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Aparri townsmen online portal: Sustaining access and improving delivery of key information services

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ABSTRACT

This study assessed the user acceptability and level of usability of the Aparri Townsmen Online Portal (ATOP)- a locally developed digital platform designed to enhance public access and the delivery of key information services in the Municipality of Aparri, Cagayan. Despite increasing adoption of e-governance systems, many local government portals still face challenges related to usability, reliability, and sustained user engagement. This study addressed this gap by systematically evaluating the ATOP's performance using the System Usability Scale (SUS) and the ISO 25010 software quality framework to determine user perceptions across usability constructs, including reliability, security, maintainability, and portability. A mixed-methods design was employed involving purposively selected participants who utilized the portal's core services. Quantitative data were analyzed through descriptive statistics, while qualitative feedback was thematically coded to identify best features and areas needing improvement. Results revealed a composite SUS score of 75.17, corresponding to a "Good" usability rating (Grade B), and strong agreement in usability constructs, particularly portability (mean=3.98) and usability (mean=4.22). However, lower mean ratings were observed for maintainability (mean=3.20) and reliability (mean=3.73), indicating areas requiring enhancement. Qualitative insights highlighted system accessibility, clarity, and responsiveness as key strengths, while users recommended faster loading times, improved design aesthetics, and broader service coverage. In conclusion, the ATOP demonstrated high usability and user acceptability but requires optimization in performance efficiency and technical stability. It is recommended that the system undergo continuous usability testing, periodic maintenance updates, and interface redesign guided by user feedback and ISO 25010 principles to ensure sustained adoption and improved digital service delivery.

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INTRODUCTION

Modernizing public services requires web-based and responsive governance portals for citizens to access government related information and services anywhere, anytime, and using any device. The portals can serve a variety of functions, including self-service e-portals for license renewals, tax filing, permit requests, and social service engagement, primarily to increase efficiency, transparency, and citizen engagement. The use of mobile internet via mobile phones and tablets in various sectors of the society including educational institutions has been leveraged through classrooms, and across organizations (Nikolopoulou *et al.*, 2021). Access and use of devices to utilize web-based government portals has played significance in improving and sustaining portals. Adaptive to diverse use bases, promoting user collaboration and participation, and facilitating data understanding and explorations are central to a highly scalable use of web portals among uses for improved governance (Molodtsov and Nikiforova, 2024).

However, deployment is challenging and exposes governments to the risks associated with cybersecurity, compliance needed by organizations (i.e., FedRAMP and FISMA), organizational resistance to change, a collectivism like mentality that often limits organizational performance, scant maturity models to support all other deployments, and limiting accessibility for those unserved by digital means due to the previously mentioned lack of connections and capability. There is numerous digital government service, including those in the Philippine eGov project, electronic document management, public safety alert services (messaging, push-alerts, etc.), predictive analysis of resource planning, eVoting, citizen engagement etc.

Around the globe, local governments are quickly digitizing public services in the name of making them transparent, accessible, and efficient. Municipal portals and citizen-facing information systems are plentiful today, however, their standards of technical quality and social acceptability are key determinants of whether public funds are invested wisely. An online portal- for example, the Aparri Townsmen Online Portal— needs societal trust to be successful and sustainably utilized. Documented and standards-based evaluations are needed to determine whether the system meets objective software-quality criteria, and the community will trust the system to be useful and to inform a decision that positively affects their well-being. International software-quality frameworks - such as ISO/IEC 25010:2023 - provides an established vocabulary of the characteristics of product quality to help provide direction on what to measure (e.g. functional suitability, performance efficiency, usability, reliability, security, maintainability, portability). Adoption models of behavior, such as UTAUT2, help us identify the psychological and contextual factors to predict this acceptability of use (e.g., performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit). Taken together, the standards of technical quality and models of user adoption yield a holistic evaluation framework for municipal information systems (Lnenicka *et al.*, 2025).

