



Human and Technology Collaboration Creates a Smart Society in Lampung Province Area

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Abstract: Lampung Province aspires to realize a smart society through collaboration between humans and technology. This study aims to analyze the technology readiness level (TRL) of various ongoing smart society initiatives in Lampung and identify the role of human collaboration in improving this TRL. Research methods include surveys, interviews with technology developers and users, and case studies of several smart society projects in Lampung. The results show that most implemented technologies are still at a low TRL (1-4), namely the basic research and concept validation stage. However, several initiatives have achieved TRL 5-6 (technology validation in a relevant environment), such as agricultural information systems and public transportation applications. Collaboration between academia, industry, and government is crucial to elevate TRL to a higher level (7-9), namely the system demonstration, implementation, and commercialization stages. Policy recommendations focus on increasing research and development (R&D) investment, facilitating technology transfer, and developing an innovation ecosystem that supports improving the TRL of technology for a smart society in Lampung.

Keywords: TRL, smart society, industry, technology, humans

1. INTRODUCTION

Lampung Province has presented a compelling vision for the development of a smart society in which human potential and technical innovation work together harmoniously. As Indonesia's digital transformation picks up speed, regional administrations are under more and more pressure to assess emerging technologies' availability as well as their suitability for deployment in practical settings (Cannavacciuolo et al., 2023). A crucial analytical tool for determining the maturity of innovation projects is the Technology Readiness Level (TRL) assessment, particularly in areas that aim to strike a balance between local socioeconomic realities and technical advancement. Lampung offers a distinctive example in this regard, as the province keeps growing its programs in the areas of public services, agriculture, transportation, and community empowerment via digital solutions (Azar & Ciabuschi, 2017).

Even while smart society initiatives are receiving more attention and funding, many of Lampung's current technologies are still in their infancy (Ma et al., 2022a). As per initial observations, the majority of innovations fall into TRL levels 1–4, which stand for concept exploration, fundamental research, and preliminary proof-of-concept initiatives. These immature technologies draw attention to the discrepancy between operational viability and

idealistic planning (Rachmad, 2021). Though validation takes place in relevant environments, projects including public transportation apps and agriculture information systems have achieved mid-level TRL (5–6), indicating progress in a number of industries. This variation in TRL distribution emphasizes the necessity of methodical assessment to guarantee the strategic and long-term growth of smart societies (Ma et al., 2022a). In order to improve Lampung's technical ecology, human cooperation is essential. How developers, consumers, institutions, and community stakeholders interact determines whether technologies may develop into scalable, functional systems outside of lab settings. The province's progress toward higher TRL stages (7–9), which include system demonstration, practical application, and eventual commercialization, is largely dependent on the ability of government, business, and academia to pool resources, exchange knowledge, and foster innovation pathways. In order to ensure long-term societal advantages and accelerate technological maturation, it is crucial to comprehend the dynamics of this relationship (Ghobakhloo et al., 2021). To address these issues, this research investigates how human collaboration affects technical maturity while performing a thorough evaluation of TRL across multiple smart society projects in Lampung. The study finds important possibilities and limitations in the province's innovation landscape

through surveys, interviews, and case studies. Policy proposals that aim to improve technology transfer processes, boost investment in research and development, and establish a conducive innovation environment are based on the findings. Finally, this study helps to mold a more human-centered and flexible strategy for the development of smart societies in Lampung Province.

2. MATERIALS AND METHODS

This study employed a mixed-methods approach to evaluate the Technology Readiness Level (TRL) of smart society initiatives in Lampung Province and to examine how human collaboration contributes to accelerating technology maturity. Both quantitative and qualitative data were utilized to obtain a comprehensive picture of technological performance, user experience, and the collaborative environment that supports each initiative. Data were gathered using surveys, semi-structured interviews, and case studies. Surveys were distributed to technology users, government officers, service providers, and community groups participating in smart society programs, capturing information on usability, implementation challenges, collaboration intensity, and TRL indicators (Bates & Clausen, 2020). Semi-structured interviews with technology developers, project managers, academic researchers, and industry partners provided deeper insights into system development processes, integration obstacles, and factors that influence readiness progression. Additionally, three active initiatives agricultural information systems, public transportation applications, and digital community services were selected as case studies to analyze technical characteristics, alignment with

local environments, user engagement, and stakeholder collaboration.

