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6G4SOCIETY

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Abstract This position paper examines how social acceptance of 6G technology is currently conceptualised and operationalised within the European research and innovation (R&I) community and proposes a shared framework to support coordinated action across the Smart Networks and Services Joint Undertaking (SNS JU) ecosystem. While European 6G development has formally committed to embedding societal values from the outset, translating this ambition into practice remains challenging. Lessons from 5G deployment demonstrate that technical performance alone does not ensure societal legitimacy, as public

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resistance, local moratoria, and trust deficits exposed persistent gaps between technological development and societal expectations. Drawing on extensive engagement with the SNS JU ecosystem, the paper identifies three key findings: approaches to social acceptance are highly fragmented; a substantial awareness–action gap persists; unresolved 5G controversies continue to shape perceptions of 6G. In response, the paper introduces the Social Acceptance of Technology (SAT) framework, offering shared terminology, a multi-level analytical structure, and tools to address societal values and contestation directly. The paper concludes that 6G's central challenge is legitimacy, requiring acceptance to be treated as a core dimension of responsible innovation rather than a downstream concern.

Keywords 6G, Social Acceptance, responsible innovation, societal values, stakeholder engagement

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* R: Document, report (excluding the periodic and final reports)

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DEC: Websites, patents filing, press & media actions, videos, etc.

DATA: Data sets, microdata, etc.

DMP: Data management plan

ETHICS: Deliverables related to ethics issues.

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OTHER: Software, technical diagram, algorithms, models, etc.



EXECUTIVE SUMMARY

This position paper examines how social acceptance of 6G technology is understood and addressed within the European research and innovation community, and proposes a common framework to strengthen coordinated action across the Smart Networks and Services Joint Undertaking (SNS JU) ecosystem. European 6G development has committed to embedding societal values and social acceptance into next-generation networks from the outset. However, translating this commitment into practice faces significant challenges. The 5G experience revealed that technical capability alone does not guarantee societal legitimacy: deployment encountered resistance across Europe, from infrastructure attacks to municipal moratoria, exposing gaps between technology communities and the publics they serve. As 6G enters design specification and development, the question is whether these lessons will inform different approaches, or whether similar patterns will recur.

Drawing on comprehensive engagement with the SNS JU ecosystem, surveys gathering 63 responses across projects from Calls 1-3, interviews with nine representative projects, and expert consultations, the paper documents three principal findings that emerge from this investigation. First, **significant conceptual fragmentation characterises the SNS community's approach to social acceptance**: among 44 definitions collected, nearly all were distinct, and projects employ diverse theoretical frameworks ranging from Technology Acceptance Models to no framework at all. This heterogeneity, while reflecting disciplinary diversity, impedes coordinated action and knowledge transfer across the ecosystem. Second, **a pronounced awareness-action gap pervades the community**: while virtually all surveyed projects acknowledge the importance of acceptance-related themes as relevant to their work (such as user experience, user needs, and accessibility), fewer than half report implementing concrete approaches, with many citing resource constraints, timing challenges, and expertise gaps as barriers. Third, **the legacy of 5G controversies casts a long shadow over 6G development**, with operators expressing particular concern about public trust erosion and several interviewees questioning whether 6G can succeed where 5G's business model faltered. Moreover, unresolved controversies and trust deficits continue to shape how acceptance is understood, often through a "deficit model" that treats public concerns as communication problems rather than governance challenges.

In response to these challenges the **Social Acceptance of Technology (SAT) framework** provides three core contributions to the 6G community. It offers shared terminology enabling cross-project learning and knowledge accumulation. It provides a multi-level analytical structure (systemic, societal, individual) that expands attention beyond individual user acceptance to encompass the broader governance challenges that infrastructure technologies present. And to confront the 5G legacy directly, it makes explicit the societal values, trade-offs, and controversies that acceptance inevitably involves, providing structured approaches for navigating them and feeding design and business choices rather than treating contestation as noise to be managed.

These contributions inform the paper's recommendations, organised around **three strategic priorities: addressing conceptual fragmentation through common frameworks and shared terminology; closing the awareness-action gap through structural reforms in project design and resource allocation; and rebuilding trust through transparent governance and meaningful stakeholder engagement**. The paper concludes that 6G's defining ambition extends beyond technical performance to encompass the societal dimensions that determine whether advanced connectivity genuinely serves European citizens. The SNS JU community must reconceptualise acceptance as an integral component of responsible innovation, not an afterthought to be addressed once systems are complete.

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ABBREVIATIONS

6G IA	6G Smart Networks and Services Industry Association
ELSA	Ethics Legal and Social Aspects
RRI	Responsible research and Innovation
R&I	Research and Innovation
KVI	Key Value Indicator
SAT	Social Acceptance of Technology
SNS JU	Smart Networks and Services Joint Undertaking
STS	Science and Technology Studies
TAM	Technology Acceptance Model
TCP	Transmission Control Protocol
UTAUT	Unified Theory of Acceptance and Use of Technology

1 INTRODUCTION

European 6G development has explicitly committed to going beyond technical performance, **embedding societal values, sustainability, and social acceptance into the design and deployment** of next-generation networks from the outset. This paper examines **how that commitment is being operationalised** in practice by 6G4Society.

Drawing on comprehensive engagement with the Smart Networks and Services Joint Undertaking (SNS JU) [1] ecosystem, surveys gathering 63 responses across projects from Calls 1-3, interviews with representative projects, and expert consultations, the analysis documents systematic patterns that current approaches struggle to address: **conceptual fragmentation that impedes coordination, awareness-action gaps that leave recognised challenges unaddressed, and unresolved 5G legacies that continue to shape how acceptance is understood and approached.**

In response to these findings, this paper proposes the **Social Acceptance of Technology (SAT)** framework as a common reference model for the 6G community. While EU frameworks such as Responsible Research and Innovation (RRI) and Ethical, Legal and Social Aspects (ELSA) have long recognised the importance of integrating social considerations into R&I processes, they remain insufficiently operationalised within technology development contexts. SAT addresses this implementation gap by providing a **structured methodology for anticipatory reflection on the social consequences of technology.** In so doing, this framework enables and supports the design and development process to feed and integrate actionable insights and translate them into corresponding requirements for identifying, mitigating and potentially addressing societal concerns, ensuring that societal needs and values are embedded from the point of technology conception. Without this fundamental step, technology providers lack the necessary tools to discover latent societal concerns and integrate them into the development of business models, use cases, and technical specifications.

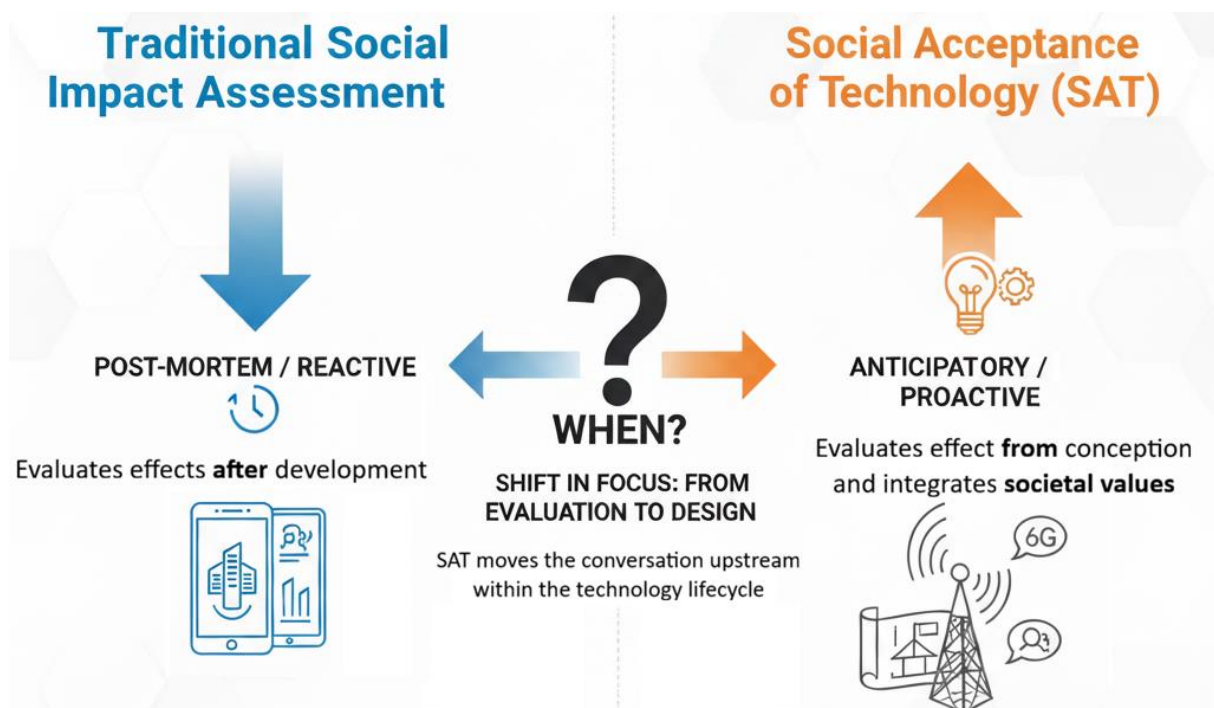


FIGURE 1: SOCIAL ACCEPTANCE OF TECHNOLOGY VS TRADITIONAL SOCIAL IMPACT ASSESSMENT

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Social acceptance is understood here not as individual user behaviour, but as the process through which technological innovations achieve legitimacy and support within society, encompassing collective evaluation, contested values, and systemic embedding. **The specific focus on consequences that could affect whether society accepts or rejects the technology distinguishes SAT from broader social impact assessments.** SAT does not replace existing approaches but provides a structure within which diverse project-specific methods can be situated, enabling cross-project learning and cumulative improvement. The framework emerged from the 6G4Society project's mandate under WP1 [2], based on preliminary studies and results achieved in the context of the 5G-SOLUTIONS project [3] [4], and has been refined through the empirical engagement reported here.

1.1 WHY SOCIAL ACCEPTANCE MATTERS FOR 6G

Sixth-generation mobile networks unfold in a context fundamentally different from previous connectivity generations. The 2025 survey confirms that 6G is recognised as genuinely disruptive: nearly 90% of responding projects characterise it as representing **transformative rather than merely incremental change**. This disruption concentrates in safety-critical sectors, transportation and healthcare most prominently, where public trust thresholds are elevated and the consequences of deployment failures are highly visible.

The **technical dimensions of this disruption are substantial**: native AI integration, cell-free architectures, non-terrestrial networks, and integrated sensing capabilities that blur traditional boundaries between communication infrastructure and environmental monitoring. These are not incremental improvements but architectural transformations with additional functionalities and profound implications for how connectivity systems relate to society.

The 5G experience casts a long shadow. Across Europe, 5G deployment encountered resistance that caught operators and policymakers off guard, from antenna burnings in England to municipal moratoria in countries like France, Switzerland and Italy, where by 2021 approximately 60 Italian municipalities alone had implemented measures against deployment [2] [5]. Yet these controversies were only part of a broader pattern of challenges. Supply chain disruptions, particularly during the COVID-19 pandemic, delayed rollout significantly [6]. Geopolitical tensions surrounding industry players from outside the EU entangled infrastructure decisions in sovereignty debates. Inter-industry conflicts emerged as aviation authorities raised concerns about interference with aircraft navigation systems and meteorologists warned of impacts on weather forecasting. Perhaps most significantly, a gap opened between the revolutionary promises that accompanied 5G, autonomous vehicles, telesurgery, immersive extended reality, and the more evolutionary reality of its implementation.

As the Commission's own assessment acknowledges, 5G in Europe remains an "incompletely fulfilled promise, notably regarding Verticals usages and 5G SA deployment,"¹ with fragmented markets, insufficient investment, and difficulties stimulating demand for advanced connectivity services compounding the picture. Whether framed as misinformation, legitimate concern, governance failure, or market dysfunction, **these experiences revealed that technical capability alone does not guarantee social acceptance or successful deployment.** The

¹ T.Kleiner, "Opening Session Address," EuCNC & 6G Summit 2025, Poznań, Poland 4 June 2025.

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6G community has an opportunity to learn from this experience, but only if acceptance is approached with the richness and complexity it requires.

