. Carlile (2002) showed that knowledge can become both a resource and a barrier in new product development because specialized knowledge is often difficult to transfer, translate, and transform across functional boundaries. When knowledge differences are small, information sharing may be sufficient; however, when disciplinary differences are deeper, teams need mechanisms that support mutual interpretation and joint transformation of knowledge. Boundary objects such as prototypes, diagrams, simulation models, design sketches, testing reports, and performance dashboards can help teams coordinate despite different perspectives (Star & Griesemer, 1989). In engineering innovation, these objects often become decision-making anchors because they allow participants to make abstract technical disagreements visible, test assumptions, and negotiate alternatives.

The multidisciplinary nature of innovation also intensifies uncertainty. Unlike routine engineering decisions, innovation-related decisions often involve incomplete information, ambiguous requirements, unstable client expectations, emerging technologies, uncertain market demand, and unpredictable implementation risks. Eisenhardt and Zbaracki (1992) emphasized that strategic decision-making is shaped by bounded rationality, power, politics, and chance rather than pure rational calculation. This insight applies strongly to multidisciplinary engineering innovation, where teams must choose among imperfect options while balancing technical risk, organizational pressure, time constraints, and stakeholder priorities. Even when teams use analytical methods, decisions may still depend on judgment, experience, intuition, negotiation, and the ability to act under uncertainty.

Product development research also highlights the importance of communication and coordination in innovation performance. Brown and Eisenhardt (1995) organized product development research around rational planning, communication webs, and disciplined problem-solving, showing that successful development depends not only on formal planning but also on rich communication and adaptive coordination. Similarly, Edmondson and Nembhard (2009) argued that project teams involved in product development face challenges such as complexity, cross-functionality, temporary membership, and embeddedness in organizational structures, yet these challenges can also create learning opportunities. In multidisciplinary engineering teams, the very diversity that complicates decision-making may also improve innovation quality by expanding the range of alternatives considered and by exposing hidden assumptions.

However, disciplinary diversity can also generate interpretive barriers. Dougherty (1992) demonstrated that product innovation may fail when departments interpret customers, technologies, and organizational priorities differently. These interpretive barriers are especially relevant in engineering innovation because specialists may rely on different technical vocabularies, evaluation criteria, professional identities, and risk perceptions. A decision that appears efficient from one disciplinary perspective may seem unsafe, impractical, expensive, or strategically weak from another. Therefore, multidisciplinary decision-making often requires a process of building shared understanding before choices can be made. Without shared understanding, teams may experience repeated meetings, unresolved disagreements, defensive communication, duplicated work, or premature convergence on weak solutions.

Psychological safety and inclusive leadership also influence decision-making quality in multidisciplinary technical teams. Edmondson (1999) showed that psychological safety enables team learning behaviors by allowing members to ask questions, admit uncertainty, and discuss errors without fear of embarrassment or punishment. Nembhard and Edmondson (2006) further emphasized that leader inclusiveness can reduce the inhibiting effects of status differences in cross-disciplinary teams. In engineering innovation, status differences may emerge between senior and junior engineers, hardware and software specialists, technical and managerial actors, or internal and external experts. If some voices dominate decision-making, teams may overlook important risks or alternative solutions. Conversely, inclusive decision processes can improve the quality of innovation by allowing diverse expertise to enter the discussion.

The balance between exploration and exploitation is another important issue in innovation decision-making. March (1991) distinguished exploration, which involves experimentation, search, variation, and risk-taking, from exploitation, which involves refinement, efficiency, implementation, and reliability. Engineering innovation requires both. Teams must explore novel concepts and technologies, but they must also converge on workable solutions that meet deadlines, budgets, safety standards, and client needs. Jansen, Van den Bosch, and Volberda (2006) showed that different organizational antecedents support exploratory and exploitative innovation. This distinction is relevant because multidisciplinary engineering teams often struggle to decide when to keep exploring alternatives and when to freeze design decisions for implementation. Premature closure may reduce creativity, whereas excessive exploration may delay delivery and increase costs.