Portals of advanced and highly urbanized Local Government Unit (LGU) are established to provide public services (licenses, permits, information) in a timely and inclusive manner. Poorly designed software can result in system outages, data breaches, slow responsiveness or inaccessible interfaces. Poorly designed software can produce failures or data breaches or slow system responsiveness or inaccessible interfaces that further marginalize vulnerable users. Likewise, even well-designed software can still fail to generate the intended impact if citizens are left with the perception that it is difficult to use or is irrelevant. On the basis of evidence gained through empirical studies of municipal and broader governmental portals, we are finding that measuring both the technical quality, and the user perspective foster systems that are credible, acceptable, and built to last. For example, studies of recent municipal geoportal and e-government studies deployed checklist and user-experiences tests to expose concrete usability issues. Likewise, development-based projects that applied ISO-based assessments documented findings related to reliability, usability, and performance that supported

iterative improvements (Jornadal *et al.,* 20256; Pribeanu *et al.*, 2010). These representative evaluations confirm approaches that agendas and health objectives are related. They also indicate that outcome systems that serve the agreements of government to employ standard quality models and HCI methods generate reliable documentation of accountability information were digital public service quality matters to users.

However, no matter how an innovative solution is generally of high technical quality, it does not mean it will be adopted. The Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) identifies social and perceptual constructs that influence both intention and actual use, for example, performance expectancy (perceived usefulness), effort expectancy (ease of use), social influence, facilitating conditions, hedonic motivation, price value, and habit (Marikyan and Papagiannidis, 2025). Applied studies in public health, e-services, and municipal contexts that use UTAUT2 have demonstrated that these seven constructs explain a great deal of variance in intention and use behavior and may therefore be important to explore as a means of explaining why citizens may or may not engage with the Aparri portal. Including indicators of the seven constructs in the evaluation instruments (surveys, interviews, usage analytics alongside attitudinal measures) will enable evaluators to relate measurable qualities of the software to anticipated user behaviors.

Additionally, Human-Computer Interaction (HCI) offers methodologies and approaches for actualizing ISO 25010's Usability characteristic as well as understanding the lived experiences of real users. Traditional HCI-based metrics includes effectiveness (task success), efficiency (time and resources required), and satisfaction, (subjective ratings).

Additionally, together with qualitative methods (think-aloud, contextual interviews, heuristic evaluation) HCI-based metrics will uncover usability barriers and accessibility problems that purely technical metrics will overlook (Sørum *et al.*, 2012). Moreover, HCI testing will inform UTAUT2 constructs; for example, demonstrably easier task completions will enhance the effort-expectancy construct scores, while enjoyable interaction (hedonic motivation) will positively impact behavioral intention (Raman and Don, 2013). Evaluations of government-facing portals that have paired HCI usability testing with ISO quality checks and acceptance modeling have shown improved recommendations for redesign and enhanced adoption after deployment.

While some research has conducted evaluations utilizing ISO-based evaluations, or UTAUT or UTAUT2, in relation to e-government and public health platforms, there is still a need for integrated, contextually relevant evaluations that identifies ISO 25010:2023 characteristics and their relationship to UTAUT2 adoption indicators in municipal settings in the Philippines (Amar, 2025). Systems that are developed locally (e.g. barangay management or town portals) have been released in the past with little or no evaluation conducted post deployment against international standards and there is also limited publish evidence that connects technical compliance to citizen acceptance and actual use. This gap in suitable evaluation is particularly important for Aparri's Townsmen Online Portal, where the local context (connectivity, device mix, digital literacy and social norms) will mediate both system performance and user behavior.

As part of the study, it is expected that outputs include an ISO 25010 Compliance Report indicating quantitative scores for each quality characteristic, UTAUT2 Adoption Analysis identifying significant predictors of portal use intention, Usability Evaluation Report summarizing efficiency, satisfaction, and interface issues, and an integrated recommendations for system refinement, user training, and policy support for digital transformation in LGU of Aparri.