1.2 THE CHALLENGE: DIVERSITY WITHOUT COORDINATION

When 44 SNS JU researchers were asked what 'social acceptance of technology' means to them, they provided 44 different answers with remarkable diversity. This diversity is not a failing but a reflection of acceptance's genuine multidimensionality, as well as a lack of a commonly agreed terminology definition within the SNS JU community:

Some emphasised **behaviour**: '*Technology accepted by the general public*', acceptance as **usage** and **adoption**. Some emphasised **psychology**: '*Whether people see it as beneficial, trustworthy*', acceptance as **confidence** and **perception**. Some emphasised **ethics**: "Aligned with their cultural and ethical values", acceptance as legitimacy and value alignment. Some emphasised **equity**: 'Everyone should be able to benefit in equal terms' – acceptance as **inclusion** and **justice**.

Each perspective captures something real about what acceptance involves and identifies (e.g., societal values and concerns). The challenge is not that these perspectives are wrong, but that without **common frameworks** for integrating them into technology design and development, cross-project learning becomes difficult and coordinated ecosystem-wide responses remain elusive.

This fragmentation matters because acceptance challenges do not respect project boundaries. When security concerns, health worries, digital divide implications, and business model questions emerge across multiple projects, addressing them requires coordination that conceptual diversity impedes. The gap between recognising challenges and implementing responses, documented in what follows, reflects not attitudinal failures but structural barriers that coordinated action can help address.

1.3 6G4SOCIETY CONTRIBUTION

This position paper offers three contributions in the technology acceptance context to the 6G and SNS JU community:

- **First, empirical diagnosis.** The analysis presents findings on how the SNS JU ecosystem currently approaches acceptance, not as critique but as foundation for improvement, integrating Social Sciences and Humanities (SSH) perspectives. The patterns documented here emerge from the community's own voices: survey responses, interview reflections, and assessments of what works and what doesn't.
- **Second, a common reference framework.** The SAT framework provides shared vocabulary and analytical structure that support coordination while respecting the diversity of project-specific approaches. Projects using Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), or other established frameworks can continue doing so; SAT provides the broader frame within which these approaches can be situated, as well as improving them by bridging gaps for considering and integrating societal values into technology design and implementation.

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- **Third, actionable recommendations.** For projects, for the SNS JU and 6G-IA, and for European policymakers, the paper offers specific suggestions for strengthening acceptance work going forward.

The paper does not claim to have solved acceptance challenges. It offers tools and frameworks that require implementation and iteration to realise their potential. What distinguishes this contribution is its empirical grounding: rather than prescribing from theory, it builds from what the ecosystem itself reveals about its needs and opportunities.

1.4 HOW THIS PAPER IS ORGANISED

Section 2 describes the project's investigation: the SNS JU ecosystem as the field of inquiry and the methods through which we engaged it.

Section 3 presents findings organised thematically, conceptual fragmentation, awareness-action gaps, 5G legacy, value trade-offs, sustainability scope, and time horizon challenges, drawing on survey, interview, and expert consultation data integrated under each theme.

Section 4 introduces the SAT framework as a response to the documented gaps, showing how each component addresses specific challenges the findings reveal.

Section 5 offers guidance for operationalising SAT in practice.

Section 6 presents implications and recommendations for different stakeholder groups.

Section 7 concludes with reflections on what the 6G community's engagement with these questions suggests about the path forward.

Appendix A completes the document, showing the full evidence supporting project findings.

2 THE INVESTIGATION

2.1 THE SNS JU ECOSYSTEM

The SNS JU represents Europe's primary institutional mechanism for coordinating 6G research and innovation. Established under Horizon Europe, the SNS JU brings together the European Commission, Member States, and industry partners to advance European leadership in next-generation connectivity. Through successive funding calls, the SNS JU has built an ecosystem of interconnected projects spanning fundamental research, technology development, and application validation.

By the time of the 2025 survey carried out in the context of the 6G4Society project, the ecosystem encompassed projects from three completed funding calls:

- **Call 1 (2022-2023)** established foundational research directions, with flagships like Hexa-X-II **Error! Reference source not found.** providing architectural visions and Stream B projects exploring specific technical challenges. These projects have now reached maturity, with substantial experience in addressing acceptance-related questions.
- **Call 2 (2023-2024)** expanded the ecosystem with additional Stream A, B, and D projects, many focused on specific verticals (healthcare, transportation, energy) where acceptance challenges are particularly salient.
- **Call 3 (2024-2025)** brought newer projects into the ecosystem, many still in early phases but already grappling with how to integrate societal considerations into their technical work.

The ecosystem's diversity, in technical focus, interdisciplinary composition, stakeholder relationships, and explicit attention to acceptance, makes it a rich site for understanding how acceptance is conceptualised across different contexts. This heterogeneity also presents the coordination challenges that **common frameworks can help** address.

2.2 ENGAGEMENT METHODS

6G4Society's engagement with the SNS ecosystem proceeded through multiple complementary methods, each designed to capture different dimensions of how projects approach acceptance.

2.2.1 SNS-Wide Surveys (2024 and 2025)

Two survey rounds collected structured data across the ecosystem. The 2024 survey established baseline understanding of acceptance awareness and approaches among Call 1 and Call 2 projects, yielding 22 responses. The 2025 survey expanded coverage to include Call 3 projects while deepening inquiry into specific dimensions revealed as important in the first round, achieving 41 responses from distinct projects, representing over half of the active SNS JU ecosystem.

The survey instrument covered multiple thematic areas: perceptions of 6G's disruptive potential, understanding of acceptance challenges, current approaches and frameworks, lessons from 5G controversies, and engagement with Key Value Indicators (KVI)s. Both

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closed-ended questions enabling quantitative analysis and open-ended questions capturing nuanced perspectives were included. Combined, the two rounds yielded 63 total responses providing quantitative and qualitative data on conceptualisations, practices, challenges, and needs.

2.2.2 Semi-Structured interviews (2025)

Following survey analysis, nine projects were selected for in-depth interviews to explore themes emerging from quantitative findings. Selection criteria ensured representation across project types (Flagship, Stream A, B, D), call cohorts (Calls 1, 2, and 3), technical focus areas (architecture, sustainability, security, sensing, trials), and levels of acceptance engagement (from dedicated activities to primarily technical focus).

The interviewed projects were: Hexa-X-II (Call 1, Stream B, Flagship) [7], TrialsNet (Call 1, Stream D) [8], FIDAL (Call 1, Stream D) **Error! Reference source not found.**, VERGE (Call 2, Stream B) [10], SUSTAIN-6G (Call 3, Stream B, Flagship) [11], 6G-PATH (Call 2, Stream D) [12], FLECON-6G (Call 3, Stream B) [13], NexaSphere (Call 3, Stream B) [14], and AMBIENT-6G (Call 3, Stream D) [15].

Interviews followed a semi-structured protocol exploring how projects define acceptance, what challenges they encounter, how they engage stakeholders, and what support would help them address acceptance more systematically. Interviews were conducted between September and November 2025, typically lasting 45-60 minutes.

External expert consultations provided perspectives beyond the immediate SNS JU community. An expert in social acceptance of infrastructure technologies, whose research on wind farm controversies and infrastructure deployment offers direct parallels to 6G challenges, contributed scholarly grounding on technology acceptance and science-society relations. Additionally, consultation with a senior telecommunications industry practitioner who experienced 5G deployment and its controversies firsthand provided insight into how acceptance challenges manifest in operational contexts. This expert, whose professional trajectory was directly shaped by French 5G experience, offered particularly valuable perspective on the gap between technical planning assumptions and ground-level deployment realities.

These consultations helped situate SNS JU patterns within broader contexts and informed framework development by testing whether patterns observed internally align with broader scholarship on technology-society relations and with practitioner experience. Respondents were selected as key informants, individuals whose roles as project coordinators, work package leaders, or technical leads position them to represent their projects' approaches to acceptance. While any individual perspective is necessarily partial, the consistency of patterns across multiple informants and sources suggests these findings reflect ecosystem-wide dynamics rather than idiosyncratic viewpoints.

2.3 METHODOLOGICAL NOTE: WHY MAP COMMUNITY PERSPECTIVES?

Three considerations inform the decision to map how the R&I community conceptualises acceptance rather than surveying public attitudes directly.

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FIGURE 2: MAPPING COMMUNITY PERSPECTIVES

- **First, 6G does not yet exist.** Surveying public attitudes toward hypothetical technology yields limited insight. As one Science and Technology Studies (STS) expert interviewee noted, asking people about technologies they have not experienced produces responses that reflect general attitudes toward technology rather than specific evaluations. The current moment is one of acceptability, assessing whether deployment would be justified, rather than acceptance, measuring actual responses to real infrastructure. Public engagement activities are underway elsewhere within the broader project, but this paper focuses on the development community itself.
- **Second, developer orientations shape outcomes.** How researchers and projects conceptualise acceptance influences what they build and how they build it. If acceptance is understood narrowly as “will users adopt”, different design choices follow than if it is understood as “does this align with societal values?”. The orientations embedded now will shape what 6G becomes.
- **Third, coordination requires shared understanding.** Strengthening acceptance work across the ecosystem requires knowing where that ecosystem currently stands. The diversity documented in what follows, 44 definitions with remarkable diversity, varying frameworks, different levels of operational engagement, provides the diagnostic foundation for improvement.

This approach does not deny the importance of public engagement. It sequences the work: **understanding how the development community thinks about acceptance is prerequisite to supporting more systematic engagement with the publics that 6G will ultimately serve.**

3 PROJECT FINDINGS

The empirical engagement described in Section 2 revealed systematic patterns across the SNS JU ecosystem. This section summarises those findings thematically; full evidence including interview excerpts, survey data, and detailed analysis is provided in **Appendix A**.

The themes presented here were not imposed *a priori* but emerged from the data itself: they represent what the ecosystem's own voices consistently surfaced as significant. Together, they build toward understanding what kinds of frameworks would be adequate to 6G's acceptance challenges.

3.1 CONCEPTUAL FRAGMENTATION

The 2025 survey revealed significant conceptual fragmentation. As stated in section 1.2, among the definitions collected, the vast majority were distinct, reflecting genuine conceptual diversity. Responses clustered around behavioural framings emphasising adoption and usage, psychological framings emphasising trust and perception, ethical framings emphasising value alignment, and equity framings emphasising inclusion and justice. Some defined acceptance through its absence, focusing on resistance or rejection.

This diversity echoes patterns documented in energy transition research. Wüstenhagen et al. [16] observed that "social acceptance is an often-used term...but clear definitions are rarely given." Moesker et al. [17] recently mapped how acceptance and acceptability are "frequently conflated, poorly defined, or used interchangeably, hampering interdisciplinary dialogue and comparative research." Our survey data confirms that 6G research exhibits the same conceptual fragmentation.

Interview data confirmed that projects hold genuinely different conceptions. Some work with formal quantitative definitions rooted in TAM tradition; others candidly acknowledge they "haven't gone and said, here's how we understand it." Approximately 50% of respondents indicated familiarity with established acceptance frameworks such as TAM or UTAUT.

[Full evidence: Appendix A.1 Conceptual fragmentation; Source: 2025 Survey Q8]

3.2 THE AWARENESS-ACTION GAP

The 2024 survey provided the first clear evidence of a gap between recognition and implementation. All responding projects selected at least one acceptance-related theme they were addressing; User Experience, User Needs, and Accessibility were most frequent. However, when asked what concrete actions they take, more than 50% reported taking no specific actions.

The 2025 survey confirmed the pattern. While most projects selected acceptance-related themes as pertinent to their work, fewer than half report concrete approaches. The most common response was "consider in discussions" – acceptance features in project conversations without dedicated activities.

The gap is structural, not attitudinal. Interviews identified three barriers: resource constraints ("sometimes we do not study these aspects in depth just because there are no resources... it's a lost game afterwards"), expertise gaps in technical consortia that often lack social science partners, and timing pressures that position user engagement too late in development cycles.

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3.3 THE 5G LEGACY AND TRUST EROSION

The 2025 survey confirms broad awareness of 5G controversies: the majority of projects (35 of 41 responding projects) explicitly acknowledged familiarity with antenna burnings, municipal moratoria, and public resistance. However, awareness and learning are different things. Survey responses reveal a pattern: projects recognise that controversies occurred while often attributing them to misinformation, public ignorance, or irrational fear.