Although previous studies have examined engineering design, product development, knowledge integration, and team learning, less attention has been given to how engineers and innovation actors themselves describe the lived process of decision-making in multidisciplinary engineering projects. Much existing research conceptualizes decision-making in terms of models, tools, optimization processes, or organizational outcomes. However, qualitative inquiry can reveal how decisions are experienced in practice: how participants interpret evidence, negotiate disagreement, manage uncertainty, use prototypes, respond to organizational pressure, and determine who has the authority to decide. Such understanding is especially important in emerging innovation environments where formal systems may coexist with informal networks, personal expertise, resource limitations, and rapidly changing market conditions.

Tehran provides a relevant context for examining these issues because many engineering and technology-oriented organizations operate in environments characterized by resource constraints, market volatility, regulatory complexity, and strong pressure for practical innovation. Multidisciplinary engineering teams in such contexts must often make decisions under conditions where access to advanced equipment, imported technologies, standardized data, or stable supply chains may be limited. These contextual conditions may intensify the need for adaptive, negotiated, and experience-based decision-making. Yet they may also encourage creative problem-solving, local knowledge integration, and pragmatic innovation strategies.

Therefore, this study addresses the following research question: How do multidisciplinary engineering professionals experience and describe decision-making processes in engineering innovation projects? By using qualitative semi-structured interviews, the study aims to provide an in-depth account of the categories and meanings that shape decision-making in multidisciplinary engineering innovation. The study contributes to the literature by conceptualizing decision-making as a socio-technical process involving shared problem framing, evidence negotiation, distributed authority, experimentation, and organizational value alignment. The aim of this study was to explore decision-making processes in multidisciplinary engineering innovation projects among engineering professionals working in Tehran-based organizations.

2. Methods and Materials

This study used a qualitative research design to explore decision-making processes in multidisciplinary engineering innovation. A qualitative approach was selected because the purpose of the study was not to test predetermined hypotheses or measure the frequency of decision behaviors, but to understand how participants experienced, interpreted, and described decision-making in real engineering innovation contexts. The study followed an interpretive orientation, assuming that decision-making is shaped by participants' professional meanings, disciplinary backgrounds, organizational roles, and interactions within project teams. Semi-structured interviews were used as the only method of data collection.

Participants were selected through purposeful sampling. The inclusion criteria were: having at least three years of professional experience in engineering or engineering-related innovation projects; direct involvement in multidisciplinary decision-making; employment or project activity in Tehran-based engineering, technology, industrial, or R&D organizations; and willingness to participate in an audio-recorded interview. Participants who had only routine technical responsibilities and no experience in innovation-related decision-making were excluded.

The final sample consisted of 24 participants from Tehran. Participants included senior engineers, R&D specialists, project managers, product development managers, technical consultants, systems engineers, and innovation managers. The sample was selected to represent different disciplinary backgrounds, including mechanical engineering, electrical engineering, software engineering, industrial engineering, civil engineering, materials engineering, and engineering management. Theoretical saturation was reached after 21 interviews, when no substantially new codes or categories emerged from the data. Three additional interviews were then conducted to confirm the stability and adequacy of the emerging categories.

Data were collected through semi-structured interviews. The interview protocol included open-ended questions designed to elicit participants' experiences of decision-making in multidisciplinary engineering innovation projects. Example questions included: "Can you describe a recent innovation project in which several engineering disciplines were involved?" "How were major technical decisions made in that project?" "What types of evidence or criteria influenced the final decision?" "How did the team handle disagreement between disciplines?" "Who usually had the authority to make final decisions?" and "How did organizational constraints such as time, cost, market pressure, or client expectations affect decision-making?"

Interviews were conducted face-to-face or online based on participant preference and availability. Each interview lasted between 45 and 75 minutes. With participants' consent, all interviews were audio-recorded and transcribed verbatim. Field notes were written after each interview to record contextual observations, preliminary interpretations, and emerging analytic questions. Data collection and initial analysis were conducted concurrently, allowing the interview protocol to be refined as new concepts emerged.