Generally, the objective of this study is to assess the Aparri Townsmen Online Portal. Specifically, it aimed at:

1. highlighting the key features of the developed ATOP project,

2. determining the extent of conformance of the developed and implemented ATOP project with ISO/IEC 25010:2023 software-quality characteristics based on technical testing and expert review, and
3. measuring user acceptance and behavioral intention with the UTAUT2 indicators, also performing an HCI usability \"test\" (task success, efficiency, and satisfaction).

MATERIALS AND METHODS

Research design

The study employed a convergent parallel mixed-methods design integrating the technical evaluation, user evaluation and usability testing. Technical evaluation among experts focused on assessing system compliance with ISO/IEC 25010:2023 through expert evaluation, software testing, and performance analytics. In addition, end-users' perceptions and behavioral intentions using a structured survey instrument based on UTAUT2 and ISO usability dimensions were used. Performing hands-on task-based evaluations with representative users to measure task success, efficiency, and satisfaction was undertaken following HCI metrics.

Locale of the study

The study was conducted in Cagayan State University at Aparri, College of Information and Computing Sciences, Maura, Aparri, Cagayan. Participants involved in the assessment were from various barangays of Aparri Cagayan as well as those from other towns or provinces were invited or remote evaluators are located.

Respondents and sampling

The study population consists of the residents and municipal employees of Local Government Unit of Aparri who had actual use of the Aparri Townsmen Online Portal. Stratified random sampling primarily includes barangay residents, personnel from the LGU and select business owners. A total of 65 residents consented to provide valid responses in the assessments. Additionally, 10 expert's evaluators consisting of (5) IT professionals and software quality assurance specialists will conduct ISO 25010 compliance checks. Fifteen (15) representative users participated in controlled usability testing sessions following Nielsen's (1993) and Ivanovs (2025) guidelines for small-sample usability studies.

General inclusion criteria included those participants aged 18 years or above, resident or employee within Aparri for at least 6 months, with basic computer literacy and internet access, and adhered to voluntary consent to participate. Expert evaluators conformed to a required minimum of 2 years experiences along web development and programming, assessing, implementing and managing IT solutions, performed system audits. Frontline employees in the LGU whose work are into data access, management, and maintaining use of applications in the unit were included.

Ethical consideration

Ethical considerations on the participants' data as well as the responses made followed the COPE guidelines, confidentiality agreements, and data privacy pursuant to data privacy act of the Philippines. Informed consent was obtained from all participants prior to data collection.

Data confidentiality and anonymity was maintained following the Data Privacy Act of 2012 (Republic Act 10175). Participations were voluntary, with the right to withdraw at any time.

Instruments

An ISO 25010-compliant evaluation checklist were developed and validated by domain experts. Although most of the indicators were proven and utilized by most research relative to compliance of web portals to ISO 25010 software quality characteristics, the study focused on the indicators designed for the ATOP. Each quality characteristic included sub-indicators rated on a five-point Likert scale (1 = Very Poor to 5 = Excellent). The checklist covers functional suitability, performance efficiency, compatibility, reliability, security, maintainability, and portability. The UTAUT2-based structured questionnaire determining user perceptions aligned with UTAUT2 constructs and relevant usability attributes focused on the aspects perceived by users of the ATOP. Each item was rated

on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). These construct both adhered with HCI indicators and the ISO 25010:2023 software quality metrics. The constructs include performance expectancy, effort expectancy, social influence facilitating conditions, hedonic motivation, price value, habit, behavioral intention to use, and usability satisfaction. A pilot test was conducted among 20 users to ensure instrument reliability (Cronbach's $\alpha \geq 0.80$) and content validity (using expert review). Usability metrics were then used to determine usability testing. This included task success rate (%), completion time (in seconds), error rate (count per tasks), system usability scale (SUS) score, and user satisfaction via post-test Likert survey.