When asked how they would address concerns about electromagnetic fields, projects overwhelmingly emphasised information provision and reference to scientific standards, the "deficit model" that STS scholarship has long critiqued [18] [19]. This framing treats scepticism as a communication problem rather than a signal of governance deficits or value misalignments.

Beyond public opposition, interviewees raised business model questions: whether 5G delivered on its promises, and whether 6G can succeed where 5G faltered. As the Commission's own assessment acknowledges, 5G in Europe remains "an incompletely fulfilled promise." One expert's reflection captured a common assumption: "Before, for me, technology was something by default acceptable. I never really had the question."

[Full evidence: Appendix A.3 The legacy and trust erosion; Source: 2025 Survey Q8, Q21; Interviews]

3.4 VALUE TRADE-OFFS WITHOUT TOOLS

The survey also revealed that approximately one-third of definitions emphasised ethical dimensions, "cultural and ethical values", "public interest", "ethical implications." These projects recognise that acceptance is not simply about usability or information but about whether technology aligns with what people consider important.

Interviews documented specific trade-offs projects encounter: energy efficiency versus performance, privacy versus service quality, inclusivity versus cost-effectiveness, security versus latency. Projects recognise these tensions but lack structured tools for navigating them. As one interviewee noted: "When expanding 6G into rural and underserved areas... inclusivity KVI often conflicts with cost-effectiveness and profitability."

Many of these trade-offs are made implicitly, embedded in technical decisions without explicit deliberation. Energy efficiency receives attention partly because it can be quantified; values that resist quantification receive less attention. The danger is that trade-offs made invisible are also made unaccountable.

[Full evidence: Appendix A.4 Value trade-offs; Source: 2025 Q8; Interviews]

3.5 SUSTAINABILITY'S NARROW SCOPE

Sustainability receives significant attention across the SNS JU ecosystem, but that attention concentrates heavily on operational energy efficiency. Survey Q7, asking about acceptance challenges, found that security/privacy (19 projects) and health concerns (10 projects) were mentioned far more frequently than environmental impacts, suggesting sustainability may not yet be fully integrated into how projects think about acceptance.

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Interview data revealed awareness of gaps even among those working explicitly on sustainability. One interviewee acknowledged: "Electronic waste hasn't been adequately identified or given enough attention... It might be because we've failed to consider e-waste as a pain point." Another posed the question: "Smart dust or smart waste?", challenging assumptions about IoT proliferation.

This narrow scope has implications beyond environmental metrics. Work on acceptability, notably [20], highlights intergenerational justice as a core normative concern: what burdens do we leave for future generations? If billions of connected devices become billions of units of electronic waste, the question is not only environmental but also ethical. Sustainability understood this way is not a separate pillar but integral to whether 6G deployment can be considered acceptable at all. Projects that address energy efficiency while overlooking material lifecycles, supply chain impacts, or long-term waste may be optimising one dimension while creating deficits in another.

3.6 THE TIME HORIZON MISMATCH

A cross-cutting challenge emerged consistently across interviews: the mismatch between project timelines and the timescales at which impacts manifest. Societal consequences of technology unfold across the entire innovation lifecycle, from conception and design choices through deployment, use, and eventual obsolescence. Some impacts are immediate (who is consulted, what trade-offs are embedded in design); others emerge at deployment (who bears costs, who benefits); still others materialise only over years or decades (institutional transformation, e-waste accumulation, trust erosion). Project-based funding cycles, typically 3-4 years, are not structured to assess or address this range. As one interviewee put it: "Societal impact... you cannot see it in a month. You cannot see it in a year. Sometimes [it] needs years or even decades."

This creates structural problems for acceptance work. Evaluation becomes difficult when impacts cannot be observed within project cycles. Accountability gaps emerge when projects conclude and teams disperse before consequences manifest. And TRL constraints compound the problem: "Usually the systems are completed towards the end of the project. So, there is not enough time to dedicate for users to evaluate..." Attention biases toward near-term, quantifiable outcomes, KPIs like speed and throughput, at the expense of longer-term dynamics that resist measurement but matter for legitimacy.

Some projects mentioned structural solutions, such as the Italian model of two-year follow-on assessment periods enabling tracking beyond initial project conclusions. But such mechanisms remain exceptions rather than norms.

3.7 SYNTHESIS: WHAT THE FINDINGS REVEAL

Taken together, these findings paint a picture of an ecosystem with genuine awareness and emerging sophistication alongside persistent structural challenges. The community recognises that acceptance matters; it struggles to translate that recognition into systematic action. The 5G experience has created motivation for different approaches; it has not yet produced the frameworks and tools those approaches require.

While this document aims to start filling this in, six specific gaps emerge from the analysis:

1. **Vocabulary gap:** 44 answers, no shared language, impedes cross-project learning.

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2. **Implementation gap:** Awareness without action, structural barriers (resources, expertise, timing) that goodwill alone cannot overcome.
3. **Trust gap:** 5G legacy of resistance, broken promises, necessity questions that erode the foundation 6G deployment requires.
4. **Values gap:** Trade-offs made implicitly, without structured tools for deliberation or transparency.
5. **Scope gap:** Sustainability attention concentrated on energy efficiency, missing e-waste, circular economy, social dimensions.
6. **Temporal gap:** Project cycles mismatched with impact manifestation, creating assessment and accountability challenges.



FIGURE 3: SIX GAPS IN SOCIAL ACCEPTANCE

These gaps are not independent; they reinforce each other. Without common vocabulary (gap 1), coordinated responses to other gaps remain difficult. Without implementation tools (gap 2), awareness of other gaps does not translate to action. Without trust (gap 3), even well-designed approaches face uphill battles.

What would an adequate framework require? The gaps documented above imply specific requirements for any framework aspiring to support the 6G community. First, it must provide common vocabulary without enforcing uniformity: a shared reference structure that enables translation across different approaches rather than demanding everyone adopt identical definitions. Second, it must be operationally actionable, offering not merely analytical categories but guidance that projects can integrate into existing development cycles with limited additional resources. Third, it must address trust explicitly, treating the 5G legacy not as a communication problem to solve but as a diagnostic resource revealing what legitimate acceptance requires. Fourth, it must make visible, providing structured approaches for identifying trade-offs, deliberating about them transparently, and documenting the choices embedded in technical decisions. Fifth, it must prompt attention beyond immediate metrics, ensuring that dimensions like e-waste, lifecycle impacts, and intergenerational justice receive attention alongside operational efficiency. And sixth, it must connect project-level activities to longer-term dynamics, bridging the temporal mismatch between funding cycles and impact manifestation.

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These requirements shaped SAT's development. The framework's multi-level structure (systemic, societal, individual) responds to the need for temporal and scalar integration. Its four dimensions (User Experience, Values, Social Disruptiveness, Trust), respond to the need for comprehensive coverage that extends beyond adoption-focused models. Its treatment of controversies as diagnostic resources responds to the need for trust-building approaches that learn from rather than dismiss resistance.

What kind of framework would address these interconnected challenges? The next section introduces the SAT framework as a response — not as external imposition, but as a structure that emerges from and speaks to the patterns the ecosystem itself has revealed.

4 THE SAT FRAMEWORK

The findings presented in Section 3 reveal an ecosystem grappling with acceptance challenges it recognises but struggles to address systematically. Six interconnected gaps, vocabulary, implementation, trust, values, scope, and temporal, define the terrain. What kind of framework would be adequate to these challenges?

This section introduces the SAT framework, proposed as a common reference model for the 6G community. SAT was originally developed by CyberEthics Lab. and has been applied across multiple EU research and innovation projects addressing responsible innovation challenges. Within the ICT domain specifically, the framework was used in 5G-SOLUTIONS [3], across four sectors: factory of the future, energy, smart cities and ports, and media and entertainment [1]. The framework was subsequently refined for the 6G context through previous conceptual work within 6G4Society, reported in *Societal Aspects in 6G Technology: Concerns, Acceptance Models and Sustainability Indicators* [2], and has been further tested against the empirical patterns documented in this paper. SAT represents an encounter between gaps identified through sustained engagement with technology-society dynamics and a structured response to address them. As such it speaks to the patterns the SNS JU ecosystem itself has revealed. Each component addresses specific challenges identified in the empirical investigation.

4.1 WHY TRADITIONAL MODELS DO NOT SUFFICE

Social acceptance cannot be reduced to individual adoption. In infrastructure domains, from wind farms to telecommunications networks, social acceptance is routinely defined as a favourable response to a proposed or deployed technology by *members of a social unit*, whether countries, communities, households, or organisations. This perspective emerged precisely because large-scale infrastructures generate stakeholders beyond 'users' and because acceptance operates across multiple arenas: market dynamics, socio-political legitimacy, and community siting and consent. As a result, social acceptance is treated in this literature as multi-dimensional, context-specific, and dynamic rather than a one-time psychological decision.

Traditional technology acceptance models, notably the TAM and its successors like UTAUT, have provided valuable frameworks for understanding individual adoption of technologies. These models emphasise perceived usefulness and ease of use as determinants of whether individuals choose to adopt technologies. Within the SNS JU ecosystem, several projects apply these frameworks productively, particularly for user-focused research. However, the findings in Section 3 reveal why such models, while valid at the individual level, cannot alone address 6G's acceptance challenges. The issue is not that TAM is wrong but that it was designed for a different problem: understanding why individuals adopt tools they can choose to use or not. 6G presents a fundamentally different challenge. Four interconnected claims, emerging from both the empirical findings and the broader infrastructure acceptance literature, establish why a different framework is required.

6G is infrastructure: acceptance is collective, not individual. The 5G controversies documented in Section 3.3 (antenna burnings, municipal moratoria, community resistance) did not involve individuals rejecting a product they could simply not purchase. They involved communities contesting infrastructure that would be deployed in shared environments regardless of individual preferences. When sensing networks monitor urban spaces, when base stations are sited in neighbourhoods, when connectivity becomes ambient rather than optional, the unit of analysis shifts from users to affected social units.

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The infrastructure acceptance literature identifies this as the "opt-out" problem: unlike consumer applications that individuals can choose to adopt or reject, connectivity infrastructures create shared environments that affect populations regardless of individual choice. Non-users become stakeholders. Future generations inherit consequences. The question is not 'will individuals adopt?' but 'under what conditions will communities consent to infrastructure that transforms shared spaces?'

The conceptual fragmentation documented in Section 3.1, where definitions were diverse with no two identical, partly reflects this problem. Some definitions emphasise behaviour ('will people use it?'), others psychology ('do they trust it?'), others ethics ('does it align with values?'), still others politics ('is deployment legitimate?'). TAM and UTAUT address the first two dimensions; they were not designed to address questions of legitimacy, governance, or collective consent that infrastructure deployment inevitably raises.

Acceptance is legitimacy under governance, not merely adoption. Adoption and legitimacy can come apart. People may adopt technologies they find problematic, because alternatives are unavailable, because they lack full information, because market structures leave little choice. The privacy-service trade-offs documented in Section 3.4, where users exchange data for convenience without understanding implications, illustrate adoption without informed consent. Conversely, technologies that would genuinely benefit communities may face rejection due to poor communication, historical mistrust, or value conflicts that different approaches might resolve.

The infrastructure acceptance literature operationalises this distinction through two forms of justice: *procedural justice* (was there a fair decision-making process giving stakeholders meaningful opportunity to participate?) and *distributive justice* (how are costs and benefits shared across affected communities?). The 5G experience documented in Section 3.3 revealed failures on both dimensions: communities felt decisions were imposed rather than negotiated, while burdens (visual impact, health anxieties, property concerns) concentrated locally while benefits accrued elsewhere.

The awareness-action gap documented in Section 3.2 persists partly because available frameworks do not translate easily into governance guidance. Projects reported familiarity with TAM concepts but uncertainty about how to implement them within technical development cycles. A framework adequate to 6G must provide not just analytical categories for understanding individual decisions but actionable structure for governance design.

Acceptance is collective and emergent, not aggregated individual psychology. When publics contest technological deployments, they are not simply aggregating individual attitudes. They are engaging in collective processes of sense-making, negotiation, and resistance that cannot be predicted from individual-level variables. The 5G controversies emerged from specific configurations of community concern, media amplification, political entrepreneurship, and governance failure, dynamics that no amount of individual attitude surveying would have predicted or addressed.