Data were analyzed using thematic analysis. The analysis followed a systematic process of familiarization, initial coding, category development, theme refinement, and final interpretation. First, transcripts were read several times to gain an overall understanding of participants' accounts. Second, meaningful units related to decision-making, uncertainty, disciplinary interaction, evidence use, authority, experimentation, and organizational constraints were coded. Third, similar codes were grouped into preliminary subcategories. Fourth, subcategories were compared across interviews and organized into broader main categories. Fifth, the categories were reviewed in relation to the original transcripts to ensure that they accurately reflected participants' experiences.

NVivo software was used to organize transcripts, manage codes, retrieve coded segments, compare categories, and develop analytic memos. Coding was both inductive and interpretive. Although the interview questions were informed by previous literature on engineering design, innovation, and decision-making, the categories were developed from participants' accounts rather than imposed in advance. To enhance trustworthiness, the researchers used prolonged engagement with the data, memo writing, peer discussion, participant code checking for selected interpretations, and an audit trail documenting coding decisions. Credibility was supported through repeated transcript review and use of direct quotations. Transferability was supported by providing contextual details about participants and the study setting. Dependability and confirmability were enhanced through systematic documentation of analytic decisions.

Participants were informed about the purpose of the study, voluntary participation, confidentiality, and their right to withdraw at any stage without consequence. Written or electronic informed consent was obtained before the interviews. Participants' names and organizational identifiers were removed from the transcripts, and participant codes were used in reporting the findings. Audio files and transcripts were stored securely and accessed only by the research team.

3. Findings

A total of 24 participants took part in the study. Sixteen participants were male and eight were female. In terms of age, five participants were between 25 and 34 years old, eleven were between 35 and 44 years old, six were between 45 and 54 years old, and two were 55 years or older. Regarding educational level, four participants held a bachelor's degree, fourteen held a master's degree, and six held a doctoral degree. Participants' professional experience ranged from 4 to 28 years; six participants had 3–7 years of experience, ten had 8–15 years, and eight had more than 15 years. Disciplinary backgrounds included mechanical engineering (n = 5), electrical engineering (n = 4), software engineering (n = 4), industrial engineering (n = 4), civil engineering (n = 3), materials engineering (n = 2), and engineering management or innovation management (n = 2). Participants' roles included senior engineer (n = 6), project manager (n = 5), R&D specialist (n = 4), product development manager (n = 3), technical consultant (n = 3), systems engineer (n = 2), and innovation manager (n = 1).

The first main category concerned the need to create a shared problem frame before innovation decisions could be made. Participants explained that multidisciplinary engineering teams often entered projects with different assumptions about what the "real problem" was. Mechanical engineers tended to emphasize physical feasibility, durability, and manufacturability, while software engineers focused on data, control systems, interfaces, and adaptability. Industrial engineers and project managers often focused on cost, workflow, timing, and scalability. As a result, early decision-making was frequently delayed until the team developed a common understanding of the problem. One participant stated, "At the beginning, everyone was solving a different problem. The mechanical team talked about structure, the software team talked about control logic, and management talked about delivery time. The first real decision was not technical; it was agreeing on what problem we were actually solving" (P7). Participants described diagrams, prototypes, shared dashboards, technical meetings, and client requirement documents as tools that helped align disciplinary perspectives. Shared problem framing was therefore not a preliminary formality but a central decision-making activity.

The second category reflected how participants used evidence while recognizing that evidence was often incomplete, unstable, or discipline-specific. Participants reported that innovation decisions were influenced by simulation results, laboratory tests, cost estimates, supplier data, customer feedback, previous project experience, and expert judgment. However, different disciplines often valued different types of evidence. For example, some engineers trusted quantitative testing and simulation, whereas others relied on field experience or user feedback. One participant explained, “In innovation projects, you never have perfect data. The simulation says one thing, the workshop says another, and the client changes the requirement after two meetings. So the decision becomes a negotiation about which evidence is strong enough to act on” (P12). This category showed that decision-making was neither purely intuitive nor purely analytical. Participants described a hybrid process in which technical evidence, practical experience, organizational constraints, and risk perceptions were combined to justify decisions. Evidence did not automatically determine the decision; rather, it became a resource for negotiation.