Data collection procedure

The ATOP application has been deployed since 2024 and modular implementation of features has been applied. With the key modules and functionalities in place covering the period of the research project, the conduct of the assessment of the ATOP project was initiated. The collection of the data comes in three (3) phases – Expert Evaluation, User Acceptance Survey, and Usability Testing. A demonstration on its use and functionalities were first initiated in an effort to provide clarity on the processes and operations involved in the ATOP.

The scope of the ATOP subjected for the evaluation and assessment both of the technical experts and users were also discussed. Technical experts evaluated the system using the ISO 25010:2023 checklist and performance tests (e.g., load testing, browser compatibility). With some consented experts working outside region 2, an online questionnaire was developed.

The questionnaire was distributed online and via paper and pen to reach both digital and walk-in users. Participants perform test tasks in a controlled environment, while data are recorded and observed. Post-test debriefing captured qualitative feedback.

Analysis of data

Descriptive statistics using weighted mean and standard deviations were used to treat compliance scores by quality characteristics. Reliability analysis (Cronbach's alpha) were used to validate questionnaire. Thematic analysis of qualitative comments to generate HCI insights were also used. With the Likert-scale-based responses, data were treated and interpreted using the matrix below for the Evaluation of the Aparri Townsmen Online Portal. This matrix serves as the data analysis framework for computing the mean and interpreting user responses across the ISO 25010:2023 software quality characteristics, the System Usability Scale (SUS), and the UTAUT2 constructs. It standardizes interpretation of quantitative data gathered from the survey questionnaires.

RESULTS AND DISCUSSION

The study focused on the assess and determine the extent of compliance of the developed and implemented ATOP project with reference to the constructs of ISO 25010:2023, UTAUT2 and the human computer interaction.

Key features of the developed and implemented ATOP

1. The developed and implemented ATOP project includes the following features:
2. Role-based User dashboards for key offices, executive, legislative and line agencies of the LGU.
3. E-Services and transactional process of key frontline offices.
4. Functional dashboards for the Office of the Mayor, Office of the Vice Mayor, Liga ng mga Barangay.
5. Interoperability of the HEROES and BDC App.
6. Centralized database of residents and community data for report generation and data-driven decision-making.
7. Certificate generation and verification services.

Profile of the respondents

As reflected in Table 1, in terms of age, the majority of users (58.46%) belonged to the 18–30 age group, with a mean age of 30.34 years (SD = 1.365), indicating that the system is primarily utilized by younger, digitally adept individuals who are more inclined toward adopting online government services. Experts and service providers had higher mean ages of 35.4 years (SD = 7.58) and 36.87 years (SD = 10.155), respectively, suggesting that evaluators and

implementers tend to be mid-career professionals with technical or administrative expertise. This aligns with the findings of Venkatesh *et al.* (2012) under the UTAUT2 model, which highlights age as a moderating factor influencing technology adoption, where younger users exhibit higher behavioral intentions toward digital platforms.

Ass to sex distribution, female participants slightly outnumbered males across groups, with 53.85% of users and 53.33% of service providers identifying as female. This gender balance indicates equitable participation and reflects the inclusive nature of the portal's user base, consistent with recent findings by (Amar, 2025), which suggest that gender differences in e-government adoption are narrowing as accessibility and usability improve.

In terms of frequency of portal use, most users accessed ATOP monthly (41.53%) or weekly (20%), while a small portion (9.23%) used it daily. Among service providers, weekly use (60%) was dominant, implying regular engagement for operational purposes. The key purposes of use were largely centered on information services (49.29%) and citizen services (32.31%), demonstrating that ATOP effectively serves its intended functions in local governance.