This is why 6G4Society focused on mapping how the development community conceptualises acceptance rather than surveying public attitudes toward non-existent technology. As noted in Section 2.3, surveying people about technologies they have not experienced produces responses reflecting general dispositions toward technology rather than the specific concerns that actual deployment would surface. The publics that will evaluate 6G do not yet exist; they will form around consequences as those consequences become apparent.

The infrastructure literature warns against treating 'social acceptance' as a top-down norm to be achieved through better communication. This framing treats resistance as noise (misinformation, NIMBYism, ignorance, irrationality) rather than as signal revealing where

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governance, justice, or value alignment failed. The pattern documented in Section 3.3, where projects emphasise 'information provision and reference to scientific standards' in response to concerns, reflects precisely this deficit model that STS scholarship has long critiqued. Resistance may indicate legitimate concerns that merit engagement, not just communication problems to solve.

Acceptance is temporal: a relationship that evolves across phases. The time horizon mismatch documented in Section 3.6 reflects a fundamental limitation of snapshot approaches to acceptance. Societal consequences of infrastructure technologies unfold across the entire innovation lifecycle, from conception and design choices through deployment, use, and eventual obsolescence. Some impacts are immediate; others emerge only after widespread adoption; still others manifest across generations.

The infrastructure acceptance literature conceptualises this through 'social licence to operate', the ongoing relationship between deploying organisations and affected communities that **must be maintained, not merely obtained**. Acceptance at the early consenting stage does not guarantee acceptance during operation; initial resistance may transform into support once technology proves beneficial; trust built over years can collapse rapidly when expectations are violated.

Survey-based acceptance research typically captures snapshots: attitudes at a single moment, often before deployment. Such snapshots miss the dynamics that determine long-term outcomes. The 5G experience illustrated how initial acceptance eroded as deployment proceeded and concerns accumulated. For 6G, understanding acceptance requires attending to the entire relationship across phases—not just measuring pre-deployment attitudes.

From micro-validity to macro-adequacy. These four claims do not dismiss TAM, UTAUT, or similar frameworks. Projects using them productively should continue to do so. But they establish that such frameworks require situating within broader structure that addresses the dimensions they were not designed to capture.

The infrastructure acceptance literature provides a useful integration device: the 'triangle' of socio-political, community, and market acceptance, each involving different stakeholders, operating at different scales, and influenced by distinct factors. TAM's focus on perceived usefulness and ease of use addresses market acceptance at the individual level—consumers deciding whether to adopt. But infrastructure technologies like 6G simultaneously require socio-political acceptance (policy frameworks, regulatory approval, stakeholder buy-in) and community acceptance (local consent for siting, ongoing relationship with affected populations). These dimensions interact: community resistance can erode socio-political support, which can undermine market conditions, which can feed back into community scepticism.

SAT provides the broader structure within which different approaches can be located. The framework's multi-level funnel (systemic, societal, individual) tells you the level of aggregation at which acceptance dynamics manifest. Its four dimensions (User Experience, Values, Social Disruptiveness, Trust) tell you the factors shaping acceptance outcomes. TAM maps to User Experience at the individual level; SAT adds the societal and systemic levels, plus the Values, Social Disruptiveness, and Trust dimensions that adoption-focused models do not address.

The goal is not methodological uniformity but interoperability, enabling cross-project learning while respecting project-specific needs. The vocabulary gap documented in Section 3.1 arose not because projects lacked frameworks but because they lacked common reference points for relating different frameworks to each other. SAT provides those reference points: projects using different approaches can locate their work within SAT's structure, enabling comparison, translation, and cumulative learning across the ecosystem.

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4.2 FOUNDATIONAL DISTINCTION: ACCEPTANCE AND ACCEPTABILITY

A crucial distinction underlies the SAT framework, one that expert consultation (Section 3.7) confirmed as essential: the difference between acceptance and acceptability.



Acceptance is descriptive. It asks whether people do in fact accept a technology, measured through adoption rates, expressed attitudes, behavioural indicators, or absence of resistance. Acceptance research documents how people actually respond to technologies they encounter.



Acceptability is normative. It asks whether people should accept a technology, whether its deployment is justified given its impacts, risks, and value implications. Acceptability analysis examines whether the conditions for legitimate acceptance exist.

This distinction matters because the two can come apart. People may accept technologies that cause them harm, particularly when alternatives are unavailable, when they lack full information about consequences, or when market structures leave them little choice. The privacy-service trade-off documented in Section 3.4, users trading data for convenience without understanding implications, illustrates acceptance without clear acceptability.

Conversely, technologies that would genuinely benefit people may face rejection due to poor communication, historical mistrust, or value conflicts that could potentially be resolved through different approaches. The 5G controversies documented in Section 3.3 involved both legitimate concerns and responses shaped by factors (misinformation, prior trust erosion) that distorted evaluation.

For 6G, currently in development, we are primarily in the realm of acceptability, assessing whether deployment would be justified, rather than acceptance, measuring actual responses to real infrastructure. This is why 6G4Society focused on mapping developer orientations rather than public attitudes toward non-existent technology: the acceptability questions must be addressed before acceptance questions become meaningful.

SAT operates across both dimensions. Its empirical methods assess how acceptance actually unfolds, what concerns people express, what trade-offs they navigate, what factors shape their responses. Its normative components examine whether technologies align with values, distribute benefits and burdens fairly, and merit the trust placed in them. This dual focus enables both descriptive diagnosis and normative evaluation.

4.3 THE SAT FRAMEWORK: STRUCTURE AND COMPONENTS

SAT provides a structured approach to acceptance analysis operating across two layers: a structural layer that organises levels of analysis, and an operational layer comprising four dimensions through which acceptance dynamics manifest. In practical terms: the structural layer tells you where *to look*, at what level acceptance dynamics are operating (individual users, affected communities, or governance systems). The operational layer tells you *what to look for*, the factors actually driving acceptance or resistance.

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4.3.1 The Multi-Level Funnel

The structural layer organises acceptance dynamics across three interconnected levels, visualised as a funnel moving from broad contextual factors to specific individual experiences:

- **Systemic level (macro)** encompasses institutional structures, regulatory frameworks, governance mechanisms, and the political-economic conditions within which technologies are developed and deployed. The time horizon mismatch documented in **Section 3.6**, project cycles misaligned with impact manifestation, operates at this level, as do the regulatory barriers and policy frameworks that shape what deployment is possible.
- **Societal level (meso)** addresses community dynamics, stakeholder relations, collective negotiation processes, and the social contexts within which technologies are received. The 5G controversies documented in **Section 3.3**, community resistance, infrastructure attacks, municipal moratoria, manifest at this level. So, do questions of distributive justice: who benefits, who bears the costs, whose voices are heard.
- **Individual level (micro)** concerns user interactions, personal experiences, and individual-level adoption decisions. This is where traditional acceptance models like TAM operate most effectively. The user experience themes that projects in **Section 3.2** most frequently selected, usability, accessibility, user needs, address this level.

The funnel structure matters because acceptance challenges manifest differently across levels and require different responses. The empirical findings revealed that many SNS projects focus primarily on the narrower individual level, user experience, ease of adoption, perceived usefulness. While this attention is valuable, it may miss societal-level dynamics (stakeholder conflicts, community concerns, justice questions) and systemic-level conditions (regulatory barriers, institutional trust deficits, governance failures) that equally shape acceptance outcomes. A technology that performs well at the individual level can still fail at deployment if communities reject infrastructure siting or if governance frameworks don't support rollout, as the 5G experience demonstrated.

The multi-level structure directly addresses the temporal gap (**Section 3.6**): connecting immediate project activities (micro) to longer-term societal dynamics (meso) to institutional mechanisms that maintain attention beyond project cycles (macro).

4.3.2 Four Operational Dimensions

The operational layer comprises four dimensions through which acceptance dynamics manifest.

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FIGURE 4: THE SOCIAL ACCEPTANCE OF TECHNOLOGIES (SAT)

Each dimension addresses specific gaps documented in **Section 3**:

- **User Experience** addresses the quality of interaction between people and technologies, usability, accessibility, whether technologies serve genuine needs and work reliably in practice. This dimension connects most directly to traditional acceptance models while extending beyond them to encompass diverse user populations and use contexts. It responds to the aspects of acceptance that SNS projects already attend to most frequently, providing structure for systematic rather than ad hoc engagement.
- **Value Impact** examines the ethical dimensions of technology, whether designs embed societal values, how values conflicts are navigated, and whether trade-offs are made transparently. This dimension directly addresses the values gap documented in **Section 3.4**: trade-offs made implicitly, without structured tools for deliberation. It responds to the approximately one-third of definitions that emphasised 'cultural and ethical values' and 'public interest,' providing framework for what those definitions point toward but do not operationalise.
- **Social Disruptiveness** concerns the broader transformations that technologies enable or impose—changes to institutions, power relations, economic structures, and social practices. This dimension captures what the ecosystem's recognition of 6G as 'genuinely disruptive' (Section 3) implies: that infrastructure technologies reshape society, not just serve individual users. It addresses the scope gap (Section 3.5) by prompting attention to systemic impacts beyond operational metrics.
- **Trust** addresses confidence in technology and its governance—institutional trust in deploying organisations, interpersonal trust among stakeholders, and social trust in the broader systems within which technologies operate. The 5G legacy (Section 3.3) particularly highlights this dimension's importance: trust erosion from broken promises,

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perception gaps, and the 'by default acceptable' assumption's failure creates conditions that technical improvements alone cannot remedy.

4.4 HOW SAT ADDRESSES DOCUMENTED GAPS

The following table maps SAT components to the specific gaps documented in Section 3, showing how the framework responds to challenges the ecosystem itself identified:

TABLE 1 : MAPPING GAPS TO SAT COMPONENTS

Documented Gap	SAT components	How SAT responds
1. Vocabulary gap Diverse definitions, no shared language	Common terminology; four-dimension structure	Shared reference framework enables translation across approaches without requiring uniform definitions
2. Implementation gap Awareness without action	Operational dimensions; structured assessment	Actionable framework projects can implement within existing constraints; clear integration points
3. Trust gap 5G legacy, broken promises	Trust dimension; controversies as diagnostics	Treats controversies as learning resources; explicit attention to trust-building across institutional, interpersonal, social levels
4. Values gap Implicit trade-offs, no tools	Values dimension; acceptability analysis	Makes values explicit; provides structured approaches for identifying and navigating trade-offs transparently
5. Scope gap Energy focus, missing e-waste etc.	Social Disruptiveness dimension; multi-level funnel	Prompts attention to systemic impacts beyond operational metrics; encompasses environmental, social, economic dimensions
6. Temporal gap Project cycles vs. impact timing	Multi-level funnel (macro-meso-micro)	Connects immediate activities to longer-term dynamics; supports institutional mechanisms beyond project cycles

4.5 CONTROVERSIES AS DIAGNOSTIC RESOURCES

A distinctive feature of SAT is its treatment of controversies. Where conventional approaches often frame controversies as obstacles to overcome, communication failures, misinformation to correct, resistance to manage, SAT treats them as valuable diagnostic windows into acceptance dynamics.

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This approach, reiterated by expert consultation (**Section 2.2.2**), recognises that when publics contest technological deployments, their objections reveal underlying values, assumptions, and governance expectations that might otherwise remain invisible. The framing offered by one STS scholar consulted for this study is instructive: controversies 'help us identify the actors involved, the stakeholders, the tension points, the arguments in favour or against, what matters for people.' The 5G health debates, for example, revealed less about electromagnetic field science than about public expectations for precaution, consultation, and transparent governance.

The 5G controversies that accompanied rollout across Europe, health concerns, privacy worries, aesthetic objections to infrastructure, necessity questions, and yes, conspiracy theories, provided precisely this diagnostic value. Rather than treating such incidents only as problems to solve, SAT approaches them as sources of insight about what acceptance requires:

- **What actors emerged?** Not just anti-technology activists but concerned citizens, local governments, health advocates, environmental groups — stakeholders whose concerns merit engagement even when expressed in ways that technical communities find frustrating.
- **What values surfaced?** Precaution, local control, transparency, necessity justification — values that marketing messages about faster downloads do not address.
- **What governance expectations were revealed?** Desires for meaningful consultation, not just information provision; expectations of democratic input into infrastructure decisions that affect shared environments.

For 6G, attending to emerging controversies, around sensing and surveillance, AI integration, energy consumption, digital sovereignty, necessity, offers early warning about potential acceptance challenges and opportunities to address concerns proactively rather than reactively.

