What is Technology Readiness Level (TRL)?

Technology Readiness Level (TRL) is a standardized scale used to assess the maturity of a particular technology, ranging from initial concept and basic research (TRL 1) to fully developed and operational systems (TRL 9). This framework provides a clear indication of a technology's development stage, serving as a valuable tool for informed decision-making in areas such as project funding, risk assessment, and technology transition.

Origin:

The Technology Readiness Level (TRL) framework was first introduced by NASA as a tool for managing technological risks in its space exploration programs.

Global Standardization:

The ISO 16290:2013 standard provided further standardization of the Technology Readiness Level (TRL) scale.

Image source: Defense Acquisition Guidebook, U.S. Department of Defense, 2010, *https://api.army.mil/e2/c/downloads/404585.pdf*.

Questionnaire for TRL Calculation

Please Answer (Yes/No/Not Applicable)

Basic Principles Observed TRL-1

1: Have fundamental scientific principles been identified and examined?

2: Has a literature review been conducted to explore relevant theories?

3: Have observations or theoretical insights been systematically documented?

Technology Concept Formulated TRL-2

1: Have potential applications of the technology been identified?

2: Has a conceptual model or hypothesis been developed?

3: Have preliminary experimental designs been created?

Experimental Proof of Concept TRL-3

1: Were the initial laboratory experiments conducted?

2: Were experimental results obtained to demonstrate feasibility?

3: Were the key technical challenges identified?

Technology Validated in a Lab TRL-4

1: Have you created a working prototype in the laboratory?

2: Have you carried out thorough laboratory testing?

3: Have you recorded results verifying the expected performance?

Technology Validated in a Relevant Environment TRL-5

1: Has the technology been tested in a relevant environment?

2: Have field tests or pilot studies been conducted?

3: Has the effectiveness and reliability been demonstrated?

Technology Demonstrated in a Relevant Environment TRL-6

1: Has an advanced prototype been developed that closely resembles the final product?

2: Has extensive testing been conducted in a relevant environment?

3: Have the documented results demonstrated compliance with performance criteria?

System Prototype Demonstration in an Operational Environment TRL-7

1: Was the system prototype developed to closely resemble the final product?

2: Were operational tests conducted in a real-world environment?

3: Do the results confirm the technology's readiness for the final product?

System Complete and Qualified TRL-8

1: Has the development been completed and successfully integrated into the final product?

2: Has thorough testing and validation been conducted?

3: Are there any certifications or qualifications confirming readiness?

Actual System Proven in an Operational Environment TRL-9

1: Has it been successfully implemented in a real-world operational setting?

2: Are there documented case studies or proven operational outcomes?

3: Has it been adopted and utilized by end-users or customers?

Application of TRL assessment:

1. Assessing Technology Maturity

- TRLs provide a standardized scale (from TRL 1 to TRL 9) to assess how developed a technology is—from basic research (TRL 1) to fully operational systems (TRL 9).
- Helps stakeholders understand the current stage and what is required to advance.

2. Guiding Funding Decisions

- Investors, governments, and R&D organizations use TRLs to decide where to allocate funding.
- Early-stage technologies (TRL 1-3) may need research grants, while mid-stage (TRL 4-6) might attract venture capital or pilot program funding.

3. Strategic Planning & Roadmapping

- TRLs are used in technology roadmaps to plot development paths and timelines.
- Helps identify technical risks and prioritize actions needed to advance a technology to the next level.

4. Proposal and Grant Requirements

- Many public and private funding bodies (like the EU's Horizon Europe, DOE, DARPA, etc.) require TRL levels in applications.
- Helps reviewers quickly gauge how close the technology is to deployment.

5. Risk Management

- Lower TRLs imply higher technical risk; organizations use TRLs to assess and mitigate such risks in R&D and product development.

6. Collaboration and Communication

- TRLs offer a common language between engineers, researchers, managers, and investors.
- Makes cross-functional and cross-organizational communication clearer and more effective.

7. Product Development and Innovation Management

- TRLs help track progress in innovation pipelines.
- Companies use TRLs to decide when to transition technologies from research to product development or commercialization.

8. Technology Transfer and Commercialization

- Institutions use TRLs to assess when a technology is ready to be licensed or spun out into a startup.
- Easier to match technology with appropriate partners, investors, or manufacturers.

To know more about TRL Calculation reach out at em_ipr@iiti.ac.in (Dr. Archana Chaudhary, Executive Manager, IP Management & Techno-commercialization)