Table 1. Profile of the respondents

Variable		Experts		Users		Service providers	
		f	%	f	%	f	%
Age	18-30	2		38	58.46	5	
	31-45	5		22	33.85	7	
	46-60	3		4	6.15	3	
	Above 60	0		1	1.54	0	
Mean age		35.4		30.34		36.87	
S.D.		7.58		1.365		10.155	
Sex	Male	9	60.0	30	46.15	7	46.67
	Female	6	40.0	35	53.85	8	53.33
	Prefer not to say	0		0	0.0	0	0.00
Frequency of portal use	Daily	-	-	6	9.23	4	26.67
	Weekly	-	-	13	20.0	9	60.0
	Monthly	-	-	27	41.53	2	13.33
	Rarely	-	-	19	29.23	0	
Key purpose of using ATOP	Citizen services	-	-	21	32.31	9	60.0
	Business Permits/clearances	-	-	9	13.85	6	40.0
	Information services	-	-	32	49.29	0	0.0
	Others	-	-	3	4.62	0	0.0
Primary Device Used	Mobile phone	-	-	53	81.54	5	33.33
	Desktop/Laptop	-	-	11	16.92	10	66.67
	Tablet	-	-	1	1.54	0	0.0
	Other	-	-	0	0.0	0	0.0

Lastly, mobile phones (81.54%) were identified as the primary device for access, followed by desktop/laptop (16.92%), reflecting the growing reliance on mobile technology for public service interaction. This trend supports the assertion by (Molodtsov and Nikiforova, 2024) that mobile accessibility is a critical determinant of user satisfaction and continued use in e-government systems.

In sum, the respondent profile underscores a young, gender-balanced, and mobile-oriented user community, reinforcing the importance of maintaining responsive, portable, and user-friendly design features in sustaining engagement with the ATOP.

Assessment of the usability and acceptance of the ATOP

Table 2 presents the assessment results on the extent of compliance of the Aparri Townsmen Online Portal (ATOP) in terms of Functional Suitability, one of the core software quality characteristics defined under ISO/IEC 25010:2023. Functional suitability refers to the degree to which a system provides functions that

meet stated and implied needs when used under specified conditions (ISO/IEC 25010, 2023). This characteristic encompasses functional completeness, functional correctness, and functional appropriateness—attributes that determine whether the system delivers accurate and relevant outputs to its users.

Table 2. Summary table of the assessment of the ATOP using ISO 25010:2023

ISO 25010:2023 software quality constructs	WM	SD	Descriptive value
Functional suitability	3.90	0.656	Agree
Performance efficiency	4.32	0.624	Strongly agree
Compatibility	4.32	0.77	Strongly agree
Usability	4.22	0.585	Strongly agree
Reliability	3.73	0.578	Uncertain
Security	3.73	0.634	Agree
Portability	3.98	0.651	Agree

Along functional suitability, the results indicate that the ATOP received a weighted mean of 3.90 (SD = 0.656), which represents “Agree” in meaning, reflecting those respondents tend to perceive the system to be functionally within its design and purpose. This overall review can be interpreted as the ATOP fulfilling its core purpose while meeting the operational needs of its users, primarily the residents, officials, and stakeholders of Aparri. With performance efficiency, the composite means of 4.32 (SD = 0.624) classified as "Strongly Agree", indicates that users view the ATOP as a stable and highly effective system related to performance as a whole. The strong assessment for all indicators indicates robust handling of the information technology components and user engagement design to support rapid user transactions and data interactions.

The findings relative to compatibility show a composite mean of 4.32 (SD = 0.77), which is interpreted as “Strongly Agree” and suggests that the ATOP exhibits a high level of adherence to the criterion of compatibility. This interpretation indicates that the portal is reliable in different settings and that it interacts well with other applications most of the time. From the table, the results provided a total mean of 4.22 (SD = 0.585), indicating "Strongly Agree". Users perceived the ATOP to be usable, intuitive, and easy to access. This finding reflects the Human-Computer Interaction (HCI) principles of Effort Expectancy and Hedonic Motivation from the UTAUT2 framework (Venkatesh *et al.*, 2012). Additionally, these findings suggest that the portal's interface and physical structure promote user engagement, reduce cognitive overload, and help users accomplish tasks with little effort.