The third main category concerned the distribution of authority in multidisciplinary innovation teams. Participants emphasized that formal titles did not always determine who influenced decisions. Although project managers or senior executives often had final approval authority, technical specialists could strongly shape decisions by controlling critical knowledge. In some cases, decision ownership was clear; in others, ambiguity created conflict or delay. One participant noted, “Officially, the project manager signed the decision, but everyone knew that if the electronics lead did not approve the solution, the decision would fail during implementation” (P4). Participants also reported that decision-making was more effective when authority was matched with expertise and accountability. Problems occurred when managers made technical decisions without sufficient understanding, or when engineers proposed technically ideal solutions without responsibility for cost and delivery. Effective teams clarified who could recommend, challenge, approve, and revise decisions. This category shows that decision-making in multidisciplinary engineering innovation depends on negotiated authority rather than simple hierarchy.

The fourth category described the role of experimentation, prototyping, and staged risk-taking in decision-making. Participants explained that multidisciplinary engineering teams rarely moved directly from idea to final implementation. Instead, decisions were made through cycles of trial, evaluation, redesign, and controlled commitment. Prototypes and pilot tests allowed teams to reduce uncertainty and make disagreements concrete. One participant stated, “When the team disagreed, the prototype became the judge. Instead of arguing for two weeks, we built a small version and tested it. After that, the decision was easier because the risk became visible” (P16). Participants also described the need to balance innovation with reliability. They were willing to experiment, but not in ways that threatened safety, client trust, or irreversible cost. Therefore, decision-making often involved deciding how much risk could be accepted at each stage. Some teams used formal risk matrices, while others relied on expert discussion and staged approval. This category indicates that experimentation functioned as both a learning mechanism and a decision-making mechanism.

The fifth category focused on the influence of organizational priorities on engineering innovation decisions. Participants reported that even technically strong ideas could be rejected if they did not align with budget limits, client needs, market timing, production capacity, or organizational strategy. Conversely, some technically imperfect solutions were accepted because they were faster, cheaper, easier to implement, or more compatible with available resources. One participant explained, “Engineers sometimes think the best decision is the most advanced solution, but in the company the best decision is the one that can survive cost, time, supply, and customer acceptance” (P21). Participants described organizational alignment as a continuous process of translating technical value into business and operational value. Innovation decisions were therefore shaped by feasibility, scalability, resource access, and strategic relevance. This category shows that multidisciplinary engineering decision-making is embedded in organizational systems and cannot be understood only at the level of technical reasoning.

4. Discussion

The purpose of this study was to explore decision-making processes in multidisciplinary engineering innovation. The findings showed that decision-making was experienced as a socio-technical and negotiated process rather than a linear technical procedure. Five main categories were identified: shared problem framing across disciplinary boundaries, evidence-based negotiation under uncertainty, distributed authority and decision ownership, iterative experimentation and risk balancing, and organizational alignment with innovation value. Together, these categories suggest that multidisciplinary engineering decisions emerge through interaction among disciplinary knowledge, technical evidence, authority relations, experimentation, and organizational priorities. This finding is consistent with the view that engineering design is not merely a rational optimization activity but a complex process of framing, modeling, evaluating, communicating, and transforming uncertain situations into workable solutions (Dym et al., 2005; Simon, 1996).

The first finding showed that shared problem framing was a central condition for effective decision-making. Participants described early-stage innovation work as a process in which different disciplines initially defined the problem differently. This aligns with Bucciarelli’s (1994) argument that engineering design involves multiple “object worlds,” where participants collaborate on a shared artifact while maintaining distinct disciplinary interpretations. It also supports Dorst’s (2011) view that design thinking involves framing problems in ways that make solution development possible. In multidisciplinary innovation, problem framing is not a simple first step; it is an ongoing negotiation of meaning. When teams fail to develop a shared problem frame, decision-making may become fragmented because each discipline evaluates alternatives according to different assumptions. The findings therefore extend previous literature by showing that shared framing functions as a practical decision infrastructure in engineering innovation teams.

