Hwb Gwyddorau Bywyd Cymru
Life Sciences Hub Wales

Understanding Technology Readiness Levels

Technology Readiness Levels (TRLs) measure how far an innovation has progressed, from early concepts to real-world use. However, not all innovations follow the same path, and the broad definitions of TRLs can make them difficult to apply consistently across different types of technologies. Pharmaceuticals typically advance through a strict, milestone-driven process tied to formal clinical trial phases. In contrast, digital tools, medical devices, and care delivery models often follow more flexible pathways and may not require formal trials.

The TRL scale includes 9 levels:

TRL 1 - 4: The idea is still being developed and tested in the lab.
TRL 5 - 7: The technology is tested or demonstrated in a real-world or relevant setting (pilot phase).
TRL 8 - 9: The innovation is fully implemented and used in its intended environment.

The table below offers a simplified overview of TRLs designed to be relevant across various health and care innovations. For a detailed breakdown by innovation type please see ***Understanding Sector-Based Technology Readiness Levels.***

TRL	Description	Expectation
1. Basic principles observed	Initial idea is explored and reported.	Systematic review of existing innovation evidence.
2. Technology concept formulated	Hypothesis development. Focusing on practical applications formed from basic principles.	Establishing the question. The what, how, when and why? Development of experimental designs to establish feasibility.
3. Experimental proof of concept	Early laboratory tests to explore concepts and establish initial proof of concept.	Begin R&D, data collection, and analysis to validate predictions and assumptions.
4. Technology validated in lab	Optimising experiments to confirm concept works.	Utilise previous findings for further detailed testing to finalise innovation. Ensuring it is scalable and has measurable outcomes.
5. Technology validated in relevant environment	Testing moves beyond the lab, into small scale real-world conditions.	Pre-clinical trials: Validating that innovation can produce benefits.
6. Technology demonstrated in relevant environment	Demonstrate innovation in a realistic health care setting.	Clinical trials phase I: Small cohort of humans to focus on monitoring the innovations efficacy, safety and side effects, if applicable.
7. System prototype demonstration in operational environment	Prototype evaluated in health care setting with target users.	Clinical trials phase II: Assessing innovations efficacy. Ongoing surveillance of safety and side effects.
8. System complete and qualified	Innovation scale up to large cohort of users. Ensures innovation meets all requirements and is ready for commercial use.	Clinical trials phase III: Innovation is compared to standard practice and shows effectiveness and real results. Regulatory approval submitted, if applicable.
9. Actual system proven in operational environment	Technology is fully operational and adopted.	Regulatory approval obtained; product adopted into practice. Ongoing surveillance conducted.

Why TRLs are important in Health and Care Research

- Clear roadmap: Helps to understand where a project stands and where it is heading.
- Risk management: Identifies what steps are needed to reduce risks before wider adoption.
- Resource planning: Guides allocation of funds and resources at each stage.
- Regulatory alignment: Supports compliance with clinical and safety standards.