More so, the system's high learnability and operability, presenting that a user can operate the portal's functions independent of any previous technical skill or training. This finding supports (Nielsen, 1994) usability heuristics which state multi-faceted usability and engagement through simplicity and design will minimize barriers to learning and improve user autonomy. A clear interface supports the user’s ability to engage on content and actions, which (Fonseca *et al.*, 2020) relate to aesthetic usability, whereby visual design can enhance perceived system usability and trust. Subsequently, (Ranganathan *et al.*, 2023) found that visually appealing and consistent visual layouts enhance satisfaction and encourage continued use - consistent with the Hedonic Motivation of UTAUT2. The report of (Shneiderman *et al.*, 2016) noted that navigation ease is central in web system usability, directly affecting user performance and perceptions of efficiency. Similarly, (Venkatesh *et al.*, 2012) emphasized that logical information hierarchy and consistent page structure contribute to reduced user effort and increased satisfaction in e-government portals.

The reliability construct refers to the ability of the system to perform its required functions under stated conditions for a specified period of time without failure (ISO/IEC 25010:2023).

It encompasses system stability, fault tolerance, recoverability, and the accuracy of processes during continuous operation. The data gathered from the assessment of the Aparri Townsmen Online Portal (ATOP) indicate an overall composite mean of 3.73 (SD = 0.578), interpreted as “Agree.”

This suggests that respondents generally perceived the portal as reliable, though certain areas require further improvement to achieve full user confidence. Zhu *et al.* (2021) indicated that the reliability of a system significantly impacts user satisfaction and trust in e-governance technology, as users expect a seamless and reliable service experience when using digital systems. When an application does not work, or the content is not available, it negatively impacts users and undermines the public's trust in the government's capabilities in technology. Al-Khouri (2013) added that having reliability with public information systems is important in maintaining continuous operations and citizen confidence in government functionality, especially critical services such as permits, taxes, or documentation.

From a Human-Computer Interaction (HCI) perspective, reliable systems enable positive user experience, as they tend to be less frustrating or reduce perceived risk of use. For example, Nielsen (2012) suggests that a system's perceived reliability increases the overall usability of the system because users divert cognitive resources from managing an error to completing a task. Given this, the ATOP project should consider improving the resilience of its backend systems—for example, increasing recovery protocols and server uptime—while continuing to meet ISO 25010 quality attribute guidelines and user expectations.

Security is a fundamental component of software quality, defined in ISO/IEC 25010:2023 as the degree to which a system protects information and data such that unauthorized persons or systems cannot read or modify them, and authorized persons or systems are not denied access. The evaluation of the Aparri Townsmen Online Portal (ATOP) in terms of security produced a composite mean of 3.73 (SD = 0.634), corresponding to an "Agree" descriptive value as presented. This suggests that users generally perceive the portal as secure and trustworthy, although opportunities for strengthening user assurance and transparency remain.

Our results align with Maldonado and Cruz (2022), who stated that user trust in e-government portals is reliant upon a perceived security and privacy assurance. Even if security is built into the technology, if security mechanisms are not explicitly communicated, an end-user is likely to trust the technology less than one that is communicated to them. Similarly, Bélanger and Carter (2008) note that perceived security uniquely impacts user adoption of government online services. These findings highlight the important relationship between data protection and public trust. Ameen *et al.* (2021), also found that system security directly influences behavioral intention to use the technology in the UTAUT2 framework with particularly sensitive personal information or financial transactions.

Additionally, Al-Khouri (2013) noted that confidentiality, integrity, and availability constitute the "triad pillars" of government information systems which serve to provide both technical protective measures as well as citizen confidence. In terms of compliance with the recommendations of these security measures, the results from ATOP's assessment suggest that the portal exhibits a credible level of commitment to these pillars but can have a further positive impact by having more apparent and visible use education and transparency into data practices and use policies. From an HCI perspective, security serves to both enhance functional integrity, or usability, but contributes to perceived usability. As Nielsen (2012) states, a secure system can improve the overall user experience by providing feelings of safety and control. When users can see or read information about the protection of their data, including contextual design features like colors, visual cues, action buttons, privacy statements and even authentication feedback, they are more likely to feel confident engaging in the system.