4.6 WHY SAT IS SUITABLE FOR 6G

SAT was developed specifically to address the acceptance challenges that infrastructure technologies present, challenges that 6G exemplifies. Three features make it particularly suitable:

- **Multi-level scope.** Unlike models focused on individual adoption, SAT's funnel structure ensures attention to societal and systemic dynamics that infrastructure technologies inherently involve. The sensing, AI integration, and sovereignty dimensions of 6G cannot be adequately addressed at the individual level alone. When a sensing network monitors urban environments, the acceptance question is not just 'will individuals use it?' but 'should communities accept this form of environmental monitoring?' and 'what governance structures make such monitoring legitimate?'
- **Values-explicit approach.** Conventional approaches treat technology as neutral and reduce acceptance questions of usability or information provision. SAT rejects this framing. Technologies carry and spread values regardless of how users employ them; their deployment involves trade-offs that prioritise certain values over others, embedding those priorities into society through the infrastructure itself. This perspective aligns with the EU's commitment to human-centric technology development and

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enables meaningful dialogue about what 6G should become, not merely whether people will adopt what technologists build.

- **Controversies as resources.** SAT's treatment of controversies as learning opportunities rather than obstacles positions it to help the 6G community learn from 5G experience and anticipate emerging challenges before they escalate. The 'by default acceptable' assumption that 5G disrupted need not catch 6G developers off guard.

4.7 INTEGRATION WITH EXISTING APPROACHES

SAT complements rather than replaces existing frameworks. The goal is not methodological uniformity but interoperability, enabling cross-project learning while respecting project-specific needs.

- **Projects using TAM or UTAUT** can situate their user acceptance work within SAT's broader structure. TAM's focus on perceived usefulness and ease of use maps to SAT's User Experience dimension at the individual level. SAT adds the societal and systemic levels, plus the Values, Social Disruptiveness, and Trust dimensions that TAM does not address.
- **Projects developing KVIs** can map their indicators onto SAT dimensions. Energy efficiency KVIs connect to Social Disruptiveness (environmental impact); inclusivity KVIs connect to Values (equity) and User Experience (accessibility); trust KVIs connect directly to the Trust dimension. SAT provides structure for relating KVI work to acceptance outcomes. SAT can also help identify KVI gaps, acceptance dimensions where projects currently have no indicators at all, particularly around trust, procedural justice, and lifecycle impacts.
- **Projects using Social Readiness Levels** find SAT compatible with SRL's staged approach to societal integration. SAT's multi-level funnel parallels SRL's attention to different scales of readiness; the frameworks can be used together, with SAT providing dimensional structure and SRL providing maturity staging. In practice, SRL answers 'when should we assess acceptance?' while SAT answers 'what should we assess?', together they provide both timing and content for societal integration work.

The vocabulary gap documented in Section 3.1 arose not because projects lacked frameworks but because they lacked common reference points for relating different frameworks to each other. SAT provides those reference points: projects using different approaches can locate their work within SAT's structure, enabling comparison, translation, and cumulative learning across the ecosystem.

4.8 SUMMARY: FROM GAPS TO FRAMEWORK

The SAT framework **responds directly to the challenges** documented in Section 3:

- To the **vocabulary gap**, it offers common terminology and dimensional structure that enable translation across diverse approaches.
- To the **implementation gap**, it provides operational guidance that projects can integrate into technical development cycles.
- To the **trust gap**, it offers explicit attention to trust dynamics and treats controversies as diagnostic resources.

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- To the **values gap**, it makes trade-offs visible and provides tools for deliberation.
- To the **scope gap**, it prompts attention to impacts beyond operational metrics.
- To the **temporal gap**, it connects project-level activities to longer-term societal dynamics through multi-level analysis.

SAT does not guarantee acceptance. Genuine societal concerns cannot be managed away through better frameworks. But it provides tools for **engaging those concerns systematically**, learning from them, and responding in ways that earn rather than demand acceptance. The next section offers guidance for operationalising these tools in practice.

5 OPERATIONALISING SAT FOR 6G

The SAT framework's value lies in its practical utility. This section offers guidance for translating SAT's structure into operational activities that projects can integrate into their work. The guidance responds directly to the implementation gap documented in Section 3.2: the persistent challenge of moving from awareness to action. Practical, however, does not mean prescriptive. SAT provides categories and questions, not answers. Meaningful operationalisation requires projects to conduct context-specific analytical work: mapping their stakeholders, identifying the values at stake in their technical choices, and understanding the trust dynamics that shape their deployment context.

Operationalisation proceeds at three scales: individual project activities, ecosystem-level coordination, and policy integration. Each scale requires different approaches and engages different actors.

5.1 PROJECT-LEVEL IMPLEMENTATION

For individual SNS JU projects, SAT implementation can be approached incrementally. Projects need not restructure their work entirely; rather, they can integrate SAT thinking into existing processes.

5.1.1 Dimensional Assessment

The four SAT dimensions (User Experience, Values, Social Disruptiveness, and Trust) provide a checklist for assessing acceptance coverage. Projects can begin by asking:

- **User Experience:** Have we engaged diverse user populations, not just early adopters or technical users? Have we assessed accessibility across different abilities, contexts, and levels of digital literacy? Do our designs respond to genuine user needs or to needs we have imputed to users?
- **Values:** What values are embedded in our technical choices? Where do value trade-offs arise, and how are we navigating them? Have we made these trade-offs transparent and subject to deliberation, or are they buried in implementation details?
- **Social Disruptiveness:** What broader transformations might our technology enable or impose? Who benefits and who bears costs? What institutional changes would deployment require, and are those changes desirable?
- **Trust:** What is the trust baseline we are working from? Has previous technology deployment (including 5G) affected trust levels among our stakeholders? What would rebuilding or maintaining trust require?

Projects currently addressing only one or two dimensions can use this assessment to identify gaps and prioritise expansion. Projects addressing all four can use it to ensure coverage is genuine rather than superficial.

5.1.2 Multi-Level Thinking

The funnel structure—systemic, societal, individual—prompts projects to consider acceptance dynamics beyond immediate user interactions. Practical questions at each level include:

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- **Individual level:** How will end users experience this technology? What barriers to adoption exist? What would make the technology genuinely useful rather than merely technically impressive?
- **Societal level:** Which communities will be affected by deployment? What stakeholder concerns should inform design? Where might resistance emerge, and what would it reveal about legitimate concerns?
- **Systemic level:** What regulatory frameworks enable or constrain deployment? What governance structures would legitimate deployment require? How do our activities connect to longer-term policy objectives?

Many projects focus primarily on the individual level—which traditional acceptance models address well. SAT's multi-level structure ensures that societal and systemic considerations receive attention, even when they are harder to address within project timelines.

5.1.3 Integration with Technical Development

The implementation gap persists partly because acceptance work is often positioned as separate from technical development, an add-on rather than an integrated activity. SAT implementation is most effective when integrated into development cycles:

- **Requirements phase:** Include acceptance considerations in requirements specification. What acceptance conditions must the technology meet? What stakeholder concerns should shape design choices?
- **Design phase:** Apply dimensional assessment to design alternatives. How do different design choices affect each SAT dimension? Where do trade-offs arise, and how should they be resolved?
- **Testing phase:** Include acceptance indicators in evaluation criteria, not just technical performance, but also user experience quality, values alignment, and trust levels.
- **Deployment phase:** Plan for ongoing monitoring of acceptance dynamics. What feedback mechanisms will capture acceptance challenges as they emerge? How will the project respond to concerns that arise?

5.2 ECOSYSTEM-LEVEL COORDINATION

Individual project efforts gain power through coordination. The vocabulary gap documented in Section 3.1 arose partly from projects working in isolation, developing approaches without common reference points. Ecosystem-level coordination can address this.

5.2.1 Shared Resources

The SNS JU and 6G-IA can support project-level implementation by developing shared resources:

- **Common glossary:** Building on SAT's dimensional structure, a shared vocabulary for acceptance-related concepts would enable cross-project communication. The varied definitions documented in Section 3.1 need not collapse into one; but projects using different definitions should be able to locate their usage within a common reference framework.
- **Assessment templates:** Structured templates for dimensional assessment and multi-level analysis would lower barriers to SAT implementation. Projects could adapt

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templates to their specific contexts while maintaining compatibility with ecosystem-wide approaches.

- **Good practice repository:** Documentation of acceptance approaches that have worked well, and those that have not, would support cumulative learning across the ecosystem.

5.2.2 Cross-Project Learning

The surveys and interviews documented in this paper represent one form of cross-project learning. Ongoing mechanisms could extend this:

- **Working groups:** Dedicated working groups on acceptance topics — organised by SAT dimension, by vertical sector, or by challenge type — would create forums for sharing experience and developing collective responses.
- **Peer review:** Projects could review each other's acceptance approaches, providing feedback and identifying opportunities for collaboration.
- **Joint stakeholder engagement:** Where multiple projects engage similar stakeholder groups, coordinated engagement could reduce stakeholder fatigue while improving insight quality.

5.3 CONNECTING SAT TO KEY VALUE INDICATORS

The SNS JU ecosystem has invested significantly in developing Key Value Indicators (KVI) as complements to traditional Key Performance Indicators (KPIs). SAT provides structure for relating KVI work to acceptance outcomes.

KVIs address the question: how do we measure whether 6G delivers societal value, not just technical performance? SAT addresses a related question: how do we assess whether 6G achieves social acceptance? The frameworks are complementary:

- **KVIs focused on environmental sustainability** (energy efficiency, carbon footprint, circular economy indicators) connect to SAT's Social Disruptiveness dimension. Meeting environmental KVI targets contributes to acceptance by addressing concerns about 6G's ecological impact.
- **KVIs focused on inclusivity** (digital divide indicators, accessibility metrics, coverage equity) connect to SAT's User Experience and Values dimensions. Inclusivity KVIs operationalise the equity concerns that over one-third of acceptance definitions emphasised.
- **KVIs focused on trustworthiness** (security indicators, privacy metrics, transparency and accountability measures) connect directly to SAT's Trust dimension. Trust KVIs address the conditions necessary for the confidence that acceptance requires.

The connection is bidirectional: KVI frameworks help operationalise SAT dimensions with measurable indicators, while SAT helps situate KVI work within broader acceptance dynamics. Projects can use both frameworks together, with SAT providing conceptual structure and KVIs providing measurement approaches.

6 IMPLICATIONS AND RECOMMENDATIONS

The findings documented in Section 3 and the framework presented in Section 4 carry implications for multiple stakeholder groups. This section offers specific recommendations organised by audience: SNS JU projects, 6G-IA, European policymakers, and the research community.

6.1 FOR SNS JU PROJECTS

Projects developing 6G technologies are the primary intended users of SAT. The following recommendations address the operational challenges documented in Section 3.2.

- **Recommendation 1: Adopt dimensional assessment.** Use SAT's four dimensions (User Experience, Values, Social Disruptiveness, Trust) as a checklist for evaluating acceptance coverage. Identify which dimensions current activities address and which require strengthening.
- **Recommendation 2: Expand stakeholder engagement beyond users.** The findings revealed concentration on end-user perspectives. Acceptance dynamics at societal and systemic levels require engaging broader stakeholder groups: communities affected by infrastructure deployment, governance actors, civil society organisations, and critics.
- **Recommendation 3: Make value trade-offs explicit.** Document the value choices embedded in technical decisions. Where trade-offs arise (privacy vs. functionality, inclusivity vs. cost, sustainability vs. performance), make the trade-off visible and subject to deliberation rather than burying it in implementation.
- **Recommendation 4: Learn from 5G systematically.** The 5G legacy documented in Section 3.3 offers diagnostic insight. Projects should analyse 5G controversies relevant to their domains, identify what those controversies revealed about acceptance conditions, and design proactively to address documented concerns.
- **Recommendation 5: Integrate acceptance work into technical development.** Position acceptance activities within development cycles rather than as separate tracks. Include acceptance considerations in requirements, design reviews, testing criteria, and deployment planning.