The TRL assessment followed the standard nine-level framework. Each technology's development stage was identified through documentation review and developer interviews, followed by user validation and observation of system performance to cross-check maturity levels (Brückner et al., 2025). Technologies were then categorized into low (TRL 1–4), medium (TRL 5–6), and high readiness (TRL 7–9), allowing a clear mapping of readiness patterns across multiple sectors. Respondents were selected through purposive sampling to ensure that only individuals directly involved in the initiatives contributed data. A total of 45 survey participants and 15 interviewees represented government units, local communities, technology developers, and industry partners, while case study selection considered relevance, implementation scale, and data availability (Day et al., 2019).

Quantitative data from the surveys were analyzed using descriptive statistics to summarize user perceptions, adoption levels, and collaboration indicators. Qualitative data from interviews and case studies were analyzed thematically to identify recurring patterns related to development challenges, collaboration dynamics, and TRL improvement factors. The integration of both data types strengthened the validity of the results and provided a holistic understanding of Lampung's readiness to advance toward a smart society. All participants were informed about the objectives of the study, and data collection adhered to ethical principles of confidentiality and voluntary participation, with no personal identifiers included in the final reporting. Detail method can see (Figure 1).

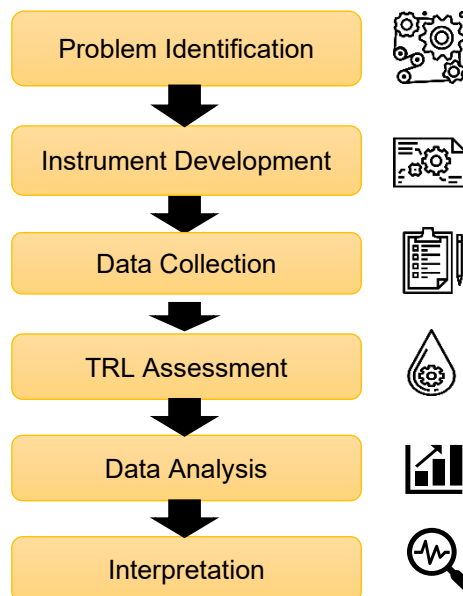


Figure 1. Flowchart TRL Method

2.1. TRL Assessment

The Technology Readiness Level (TRL) assessment was conducted to evaluate the maturity of the technologies implemented within the smart society initiatives in Lampung Province. This assessment serves as a systematic approach to determine how far each technology has progressed from conceptual development to real-world operational use (Cramer et al., 2021). By mapping the current readiness level, the study aims to identify gaps, limitations, and the potential for further enhancement of these technologies.

The TRL framework provides a structured method to categorize technological maturity across nine levels, enabling an objective comparison among various smart society projects. Through surveys, interviews, and on-site observations, each initiative was examined based on technical performance, integration capability, human-technology interaction, and readiness for large-scale deployment (Canetta et al., 2023). The findings from this assessment offer crucial insights into which technologies require improvement and how human collaboration can support their advancement toward higher readiness levels.

2.2 Data Analysis

The data analysis process in this study was conducted in several systematic stages to ensure that the assessment of Technology Readiness Levels (TRL) for smart society initiatives in Lampung Province was accurate, comprehensive, and aligned with established TRL guidelines. Both quantitative and qualitative datasets were processed to provide an integrated understanding of the current technological maturity and the role of human technology collaboration in supporting these initiatives.

Quantitative data obtained from the survey were first screened for completeness, consistency, and outliers. Responses were then coded according to the TRL indicators, enabling each technology to be mapped to one of the nine levels of readiness. Descriptive statistics including frequency distributions, mean scores, and percentage values were used to identify the dominant readiness levels among existing projects. This step helped highlight technologies that remained at conceptual or experimental phases, as well as those approaching operational deployment.