Maintainability, as defined in ISO/IEC 25010:2023, refers to the degree of effectiveness and efficiency with which a system or component can be modified to correct faults, improve performance, or adapt to a changed environment. It encompasses sub-

characteristics such as modularity, reusability, analyzability, modifiability, and testability. For the Aparri Townsmen Online Portal (ATOP), the results show a composite mean of 3.20 (SD = 0.605), interpreted as "Uncertain." This indicates that users perceive maintainability as an area needing improvement, particularly in aspects of system updates, responsiveness to user feedback, and ongoing enhancement.

This result is consistent with the findings from Maldonado *et al.* (2022) which report longitudinally that the sustainability of e-government portals depends on adaptive maintenance and responsive loops for user feedback. Regular maintenance offers opportunities to not only address software concerns but to also help sustain public confidence in the system's reliability and relevance. Huang and Benyoucef (2013) similarly argue that ongoing maintenance of e-government, or any software, should include an element of iterative refinement, building on both technical audits and citizen feedback loops, as user needs and technology standards evolve, requiring the system to be flexible. From the perspective of ISO 25010 maintainability sub-characteristics, the data suggest that the ATOP sustains a basic capacity for modifiability, and analyzability—the developers can track and execute updates—but likely could benefit from bolstering their testability, and continuous improvement processes. Kitchenham and Pfleeger (2010) note that maintainability is the least talked about dimension of software quality, despite directly influencing costs and user satisfaction in the long term. A lack of regular, visible updates can also modify the perception of system credibility and user confidence.

Portability, as described in ISO/IEC 25010:2023, refers to the degree of effectiveness and efficiency with which a system or software product can be transferred from one environment to another. This includes the system's ability to maintain performance and functionality across different hardware, software platforms, and operating environments. In the assessment of the Aparri Townsmen Online Portal (ATOP), results yielded a composite mean of 3.98 (SD = 0.651), interpreted as "Agree." This indicates that users generally perceive the portal as adaptable and accessible across various devices and platforms, reflecting commendable compliance with the portability quality characteristic. Research findings emphasizes the significance of portability to maintain usability and sustainability of web-based government systems. Huang and Benyoucef (2013) note that access via multiple devices is an important user engagement with e-government services, as citizens have increased access to these platforms using mobile devices. Similarly, Al-Khouri (2013) remarked that a key to achieving successful digital governance systems will be interoperability, flexibility, and portability of the system and its engagement tools to support user access regardless of technological constraints.

To address the different levels of portability, ISO/IEC 25010 defines portability with three related yet distinct concepts: adaptability, installability, and replaceability. The mean scores align strongly with portability defining a system's ability to function in different environments without significant modification. Conversely, PO2 (replaceability) had a slightly lower mean score with means indicating refinements, particularly replaceability and maintainability, could be achieved during system migrations – potentially in terms of user experience, and efficiency when updating and migrating data into the full system.

Assessment of the usability and acceptability using the UTAUT2

The UTAUT2 framework was utilized to evaluate user perceptions and their behavioral intentions to use the Aparri Townsmen Online Portal (ATOP). The constructs evaluated included Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price Value, Habit, Behavioral Intention and Usability/Satisfaction. The evaluation presents the converted weighted means along with more recent empirical evidence collected from indexed studies in Scopus and Web of Science on e-government, usability, and digital adoption.