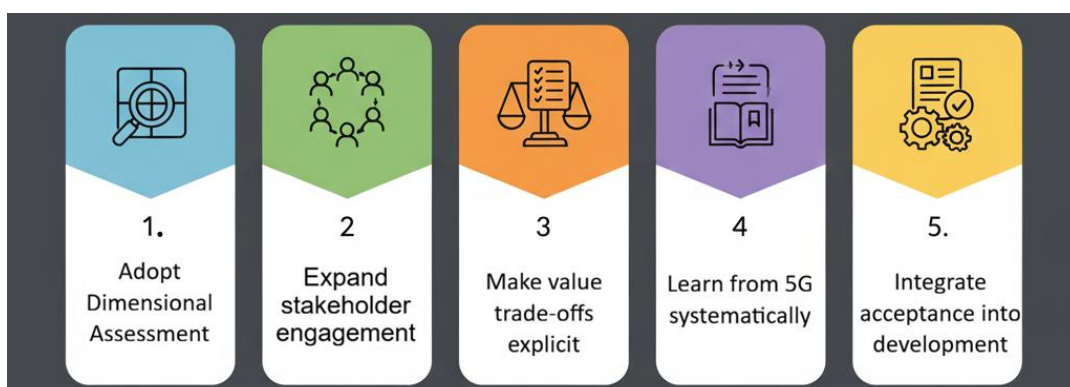


FIGURE 5: RECOMMENDATIONS FOR SNS JU PROJECTS

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6.2 FOR 6G-IA

As the industry association representing the European 6G ecosystem, 6G-IA is positioned to support ecosystem-wide coordination on acceptance. The following recommendations build on findings about coordination gaps.

- **Recommendation 6: Develop shared vocabulary resources.** The conceptual fragmentation documented in Section 3.1 impedes cross-project learning. 6G-IA can address this by developing and maintaining shared glossaries, frameworks, and reference materials that enable translation across project-specific approaches.
- **Recommendation 7: Establish acceptance working groups.** Create forums for projects to share acceptance approaches, challenges, and lessons learned. Working groups organised by SAT dimension or by vertical sector would support cumulative learning.
- **Recommendation 8: Commission ecosystem-level monitoring.** Systematic monitoring of acceptance-relevant developments — public discourse, policy evolution, emerging controversies — would provide shared intelligence that individual projects could draw upon.
- **Recommendation 9: Integrate SAT into liaison activities.** 6G-IA's engagement with policymakers, standards bodies, and international partners offers opportunities to advocate for acceptance-oriented approaches. Position SAT as a European contribution to global 6G governance discussions.



FIGURE 6: RECOMMENDATIONS FOR 6G-IA

6.3 FOR EUROPEAN POLICYMAKERS

European policy frameworks will shape the conditions within which 6G is developed and deployed. The findings suggest policy opportunities for strengthening acceptance outcomes.

- **Recommendation 10: Require acceptance assessment in funding programmes.** Future SNS JU calls and successor programmes could require projects to demonstrate

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systematic engagement with acceptance challenges. SAT provides a framework for such requirements.

- **Recommendation 11: Support long-term impact assessment.** The temporal gap documented in Section 3.6 — project cycles misaligned with impact manifestation — requires institutional mechanisms. Funding for follow-on assessment, longitudinal studies, and post-deployment evaluation would address this gap.
- **Recommendation 12: Strengthen public engagement requirements.** The awareness-action gap suggests that voluntary approaches to stakeholder engagement may be insufficient. Policy frameworks could strengthen requirements for meaningful public engagement, moving beyond information provision to genuine dialogue.
- **Recommendation 13: Address digital divide proactively.** The inclusivity-cost trade-off documented in Section 3.4 will not resolve through market mechanisms alone. Policy intervention — through universal service obligations, rural deployment incentives, or public investment — is necessary to ensure 6G narrows rather than widens digital divides.
- **Recommendation 14: Learn from 5G governance gaps.** 5G controversies revealed governance deficits: inadequate consultation, insufficient local voice, weak mechanisms for addressing community concerns. 6G governance frameworks should be designed to address these documented gaps.

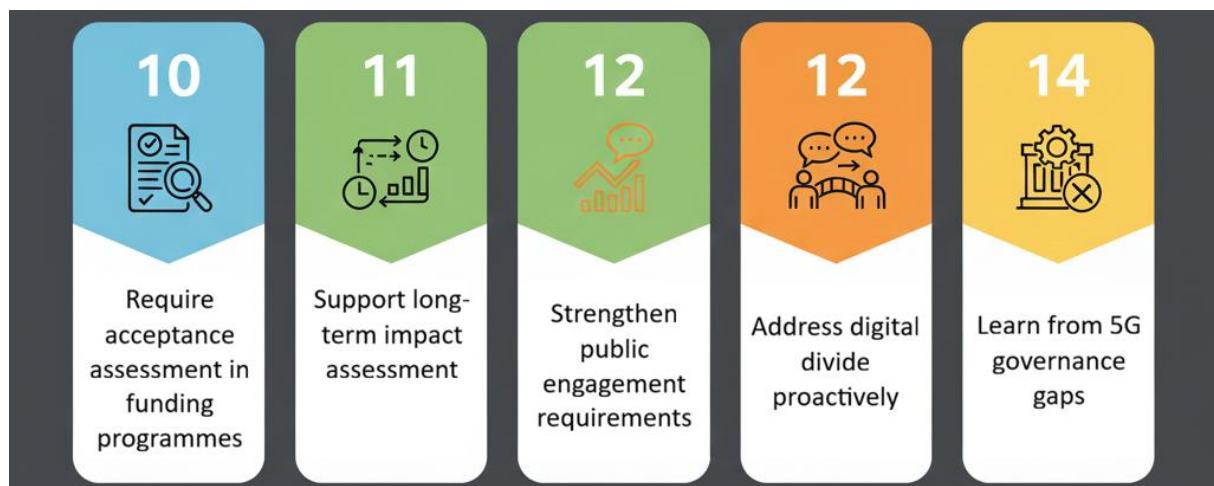


FIGURE 7: RECOMMENDATIONS FOR POLICY MAKERS

6.4 FOR THE RESEARCH COMMUNITY

The empirical work underlying this paper opens avenues for further research. The following recommendations address knowledge gaps that emerged from the investigation.

- **Recommendation 15: Develop acceptance measurement approaches.** SAT provides conceptual structure; measurement approaches for each dimension require development. How should User Experience be assessed beyond usability? How can Values alignment be measured? What indicators capture Social Disruptiveness? Research on acceptance measurement would strengthen SAT's operational utility.
- **Recommendation 16: Study 5G controversies systematically.** The 5G legacy looms over 6G development, but systematic analysis of what 5G controversies reveal

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about acceptance dynamics remains limited. Comparative research across national contexts would yield insight applicable to 6G.

- **Recommendation 17: Investigate acceptance across vertical sectors.** Acceptance dynamics likely differ across 6G application domains: healthcare, transportation, manufacturing, public services. Sector-specific research would enable targeted guidance.
- **Recommendation 18: Examine governance innovations.** Novel governance arrangements — participatory technology assessment, community benefit agreements, deliberative engagement processes — may offer models for 6G deployment. Research evaluating such innovations would inform policy design.



FIGURE 8: RECOMMENDATIONS FOR RESEARCH COMMUNITY

7 CONCLUSIONS

This paper began with an argument: that **6G's success requires attention to dimensions beyond technical performance alone**. Technical capability remains essential, but it is not sufficient. The empirical investigation presented here, surveys engaging approximately 63 responses across the SNS JU ecosystem, interviews with nine representative projects, consultations with external experts, documents the **additional challenges** that legitimacy, trust, and values alignment present, and illuminates **why current approaches struggle to address them**.

7.1 WHAT THE INVESTIGATION REVEALED

The SNS ecosystem demonstrates **genuine awareness of acceptance challenges**. Nearly 90% of projects recognise 6G as disruptive; majorities acknowledge 5G controversies; many express concerns about trust, values, and societal impacts. This awareness represents an asset: the community is not sleepwalking toward deployment but actively grappling with questions about technology-society relations.

Yet **awareness has not translated into systematic response**. The **six gaps** documented in Section 3 — vocabulary, implementation, trust, values, scope, temporal — reveal **structural barriers** that goodwill alone cannot overcome. Projects lack shared language for discussing acceptance, operational tools for addressing it, and institutional mechanisms for maintaining attention beyond project cycles. The result is an ecosystem where **acceptance challenges are recognised but inadequately engaged**.

The 5G experience intensifies these dynamics. For some, it provides cautionary lessons about what happens when acceptance is assumed rather than earned. For others, it may reinforce a sense that public opposition is irrational and best addressed through better communication. The divergence matters: **different interpretations of 5G lead to different approaches to 6G**.

7.2 WHAT SAT OFFERS

The Social Acceptance of Technology (SAT) framework responds to documented gaps with structure rather than prescription. SAT does not tell projects what to do; it **provides common reference points for organising** what they are already doing and identifying what they might do differently.

The framework's **four dimensions** (User Experience, Values, Social Disruptiveness, Trust) map the terrain of acceptance without reducing it to any single element. The **multi-level** funnel, systemic, societal, individual, ensures attention to dynamics that individual-focused models miss. The treatment of **controversies as diagnostic resources** reframes challenge as opportunity.

SAT's value proposition is not analytical novelty but **practical utility**. Projects using different approaches can locate their work within SAT's structure, enabling comparison and learning. Ecosystem coordination can build on shared vocabulary that SAT provides. Policy frameworks can reference SAT dimensions in requirements and assessments.

7.3 WHAT REMAINS TO BE DONE

This paper offers a framework, not a solution. SAT provides tools; the tools require implementation and iteration to realise their potential. Several needs emerge:

- **Operationalisation:** Section 5 offers initial guidance, but detailed implementation support — templates, assessment instruments, training resources — would strengthen uptake.
- **Validation:** SAT emerged from empirical investigation but requires testing through application. Projects implementing SAT approaches should document their experience to enable framework refinement.
- **Integration:** SAT's relationship to other frameworks, KVIs, Social Readiness Levels, sector-specific assessment approaches, requires elaboration. The goal is complementarity, not competition.
- **Extension:** The framework was developed in the European context. Its applicability to other regional contexts—where regulatory environments, cultural dynamics, and institutional structures differ—requires examination.

7.4 THE LEGITIMACY CHALLENGE

Technical systems that serve society must earn their place, not by assumption, not by imposition, but through demonstrated alignment with **what people value and what communities need**. The 5G experience showed what happens when this alignment is assumed rather than achieved. 6G need not repeat that experience.

The SNS ecosystem has resources that previous generations lacked: awareness of challenges, experience of controversies, frameworks for engagement, and time to act before deployment decisions are locked in. Whether these resources translate into different outcomes depends on choices made now, in project design, in ecosystem coordination, in policy frameworks.

SAT is one contribution to those choices. It does not guarantee acceptance — genuine concerns cannot be managed away through better frameworks. But **it provides tools for engaging those concerns systematically, learning from them**, and responding in ways that **earn rather than demand the legitimacy** that 6G's success requires.

The question now is not whether the 6G community understands acceptance challenges. The investigation documented here confirms that it does. **The question is whether understanding will translate into action adequate to the challenges ahead.**

This paper offers a framework for that translation. The work of implementation belongs to the ecosystem itself.

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APPENDIX A

This appendix presents the full evidence supporting the findings summarised in Section 3. It includes survey data, interview excerpts, and experts' perspectives organised by theme.

A.1 CONCEPTUAL FRAGMENTATION

A.1.1 The diversity of Definitions

The 2025 survey asked project representatives what "social acceptance of technology" means to them (Q8): Analysis of responses reveals clustering around different conceptual emphases, though many responses span multiple categories:

Behavioural framings emphasising adoption and usage:

- "Technology accepted by the general public" (XTRUST-6G)
- "The technology can be adopted and used" (RIGOROUS)
- "How a society perceives, adopts, and integrates new technologies into their daily life" (6G VERSUS)

Psychological definitions emphasising perception, trust, and readiness:

- "Society's readiness to embrace and integrate a new technology... whether people see it as beneficial, trustworthy" (NexaSphere)
- "In what extent citizens will trust and therefore use the technology" (6GARROW)
- "Health impact, trust, privacy, security, safety" (DETERMINISTIC6G)

Ethical or normative framings:

- "Aligned with their cultural and ethical values" (NexaSphere)
- "Compatible with wider public interest" (Sunrise 6G)
- "Willingness to adopt and use technology while considering its ethical implications, societal impact" (FLECON-6G)

Equity and inclusion definitions framings:

- "Everyone should be able to benefit from new technologies in equal terms" (6G-BRICKS)
- "My parents and computers... non digital native, they have had many difficulties on using technological devices" (DESIRE6G)

Framing through absence focusing on resistance or rejection:

- "People complaining about 5G because it kills" (MultiX)

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- "Pushback" (X-TREME 6G)
- "Possible reluctance of society to accept new technologies" (6G-EWOC)

Notably, nearly a third of responses offered comprehensive definitions spanning multiple dimensions simultaneously, recognising that acceptance involves behavioural, psychological, ethical, and social elements together. No clear majority coalesced around any single framing.