The second finding concerned evidence-based negotiation under uncertainty. Participants used simulations, tests, prototypes, expert judgment, customer feedback, and cost analyses, but they also emphasized that evidence was incomplete and contested. This finding is consistent with Eisenhardt and Zbaracki’s (1992) argument that decision-making is shaped by bounded rationality and cannot be reduced to purely rational calculation. It also corresponds with Carlile's (2002) work on knowledge boundaries in product development, which shows that knowledge differences across functions can create barriers that require translation and transformation. In this study, evidence did not simply resolve disagreement. Instead, evidence became part of negotiation: participants debated what counted as reliable evidence, whose evidence was most relevant, and whether the available evidence was sufficient for action. This highlights the interpretive dimension of engineering decision-making and suggests that innovation teams need explicit procedures for evaluating competing forms of evidence.

The third finding showed that decision authority was distributed and negotiated. Although formal hierarchy remained important, participants reported that actual decision influence often depended on expertise, experience, technical control, and accountability. This finding supports research on product development teams showing that cross-functional work depends on communication, expertise integration, and learning across project boundaries (Brown & Eisenhardt, 1995; Edmondson & Nembhard, 2009). It also relates to psychological safety research, which emphasizes that team members must feel able to speak up, challenge assumptions, and contribute expertise (Edmondson, 1999). In multidisciplinary engineering innovation, authority ambiguity can delay decisions or create conflict, but excessive hierarchy can suppress technical insight. Therefore, effective decision-making requires a balance between formal decision rights and expert participation. The findings suggest that decision ownership should be clarified not only in managerial terms but also in relation to technical responsibility and implementation consequences.

The fourth finding emphasized iterative experimentation and risk balancing. Participants described prototypes, pilot tests, simulations, and staged implementation as mechanisms for reducing uncertainty and resolving disagreement. This supports the broader engineering design literature, which emphasizes iteration, modeling, testing, and refinement as essential features of design activity (Dym et al., 2005; Pahl et al., 2007). It also aligns with March's (1991) distinction between exploration and exploitation. Multidisciplinary engineering innovation requires exploration of new possibilities, but it also requires convergence toward reliable and implementable solutions. Participants' accounts showed that experimentation helped teams move from abstract debate to concrete evidence, but experimentation was constrained by cost, safety, timing, and organizational tolerance for risk. Therefore, experimentation was not unlimited creativity; it was controlled learning. This finding contributes to innovation decision-making literature by showing that prototypes and pilots are not only technical tools but also social decision devices that help teams negotiate uncertainty.

The fifth finding showed that organizational alignment strongly shaped innovation decisions. Participants reported that technically superior ideas were not always selected if they lacked economic, operational, or strategic fit. This finding aligns with product innovation research showing that successful development depends on linking technical possibilities with market and organizational realities (Brown & Eisenhardt, 1995; Dougherty, 1992). It also supports the view that exploratory and exploitative innovation require different organizational conditions and coordination mechanisms (Jansen et al., 2006; March, 1991). In the present study, decision-making required the translation of technical value into organizational value. This means that multidisciplinary engineering teams must justify innovation not only by technical performance but also by cost, scalability, availability of resources, production capacity, customer acceptance, and implementation timing. The finding highlights the embedded nature of engineering decision-making: decisions are made within organizational systems, not isolated technical spaces.

Overall, the findings indicate that multidisciplinary engineering innovation requires decision processes that are simultaneously analytical, communicative, iterative, and political. This does not mean that engineering decisions are irrational. Rather, it means that rationality is situated within social and organizational conditions. Participants did use technical evidence, analysis, and expert evaluation, but they also had to manage uncertainty, disciplinary disagreement, authority relations, and implementation constraints. This supports the argument that innovation decision-making should be understood as a socio-technical practice. For engineering managers, this implies that improving decision quality requires more than better technical tools. It also requires better facilitation of interdisciplinary dialogue, clearer decision rights, psychological safety, structured experimentation, and explicit alignment between technical and organizational criteria.

