

# Building a Sustainable Framework for Collaborative Engineering Leadership in Multidisciplinary Teams

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Date: 22/6/2025

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## 1. Introduction

Building upon two previous studies—“Bridging the Gap Between Project Managers and Engineers” and “The Untapped Leadership Potential of Engineers in Project Management”—this paper aims to advance the discussion by proposing a practical and sustainable framework that empowers engineers to lead collaboratively within multidisciplinary teams.

While the first study focused on causes and solutions for management-engineering misalignment, and the second emphasized the leadership capabilities of engineers, this paper shifts the focus toward creating a **structured system** that enables engineers to contribute as long-term team leaders, not just technical contributors.

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## 2. Background: From Ideas to Structure

Previous studies have shown that engineers are often left out of formal leadership roles, even when they play a major part in solving technical problems. However, most studies stop at describing this issue.

What’s still missing is a clear, practical system that helps engineers become active leaders **within teams**—not just as individuals, but as part of a structured, cross-functional environment.

This paper aims to go beyond **requests and suggestions**, and instead builds a system that supports, enables, and evaluates engineering leadership as a team function.

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## 3. Related Work and Literature Context

Previous studies have talked about leadership in engineering and multidisciplinary teams.

Some focused on shared leadership, while others explored how leadership can emerge naturally within teams.

A few suggested tools or roles like “Engineering Manager” to improve collaboration between technical and non-technical members.

These ideas are helpful, but most remain theoretical or individual in nature.

What’s still missing is a **repeatable system** that teams can actually use and improve. This study proposes such a system.

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## 4. Case Studies

### ➤ Case 1: KAIST – MBZIRC Maritime Robotics Challenge (2024)

A team of KAIST students from mechanical and electrical engineering, led by professors and doctoral student Sol Han, placed second in a major robotics challenge without using GPS-based navigation. They used clear role definitions, cross-functional coordination, and autonomous system collaboration. “I am disappointed of how narrowly we missed out on winning at the end, but I am satisfied with the significance of the output we’ve got and I am grateful to the team members who worked hard together for that.”

— Sol Han, Team Leader

This comment highlights how engineering leadership was grounded in team effort and shared technical commitment, even under high-pressure competition.

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### ➤ Case 2: MIT E-Vent – Emergency Ventilator Development During COVID-19 (2020)

An ad hoc team of MIT engineers and clinicians designed a working emergency ventilator in just four weeks.

They practiced real-time engineering leadership, with distributed responsibility and close clinical collaboration.

“All of us have one mission in mind, which is to save lives, and that’s what has kept us together and turned us into a quirky MIT family.”

— Kimberly Jung, Executive Officer

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## 5. Comparative Insights

Aspect	KAIST	MIT	Context	Leadership Style
Leadership Setup	Structured and pre-planned	Agile and emergent	Robotics competition	Defined technical roles
Mission Focus	Autonomous collaboration	Emergency response	Innovation under pressure	Shared technical ownership

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## 6. Extracted Principles

- Leadership is more effective when **built into team roles**, not just based on personal traits.
  - Engineers must have **structured ways** to participate in decisions, not just provide input.
  - **Transparency and trust** are necessary for leadership to be respected and repeated.
  - Continuous **feedback and reflection** improve not only the leader, but the team itself.
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## 7. Proposed Framework Components

This framework is built around five practical components that help engineers lead in a sustainable way.

Component	What It Does	Who's Involved	When It's Used
<b>A. Role Integration Map</b>	Identifies where and when engineers can take leadership (e.g., during design, coordination, or technical decisions).	Project Manager + Team Lead	At project kickoff and at key project phases.
<b>B. Participation Protocol</b>	Provides a clear process and templates for engineers to contribute to decision-making in meetings and reviews.	Engineers + Managers	During technical meetings and decision points.
<b>C. Leadership Growth Loop</b>	Offers on-the-job leadership training, role simulations, and feedback cycles.	HR or Capability Lead	Regularly—e.g., once per quarter.
<b>D. Transparency Mechanism</b>	Ensures decisions are explained in a way that builds trust and includes engineers in the logic behind them.	Project Manager	Whenever decisions impact technical direction.
<b>E. Leadership Dashboard</b>	Collects team feedback on leadership effectiveness (communication, collaboration, initiative).	All team members	At the end of project phases or sprints.

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### ➤ How the System Works as a Cycle

1. At the **start** of the project → roles are mapped.
2. During execution → engineers contribute using the protocol.
3. Training and coaching continue in parallel.
4. All decisions are explained with transparency tools.
5. At milestones → team feedback is gathered via the dashboard.

This cycle is repeated and adjusted, making leadership a regular part of teamwork—not an exception.

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## 8. Scalability and Adaptation

- **Small teams** can use simplified versions of the framework.
- **Large teams** can apply it more formally.
- It fits in **Agile** workflows or traditional phases.
- It respects team culture—engineers can lead formally or informally, based on the team structure.

Leadership becomes shared, visible, and supported—whatever the format.

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## 9. Limitations and Future Work

This framework is based on practical insights and real-world case studies, but it has not yet been tested through formal pilot programs. The proposed system reflects what could work well in multidisciplinary engineering teams, but its success depends on team culture, size, and organizational support.

In future research, this model could be applied and studied in live projects to explore its impact on team performance, innovation, and role satisfaction. It would also be valuable to adapt the framework to specific industries—such as construction, manufacturing, or software—to understand how it fits different technical environments

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## 10. Conclusion and Recommendations

This paper offers a complete framework to support engineering leadership in real project environments. It moves beyond abstract ideas and puts structure around something many teams already feel:

**Engineers are ready to lead—but they need systems that help them grow into that role.**

➤ **Recommendations:**

- Give engineers chances to lead and structure their voice.
  - Build leadership feedback into regular team practice.
  - Use tools that support openness and collaboration.
  - Let teams adapt the system to their size and style.
  - Measure leadership impact—not just performance.
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## 11. References

1. KAIST News. (2024, February 9). *Team KAIST placed among top two at MBZIRC Maritime Grand Challenge*. Retrieved from: [https://news.kaist.ac.kr/newsen/html/news/?mode=V&mng\\_no=26784](https://news.kaist.ac.kr/newsen/html/news/?mode=V&mng_no=26784)
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