Qualitative data from interviews and document reviews were analyzed using thematic analysis. Interview transcripts were carefully examined to identify recurring patterns related to implementation challenges, collaboration dynamics, user adoption behavior, and organizational support structures. Coding and categorization techniques were applied to extract meaningful themes that supported or explained the quantitative findings. This qualitative insight

was essential for understanding why certain technologies exhibited low readiness levels and what factors hindered or facilitated their progression (Brozzi et al., 2018a).

The integration of results from both data types provided a holistic view of the technological landscape. Quantitative results established the current TRL distribution, while qualitative insights offered explanations behind these maturity levels. Together, they informed the identification of priority areas for improvement, including capability enhancement, stakeholder collaboration, and socio-technical alignment (Brozzi et al., 2018a). This combined approach ultimately strengthened the assessment framework and ensured that recommendations for advancing smart society initiatives were grounded in empirical evidence. The TRL assessment analysis can see Table 1.

Table 1. TRL assessment analysis

Initiative	Description	Evaluated	TRL Score	Readiness Category
Agricultural Information System	Digital platform providing crop data, weather info, and farming guidance	Data accuracy, usability, system integration	5	Technology validated in relevant environment
Smart Public Transportation App	Real-time bus tracking, route optimization, and user navigation	System stability, real-time data, user adoption	6	System/subsystem model or prototype demonstration
Smart Village Dashboard	Community-level monitoring of population, public services, and village programs	Data integration, IoT sensors, dashboard analytics	3	Proof of concept
E-Government Service Portal	Online administrative services (licensing, public complaints, civil services)	Service functionality, transaction reliability, cybersecurity	4	Technology validated in lab environment
Disaster Early Warning System	IoT-enabled sensors and alerts for floods and earthquakes	Sensor accuracy, connectivity, response mechanism	2	Technology concept formulated
Smart Healthcare Queue System	Digital queue management for clinics and hospitals	User interface, system reliability, interoperability	5	Technology validated in relevant environment
Smart Waste Management Pilot	Sensor-based waste collection monitoring	IoT performance, network stability, operational testing	3	Proof of concept

Digital Learning Platform for Schools	Online learning content system	Content effectiveness, platform usability, user readiness	4	Lab validation stage
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other hand, frequently experience slower development cycles and technical constraints that keep them from progressing past the experimental stages (Vo et al., 2025). The significance of creating a strong innovation ecosystem that promotes cross-sector cooperation, capacity building, and ongoing system improvement is emphasized by this. Although Lampung Province has made significant strides in creating a smart society, the findings show that there are still many potential to raise technological maturity in a variety of industries. According to the findings, a more organized TRL monitoring mechanism, increased institutional collaboration, and strategic investment in R&D are necessary to ensure long-term sustainability and speed up technology adoption. Practical suggestions that aim to improve Lampung's smart society programs' operational readiness and wider societal impact are based on these insights.

3. Results and Discussions

The evaluation of Technology Readiness Levels (TRL) for the several smart society projects in Lampung Province shows a wide range of technological maturity, which is a reflection of variations in implementation environments, stakeholder participation, and resource availability. The majority of technologies are still in the early to intermediate phases of readiness, according to the report, meaning they have a solid basis but still need a lot of work before they can be fully deployed. According to survey results, a number of projects, including the smart public transportation application and the agricultural information system, show moderate readiness levels (TRL 5–6). In pertinent situations, these technologies have demonstrated potential functioning and passed basic validation. Consistent data flow, increased user uptake, and robust system features all assist their performance. Interview data also supports the idea that these programs gain from active cooperation between government agencies, industry partners, and local developers, which speeds up their advancement toward higher TRL levels (Brozzi et al., 2018b). This result implies that increasing implementation coverage and improving system stability depend heavily on multi-stakeholder engagement. The smart waste management pilot, disaster early warning system, and smart village dashboard, on the other hand, are still at lower readiness levels (TRL 2-3). With little field testing and unfinished system integration, these technologies are still in the idea or proof-of-concept stages. Qualitative insights show that a number of reasons, such as a lack of standardized data infrastructure, fragmented collaboration, limited technical competence, and inadequate finance, are responsible for their low maturity. User input also suggests that before these systems go to higher TRL levels, usability, sensor accuracy, and interoperability need to be improved. These results emphasize that better organized development pathways and steady assistance from governmental and academic organizations are required. Furthermore, the study shows that cooperation has a big impact on technology preparedness. Because of the advantages of shared expertise, expedited testing procedures, and more thorough review systems, projects that exhibit great coordination across academics, industry, and government typically obtain better TRL scores. Initiatives without coordinated backing, on the