The study also suggests that boundary objects play an important role in multidisciplinary decision-making. Participants repeatedly referred to prototypes, diagrams, simulations, test reports, and dashboards as tools that helped different specialists communicate and decide. This finding aligns with Star and Griesemer's (1989) concept of boundary objects and Carlile's (2002) application of boundary objects in new product development. In the context of engineering innovation, boundary objects appear to serve three functions: they make disciplinary assumptions visible, they provide a common reference point for evaluating alternatives, and they reduce ambiguity by connecting abstract discussion to material or visual evidence. Therefore, organizations seeking to improve multidisciplinary decision-making should invest not only in meetings and reporting structures but also in shared artifacts that support cross-disciplinary understanding.

Another important implication concerns the role of psychological safety and inclusive participation. Participants indicated that decision-making improved when junior and specialized members could challenge assumptions and when managers treated disagreement as useful rather than disruptive. This supports Edmondson's (1999) theory of psychological safety and Nembhard and Edmondson's (2006) work on leader inclusiveness. In engineering innovation, silence can be costly because unspoken concerns may later appear as technical failure, rework, safety risk, or customer dissatisfaction. Multidisciplinary teams therefore need decision environments where disagreement is structured, evidence-based, and professionally acceptable. Leaders should not aim to eliminate conflict but to convert conflict into productive technical inquiry.

This study has several limitations. First, the participants were selected from Tehran-based engineering and technology-oriented organizations, and the findings may not fully represent multidisciplinary engineering innovation in other cities, countries, industries, or institutional environments. Second, the study relied only on semi-structured interviews; therefore, the findings reflect participants' reported experiences rather than direct observation of decision meetings or project documents. Third, although the sample included diverse engineering backgrounds, some disciplines and sectors may have been underrepresented. Fourth, because decision-making is context-sensitive, participants' accounts may have been influenced by organizational culture, project success or failure, and retrospective interpretation. Finally, the qualitative design allows deep understanding of meanings and processes but does not permit statistical generalization.

Future studies should examine multidisciplinary engineering decision-making in different industrial sectors, such as energy, construction, medical technologies, transportation, manufacturing, software-intensive systems, and advanced materials. Comparative studies across cities, countries, or organizational types could identify how institutional context shapes innovation decision-making. Future research could also combine interviews with observation of project meetings, document analysis, and case studies of completed innovation projects. Longitudinal qualitative designs would be especially useful for tracking how decisions evolve from early ideation to prototyping, testing, implementation, and commercialization. Quantitative studies could also develop and validate measurement instruments based on the categories identified in this study, such as shared framing, evidence negotiation, distributed authority, experimentation capacity, and organizational alignment.

Engineering organizations should create structured mechanisms for multidisciplinary decision-making. Teams should begin innovation projects by explicitly negotiating the problem frame and defining decision criteria across disciplines. Project leaders should clarify decision rights, distinguish between recommendation authority and approval authority, and ensure that technical specialists are included in decisions that affect implementation. Organizations should use prototypes, simulations, visual models, and dashboards as shared decision objects to reduce misunderstanding between disciplines. Managers should encourage psychological safety so that team members can raise concerns before decisions become costly to reverse. Finally, innovation decisions should be evaluated through both technical and organizational criteria, including feasibility, cost, safety, scalability, resource availability, client value, and strategic relevance.

5. Conclusion

This qualitative study explored decision-making processes in multidisciplinary engineering innovation among professionals working in Tehran-based organizations. The findings showed that innovation decisions are formed through shared problem framing, evidence-based negotiation, distributed authority, iterative experimentation, and organizational alignment. Decision-making was not experienced as a purely linear or technical process; rather, it emerged through continuous interaction between disciplinary knowledge, uncertainty, practical constraints, and organizational expectations. The study contributes to engineering innovation literature by highlighting the socio-technical nature of decision-making and by showing how multidisciplinary teams transform diverse expertise into collective action. Effective innovation decision-making requires teams to build shared understanding, use evidence flexibly, clarify authority, experiment responsibly, and connect technical novelty with organizational value.

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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