This diversity echoes patterns documented in energy transition research. Wüstenhagen, Wolsink, and Bürer [16] observed that "social acceptance is an often-used term in the practical policy literature, but clear definitions are rarely given." Their influential 'triangle of social-acceptance', distinguishing socio-political, community, and market acceptance, emerged precisely to address definitional confusion in renewable energy. Moesker et al. [17] recently mapped how acceptance and acceptability are frequently conflated, poorly defined, or used interchangeably, hampering interdisciplinary dialogue and comparative research." Expert consultation reinforced this point: "there's a strong mismatch between what social sciences research tell us about technology acceptance... and how technologists or engineers or even policy makers conceive these issues."

[Source: 2025 Survey Q8, n=41 responses]

A.1.2 Fragmentation in Practice

This conceptual diversity is not merely semantic. When projects using behavioural definitions ('will people use it?') collaborate with those using ethical definitions ('should people accept it?'), they may be talking past each other about what acceptance requires.

Interview data confirmed that projects hold genuinely different conceptions. Some projects reported working with formal definitions rooted in Technology Acceptance Model Tradition, emphasising factors like ease of use and perceived benefits, as one interviewee put it, "the ease of use is also one of the factors when we talk about technology acceptance model, how easy a technology is to use or how less complicated it is" (Hexa-X-II Interview). This framing enables measurement but may miss dimensions that resist quantification. FIDAL offered a more tentative stance:

"We haven't gone and said, here's how we understand it [social acceptance]... There's a disconnect between the tech we're designing and the impact we're claiming." – FIDAL interview

This candid acknowledgment of disconnect between design practice and impact claims suggest awareness that current approaches may be insufficient, even without clear alternatives.

A Call 3, Stream B, project expressed scepticism about acceptance discourse itself, questioning whether the framing adequately captures what matters. Such critical stances, rare in survey responses, emerged only through extended conversation, suggesting that the ecosystem harbours more conceptual uncertainty than surface-level data capture.

A.1.3 Limited Framework Awareness

The 2024 baseline survey found that only 30% of respondents (6 of 20) indicated familiarity with established technology acceptance frameworks such as TAM or UTAUT. By 2025, the pattern persisted: while some projects indicated familiarity with Social Readiness Levels or TAM variants, several projects developing sophisticated approaches reported framework unfamiliarity entirely.

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This finding resonates with broader critiques in acceptance research. Wolsink [21] warned against "regressive trends" where acceptance research collapses back into individual-level psychological models, losing sight of institutional and systemic dimensions.

[Source: 2024 Survey; 2025 Survey Q15-Q16]

A.1.4 Why this Matters

Conceptual fragmentation impedes the ecosystem in three ways:

1. **Cross-project learning difficulty:** Insights generated using one conception may not translate to projects using different conceptions.
2. **Coordination blockage:** When the community cannot agree on what acceptance means, coordinated action remains elusive.
3. **Knowledge accumulation obstruction:** Without shared vocabulary, the community cannot build cumulatively on what individual projects learn.

A.2 THE AWARENESS-ACTION GAP

A.2.1 Quantifying the Gap

The 2024 survey provided the first clear evidence. When presented with a list of acceptance-related themes (user experience, accessibility, trust, values alignment, and others) all responding projects selected at least one theme they were addressing. The most frequently selected were User Experience, User Needs, and Accessibility.

However, when subsequently asked what concrete actions they take to facilitate user acceptance, more than 50% of respondents reported taking no specific actions. This gap, between selecting themes in the abstract and implementing measures in practice, defined a central focus for subsequent investigation.

[Source: 2024: Q15: 'What actions are you taking to facilitate users' acceptance by addressing their concerns?']

A.2.2 Operational Engagement Spectrum (2025)

The 2025 survey revealed a spectrum of operational engagement:

Engagement Level	Example Projects
Consider discussions in	XTRUST-6G, NexaSphere, Unity-6G, SUSTAIN-6G
Dedicated task/WP	6G-VERSUS, AMBIENT-6G, 6G-LEADER, FLECON-6G, PROTEUS-6G
Part of objectives	RIGOROUS, 6G-PATH, TeraGreen, SUSTAIN-6G, 6G-INTENSE

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Not explicitly addressed	6G-REFERENCE, 6G-GOALS, 6G-DISAC
Unfamiliar frameworks with	6G-TWIN, BRICKS

[Source: 2025 Survey Q15-Q16]

The most common response was 'consider in discussions', acceptance features in project conversations without dedicated activities. Fewer projects report dedicated tasks, and some explicitly state they do not address acceptance at all.

A.2.3 Understanding Why the Gap Exists

Interviews illuminated the structural factors driving this gap. The explanations are not attitudinal, projects do not dismiss acceptance as unimportant, but reflect real constraints that impede systematic engagement even when will exists.

Resource constraints:

"Sometimes we do not study these aspects in depth just because there are no resources...it's a lost game afterwards." – VERGE Interview

The framing, 'a lost game afterwards', suggests that insufficient early investment in acceptance work creates problems that cannot be remedied later.

Expertise gaps:

"That's the first time in Europe... dealing with social issues. Most partners are technical." – TrialsNet Interview

This observation helps explain limited framework awareness: not because projects reject such frameworks, but because consortium composition determines available expertise.

Timing constraints:

"We focus a lot on performance and not on societal values. We design solutions that are not user friendly. This is by default." – VERGE Interview

The phrase 'by default' is revealing: the performance orientation is not deliberate rejection of societal values but an emergent property of how projects are structured and incentivised.

A.2.4 Structural Barriers

These patterns reflect what Responsible Research and Innovation (RRI) scholarship identifies as the challenge of integrating societal considerations into technically-oriented research cultures. The AIRR framework (Anticipation, Inclusion, Reflexivity, Responsiveness) provides conceptual vocabulary for what's missing, but implementing these principles requires resources, expertise, and institutional support that project structures do not always provide.

Expert consultation identified a related structural flaw in how use cases are developed: "Until 6G, I think, unfortunately including 6G, we start by creating use cases, and these use cases are created by technical people... which is a fundamental error. I think the use cases should come from the end users, not the technology creators." If use cases are generated by

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technologists rather than derived from user needs, the resulting technology may solve problems users do not have while failing to address problems they do have.

A.3 THE LEGACY AND TRUST EROSION

A.3.1 Awareness Across the Ecosystem

The 2025 survey confirms broad awareness of 5G controversies: thirty-five projects explicitly acknowledged familiarity with antenna burnings, municipal moratoria, and public resistance, including 6G-TWIN, 6G-BRICKS, NexaSphere, Unity-6G, and SUSTAIN-6G.

But awareness and learning are different things. Survey responses reveal a notable pattern: projects recognise that controversies occurred while often attributing them to factors external to the technology community, misinformation, public ignorance, or irrational fear:

"People complaining about 5G because it kills, I have seen stickies with a logo of 5G crossed."
– MultiX, Survey Q8

"Unfortunately, since the broad emergence of antivaxxer campaigns and the fairy tales of 5G-controlled nanobots in our brains, mostly nonsense." – EXIGENCE, Survey Q8

These framings locate the problem in public deficits, of knowledge, rationality, or trust, rather than in technology governance, stakeholder engagement, or value alignment.

[Source: 2025 Survey Q8, Q19]

A.3.2 The Deficit Model Critique

Science and Technology Studies scholarship has extensively critiqued this "deficit model" of science communication: the assumption that public scepticism results primarily from lack of knowledge, and that providing correct information will resolve resistance (Wynne, 1992; Sturgis & Allum, 2004).

The canonical critique comes from Wynne's (1992) study of Cumbrian sheep farmers responding to scientific advice after the Chernobyl fallout. Government scientists confidently predicted contamination would clear within three weeks; restrictions remained in place for years. The farmers' scepticism was not ignorance; it was informed judgment based on local knowledge about soil conditions, sheep behaviour, and prior experiences where official reassurances proved false. Their distrust was not a deficit to be corrected but a reasonable response to institutional history.

Sturgis and Allum (2004) confirmed these insights quantitatively, showing that while knowledge does influence attitudes, the relationship is "complex and interacting" rather than the linear causation the deficit model assumes. Context matters: how people understand science's embeddedness "within wider political, economic, and regulatory settings" shapes their responses more than factual knowledge alone.

A.3.3 The Technical Reassurance Reflex

Survey Q21 asked how respondents would address concerns from a non-technical person about electromagnetic fields and health. The responses reveal a dominant pattern: technical reassurance focused on safety standards, regulatory compliance, and scientific consensus.

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"Research by organisations like the World Health Organisation (WHO) and the International Commission on Non-Ionising Radiation Protection (ICNIRP) shows that low-level EMF exposure from technologies like 5G and Wi-Fi is safe." – RIGOROUS, Survey Q21

"This is a matter of education, if people understand technology then there will be no issue." Unity-6G, Survey Q21

[Source: 2025 Survey Q21]

A.3.4 Physical Manifestations of Resistance

For network operators, 5G resistance was not abstract discourse but material reality with concrete costs:

"Operators worry about acceptance because worldwide and in many specific places in Europe we have seen very aggressive opposition against antennas, where even antennas have been put on fire and burned down." – SUSTAIN-6G, interview

Yet the material impact does not in itself explain why resistance emerged. Infrastructure studies suggest that physical opposition often follows perceived failures of consultation, procedural fairness, or voice in decision-making. Treating antenna burnings solely as evidence of public irrationality, rather than as symptoms of governance deficits, may miss diagnostic information essential for 6G planning.

A.3.5 Beyond Misinformation: The Business Model Question

Not all 5G challenges trace to public opposition or health concerns. Interview data surfaced a parallel set of questions about economic viability:

"5G wasn't a great success in terms of business... people were expecting much more success from 5G... Who is going to pay for it? And who is going to invest in it? And who needs it?" – TrialsNet Interview

Survey data reinforces concerns about necessity:

"At this point, I am not sure that society understands why they need 6G." – TERA6G, Survey Q7

A.3.6 The Perception Gap

Part of 5G's challenge was the distance between promises and experienced reality:

"People don't seem to perceive much change in terms of throughput or performance...most European 5G deployments have been conducted in a non-standard way, not significantly different from 4G." – FLECON-6G Interview

When marketed benefits do not match user experience, trust erodes. 6G faces heightened expectations precisely because 5G's promises were not always delivered.

A.3.7 The Necessity Question

Most fundamentally, 5G experience surfaces a question that technology-led development tends to bypass: is the next generation actually needed?

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"One common question I get is, 'Why have you started working with 6G technology again when there are still controversies with 5G?' People from the general public raise this question... Even academics and researchers from different fields are questioning why we're advancing to 6G when 5G isn't even working properly yet." – 6G-PATH Interview

This is not ignorance to be corrected through better communication. It is a legitimate question about whether proposed benefits justify costs, risks, and disruptions.

A.3.8 The 'By Default Acceptable' Assumption

One industry expert's reflection captured an assumption that survey data suggests remains common:

"When we started to deploy 5G in France, we witnessed public resistance and objections. That's where, for me at least personally, the questions arose in my mind that I have ever thought about because before, for me, technology was something by default acceptable. I never really had the question so. So, I was very surprised in the beginning when I saw people saying, 'We don't want 5G.'" – Industry expert, Expert Interview

The phrase 'by default acceptable' captures an assumption the 5G experience challenged. Many projects, particularly those expressing limited concern about acceptance challenges, may be operating under similar assumptions.

A.3.9 Interpreting the Evidence

How should these patterns be understood? One STS scholar offered a reframing:

"Controversies help us identify the actors that are involved with a certain technology, who are the stakeholders for this technology, and they also help us identify the tension points: what are the arguments in favour or against a certain technology, what matters for some people." This perspective treats 5G controversies not as communication failures to be overcome but as sources of insight about what acceptance actually requires.