3.1 Technology Readiness Level (TRL)

Calculation Formula

For this study, the Technology Readiness Level (TRL) score for each smart-society initiative in Lampung Province is calculated using a weighted average approach. This allows the TRL level to reflect the combined results of survey indicators, expert validation, and field assessment.

$$TRL = \sum_i^n \frac{Si}{n} = 1 \frac{Si}{n} \quad (1)$$

TRL = Terchnology Readiness Level

Si = score of the i-th indicator (e.g., concept, prototype, integration, field test)

n = number of indicators

3.2 Interpretation

The TRL score obtained from the calculation represents the overall maturity of each smart society technology implemented in Lampung Province. Each indicator concept definition, prototype development, system integration, and field testing reflects a critical component of technological progress. The averaging these indicator scores, the assessment captures not only the technical capabilities of the system but also its readiness for real-world deployment (Brozzi et al., 2018c).

A higher TRL value indicates that the technology has progressed beyond theoretical or experimental stages and is approaching operational use. Conversely, lower TRL values suggest that the technology remains at an early phase, requiring further research, refinement, and validation. The rounding of final TRL values ensures alignment with the standardized nine-level TRL framework (Ebner et al., 2020).

In the context of the Lampung smart society initiatives, the interpretation of TRL results

highlights specific strengths and gaps in development. Technologies that reached mid-level TRL scores (5–6) demonstrate successful validation in relevant environments and reflect the positive impact of existing collaboration between developers, users, and institutions. Meanwhile, technologies with TRL levels ranging from 1 to 4 indicate the need for stronger research support, improved prototyping, and enhanced human–technology collaboration to accelerate progress toward operational readiness.

Ultimately, the interpretation of the TRL assessment provides a clear decision-making foundation for policymakers, system developers, and stakeholders. It identifies which initiatives are ready for scaling, which require further refinement, and which demand strategic investment to strengthen Lampung's transition toward a fully functional smart society (Ma et al., 2022).

4. CONCLUSIONS

This study evaluated Lampung Province's smart society initiatives' Technology Readiness Level (TRL) and looked at how human cooperation advances technological maturity. The results show that the majority of currently used technologies are still at low TRL levels (1–4), suggesting that many projects are still in the early stages of conceptual creation, fundamental research, or validation. Only a small number of initiatives, including public transportation apps and agricultural information platforms, have attained medium TRL levels (5–6), demonstrating successful validation in pertinent operational situations. The findings highlight how the level of cooperation between academics, business, government organizations, and end users has a significant impact on Lampung's advancement of smart society technologies. Technologies showed better TRL results and more transparent development routes when collaborative mechanisms were in place. On the other hand, progress toward higher TRL stages was hampered by poor coordination, inadequate R&D funding, and disjointed technology transfer procedures (7–9).

The study's overall findings indicate that Lampung Province has a great deal of potential to develop its smart society ecosystem more quickly, but that high technology readiness necessitates consistent investment, organized cross-sector cooperation, and a more robust innovation environment. Enhancing these elements will help smart technologies grow, be implemented, and eventually be commercialized, which will help Lampung realize its goal of creating a smart society that is more human-centered, connected, and efficient.

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