The same scholar sharply critiqued the 'Not in My Backyard' framing that often dismisses community opposition: "It's not just about material factors; it also has to do about what people consider that matters for them, not just the money, but also things that they value highly like landscape, like silence, like the perception of our nature as being untouched and pristine, and that is far more difficult to negotiate with people than economic benefits."

On the role of social scientists in this context: "Our role is not to persuade people that technologies are good. I'm strongly opposed to that... Our role is to assess social perceptions and concerns and needs of the populations of the communities and not persuade them that it's nice to have carbon storage under their feet or to have renewable energy in their backyards."

A.4 VALUE TRADE-OFFS

A.4.1 Recognition in Survey Data

The ethical and normative definitions captured in Q8, approximately one-third of responses emphasising 'cultural and ethical values,' 'public interest,' and 'ethical implications', indicate that a significant portion of the ecosystem conceptualises acceptance in value terms. These projects recognise that acceptance is not simply about usability or information but about whether technology aligns with what people consider important.

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This recognition aligns with what Taebi (2017) calls the distinction between acceptance and acceptability: acceptance as empirical fact (do people accept?) versus acceptability as normative question (should they accept? Is it ethically justified?). Both matter, but they require different analytical tools.

[Source: 2025 Survey Q8]

A.4.2 Trade-offs in Practice

Interviews documented specific trade-off patterns that projects encounter:

Energy efficiency versus performance:

"Energy efficiency can be mapped against KPIs, and most technical partners are happy to go with these KPIs for ease of measurement." – 6G-PATH Interview

This suggests energy efficiency receives attention partly because it can be quantified, not necessarily because it represents the most important sustainability concern. Values that resist quantification may receive less attention.

Privacy versus service quality:

"The end user sometimes doesn't care about his private data if he gets a service cheaper or for free... I believe it is also due to the fact that the average end user may not have the full picture of consequences." – SUSTAIN-6G Interview

This observation raises questions about informed consent: if users trade privacy for convenience without understanding consequences, is that a legitimate trade-off or a market failure that governance should address?

Inclusivity versus cost-effectiveness:

"When expanding 6G into rural and underserved areas... inclusivity KVI often conflicts with cost-effectiveness and profitability. We have to balance these... this specific challenge is actually one of my goals in my PhD research." – 6G-PATH Interview

Security versus latency:

Projects working on ultra-reliable low-latency communications face trade-offs between security measures (which add processing overhead) and the latency requirements of time-critical applications. These technical trade-offs have value implications: whose safety is prioritised when security and speed conflict?

[Source: Interviews]

A.4.3 The Challenge of Implicit Trade-offs

Many trade-offs are made implicitly, embedded in technical decisions without explicit deliberation. When a project prioritises throughput over accessibility, or sensing capability over privacy protection, it is making value choices, but these may not be recognized as such. The danger is that trade-offs made invisible are also made unaccountable.

An industry expert offered a concise formulation linking values to acceptance outcomes. "The more I try to look at what's behind those resistance that we saw in 5G in France, we saw that what was presented by 5G didn't match with the values of those people that objected to 5G;

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they didn't have the same values as the marketing. So, if those values do not match, there is resistance, objection, and there's no business." Values alignment, or its absence, determines acceptance outcomes. Information provision and usability improvements cannot compensate for fundamental mismatches between what technology embodies and what people consider important.

A.4.4 The KVI Challenge

The SNS JU ecosystem has invested significant effort in developing Key Value Indicators (KVIs) as complements to traditional Key Performance Indicators (KPIs). Yet survey and interview data suggest that operationalizing KVIs remains challenging.

Projects report difficulties in:

- **Definition:** What exactly counts as a "value" versus a "performance metric"?
- **Measurement:** How do you quantify trust, inclusion, or sustainability?
- **Integration:** How do KVIs influence actual design decisions when they conflict with KPIs?

As one interviewee noted, energy efficiency is tractable because it maps to existing measurement frameworks. Values like inclusion or intergenerational justice lack equivalent metrics, making them easier to acknowledge in principle than to operationalise in practice.

[Source: 2025 Survey Q24-Q28; Interviews]

A.5 SUSTAINABILITY'S NARROW SCOPE

A.5.1 Energy Dominance

Sustainability receives significant attention across the SNS JU ecosystem, but that attention concentrates heavily on operational energy efficiency. When projects discuss sustainability, energy consumption and carbon footprint dominate the conversation. This is partly appropriate: network energy consumption is substantial and growing. But the concentration of attention here may crowd out other concerns.

Survey Q7, asking about acceptance challenges, found that security/privacy (19 projects) and health concerns (10 projects) were mentioned far more frequently than environmental impacts. This suggests that sustainability, despite its prominence in policy discourse, may not yet be fully integrated into how projects think about acceptance.

When asked about values addressed in their KVI approach (Q24), the top responses were:

- Energy Efficiency (15 projects)
- Safety, Security, Privacy (14 projects)
- Economic Sustainability (10 projects)

Environmental sustainability beyond energy efficiency appeared less frequently.

[Source: 2025 Survey Q7, Q24]

A.5.2 Gaps Acknowledged

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Interview data revealed awareness of gaps even among those working explicitly on sustainability:

"Electronic waste hasn't been adequately identified or given enough attention...It's not because we've simply missed e-waste. It might be because we've either missed the whole use case related to it or we've failed to consider e-waste as a pain point." – 6G-PATH Interview

The acknowledgement that e-waste may have been 'missed' as a pain point suggests that current approaches do not adequately prompt attention to dimensions beyond operational energy.

Another raised related concerns through workshop presentations, questioning whether the vision of "smart dust" might become "smart waste", challenging assumptions about IoT proliferation. If billions of connected devices become billions of units of electronic waste, the sustainability calculus shifts significantly. The material lifecycle of 6G infrastructure, from rare earth extraction through manufacturing to end-of-life disposal, receives far less attention than operational efficiency.

A.5.3 What Gets measured gets managed

The pattern reflects a broader dynamic: what can be quantified receives attention; what resists quantification gets overlooked. Energy efficiency maps readily to existing metrics and reporting frameworks. E-waste, supply chain impacts, and lifecycle considerations are harder to measure and lack established indicators.

This creates systematic bias. Projects optimize for dimensions with clear metrics while neglecting dimensions that may matter equally but lack measurement infrastructure. The result is not necessarily the most sustainable outcome; it is the most measurable one.

A.5.4 The Three Pillars Challenge

This narrow focus on energy efficiency may miss the interdependence of sustainability's multiple dimensions. As one industry expert articulated: "If Orange does not exist as a company in 20 years from now it won't be there to push sustainability in the future. So as a company it should exist. Economical and business viability is a must. That's why we are talking about the three pillars because one doesn't work without the other."

Environmental sustainability, social sustainability, and economic viability are interdependent. Approaches that optimize for one dimension while ignoring others may prove unsustainable in the broader sense. A technology that minimizes operational energy but generates massive e-waste, or that achieves environmental gains while exacerbating digital divides, has not achieved sustainability in any meaningful sense.

A.5.5 Intergenerational Justice

Work on acceptability, notably Taebi (2017), highlights intergenerational justice as a core normative concern: what burdens do we leave for future generations? This framing reframes sustainability from a technical metric to an ethical obligation.

If billions of connected devices become billions of units of electronic waste, the question is not only environmental but also ethical. Who bears the costs of disposal? Which communities host the waste processing facilities? What toxic legacies do we create for future generations?

Sustainability understood this way is not a separate pillar but integral to whether 6G deployment can be considered acceptable at all. Projects that address energy efficiency while

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overlooking material lifecycles, supply chain impacts, or long-term waste may be optimizing one dimension while creating deficits in another.

[Source: 2025 Survey Q27; Interviews]

A.6 THE TIME HORIZON MISMATCH

A.6.1 The Assessment Challenge

A cross-cutting challenge emerged consistently across interviews: the fundamental mismatch between project timelines and impact manifestation. Project operates on scales of months to a few years; societal impacts unfold over years and decades.

"Societal impact...you cannot see the impact in a trial in one hour or one-day trial. You cannot see it in a month. You cannot see it in a year. Sometimes needs years or even decades." – TrialsNet Interview

This creates a structural problem: how can projects assess societal impacts within timeframes that preclude their manifestation?

"Most important thing, most challenging part, is that sustainability-related things are long-term, not short-term. We cannot validate or evaluate them in the short term... This is really challenging for us, working in the short term and giving an opinion on the sustainability of 6G in the short term, which is actually going to be long-term." – 6G-PATH Interview

[Source: Interviews]

A.6.2 Impacts Across the Innovation Lifecycle

Societal consequences of technology unfold across the entire innovation lifecycle, from conception and design choices through deployment, use, and eventual obsolescence. Some impacts are immediate; others emerge only over extended timeframes:

Immediate impacts (conception and design):

Who is consulted in defining requirements?

What trade-offs are embedded in architectural choices?

Which use cases are prioritised and which overlooked?

Deployment-phase impacts:

- Who bears infrastructure costs?
- Which communities host antennas and data centres?
- Who benefits first from new capabilities?

Long-term impacts (years to decades):

- Institutional transformation and labour market effects
- E-waste accumulation and environmental burden
- Trust erosion or consolidation based on experienced reality
- Digital divide narrowing or widening

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Project-based funding cycles, typically 3-4 years, are not structured to assess or address this full range. Assessment practices, as D1.1 notes, "often limit themselves to development only", missing impacts that manifest at other lifecycle stages.

A.6.3 TRL Barriers

Technology Readiness Level constraints compound the problem. Early-stage projects cannot engage meaningfully with users because the technology does yet exist in usable form:

"Since the TRL is currently too low, we're not planning to contact any specific stakeholders directly right now. – Call 2 project, Survey

Yet by the time TRL advances sufficiently for user engagement, key decisions have already been made:

"Usually, the systems are completed towards the end of the project. So, there is not enough time to dedicate for users to evaluate..." – Call 2 project, Survey

This creates a structural catch-22: too early for meaningful engagement, then too late for meaningful influence.

[Source: 2025 Survey Q17; Interviews]

A.6.4 The KPI/KVI Tension

The time horizon mismatch manifests in the tension between Key Performance Indicators and Key Value Indicators. KPIs, speed, latency, throughput, energy efficiency, can be measured within project cycles. KVIs, trust, inclusion, sustainability in its fuller sense, often cannot.

This creates systematic bias. Attention flows toward what can be demonstrated within funding periods. Longer-term dynamics that resist near-term measurement receive less attention, regardless of their importance for legitimacy and acceptance.

Projects report feeling caught between:

Funder expectations for demonstrable outcomes

Recognition that meaningful societal assessment requires longer timeframes

Pressure to show "impact" within reporting cycles

A.6.5 Structural Solutions

Some projects mentioned structural solutions that extend assessment beyond initial project conclusion:

"The Italian model of two-year follow-on assessment periods..." – Interview reference

Such mechanisms enable tracking of outcomes after projects formally conclude, maintaining attention and accountability beyond individual funding cycles. But these remain exceptions rather than norms within the SNS JU ecosystem.

Other potential approaches mentioned in interviews and literature include:

- Longitudinal study commitments built into project design

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- Handover protocols that transfer assessment responsibility to successor projects
- Ecosystem-level monitoring that track outcomes across multiple project generations
- Policy mechanisms that maintain accountability beyond project lifespans

A.6.6 Methodological Implications

These challenges have methodological implications for how acceptance should be studied at this stage. An STS scholar drew a crucial distinction:

"We tend to have a distinction between social acceptance and social acceptability. Social acceptability is something abstract. It has much more to do with the possibility of technology being implemented in the future far more remote. And it's often dealt at the level of stakeholders more than common citizens. Social acceptance is when things get real. When there's the actual possibility of the technology being implemented in a certain location or in a country." – STS scholar, Expert Interview

For 6G, currently in development, we are in the realm of acceptability, assessing whether deployment would be justified, rather than acceptance, measuring actual responses to real infrastructure. This distinction validates the methodological choice to study developer orientations rather than public attitudes toward non-existent technology.

Surveying public attitudes toward hypothetical 6G yields limited insight. As one expert noted, asking people about technologies they have not experienced produces responses that reflect general attitudes toward technology rather than specific evaluations. The more productive questions, at this state, are: are the orientations being embedded now, in design choices, value trade-offs, stakeholder engagement, ones that will support acceptance when 6G becomes real?

[Source: Interviews, Expert consultations]