Table 3. Assessment of the performance expectancy towards ATOP

Performance expectancy (PE)	W. Mean	Std. Dev.	Desc value
Performance expectancy	4.36	0.62142	Strongly agree
Effort expectancy	3.89	0.64504	Agree
Social influence	4.00	0.61197	Agree
Facilitating conditions	3.48	0.78318	Agree
Hedonic motivation	4.14	0.66024	Agree
Price value	4.61	0.48921	Strongly agree
Habit	3.27	0.85910	Uncertain
Behavioral intention	4.32	0.64616	Strongly agree
Usability and overall satisfaction	4.56	0.57724	Strongly agree
Weighted mean	4.07		Agree

As reflected in the table, Performance Expectancy surfaced as one of the most significant determinants of user acceptance as compared to other constructs. There was agreement amongst the sample indicating ATOP increases efficiency and productivity, demonstrated in the high mean scores of the items concerning service accessibility (mean = 4.52) and task completion speed (mean = 4.09) measured reliability. These resonate with the findings in Ameen *et al.* (2021) and Maqbool *et al.* (2024) demonstrating that perceived usefulness and efficiency play a strong role in the development of citizens' behavioral intentions toward adopting e-government systems. Khan *et al.* (2025) also observed that systems which are designed or arranged around user task optimization often led to sustained long-term adoption. Therefore, the perceived functional value of ATOP supports its classification as a time saving and productivity increasing public service technology.

Users reported that the portal was easy to use and navigate, which is demonstrated in the statements related to learnability (mean = 4.00) and interface clarity (mean = 3.77). This is indicative of usability and intuitive system design, supported by Lewis and Sauro (2018) and Hyzy *et al.* (2022), who suggested that ease of learning and low cognitive load increases user satisfaction and efficiency. Similarly, Ameen *et al.* (2021) found that Effort Expectancy has a direct relationship with adopting intention in public systems, specifically when supported by interface clarity and little operational friction – capabilities clearly achieved by the ATOP. In the social dimension, users positively reported acceptance of the system based on active promotion by their municipal government (mean = 4.22) and peer endorsement from other students (mean = 3.82) as seen in the table. As Ameen *et al.* (2021) and Venkatesh *et al.* (2012) suggest, social influence contributes significantly to technology diffusion in community-based settings. The high municipal endorsement of ATOP presumably generated trust and perceived legitimacy. This was echoed by Maqbool *et al.* (2023), who highlighted the role of endorsements in influencing e-government adoption adoption behavior.

While the facilitating condition construct was rated positively overall, the moderate mean indicates some limitations with regard to technical infrastructure, especially internet reliability (mean = 3.35). Ameen *et al.* (2021) found similar issues in developing contexts, where digital readiness—namely access to stable internet and mirrored devices—mediated the use of the system. Despite this flipped classroom technological issues, the ATOP's reliable availability (mean = 3.65) and technical support (mean = 3.49) preserves user confidence in the ATOP. Maqbool *et al.* (2024) support that adequate infrastructural support helps maintain perceived control and reliability of the system. The participants thought accessing the portal was enjoyable and engaging (mean = 4.14). This reinforces the assertion that enjoyable user experience (UX) encourages user's willingness to engage with the system, which corresponds with Ameen *et al.* (2021) finding that aesthetic appeal and interactive satisfaction directly influences behavioral intention. Additionally, Lewis and Sauro (2018) and Hyzy *et al.* (2022), noted that engaging design facilitates and enhances intrinsic motivation and emotional satisfaction that builds technology adoption over time. Therefore, the enjoyable interface and enjoyable interaction of ATOP increases engagement over time.

Evidenced in the table, price value construct realized the best composite mean, suggesting users firmly feel ATOP is effective in terms, both through costs and time. The indicator related to reduction of travel (mean = 4.54) and costs (mean = 4.69) were both rated exceptionally high. This corroborates Venkatesh *et al.* (2012) and Ameen *et al.* (2021) who state that perceived economic value indeed increases user intention, especially when informing citizens is part of the service, and especially after de-bureaucratizing the experience in terms of costs and transaction time. For citizens in isolated areas such as Aparri that may have to travel long distances, being able to save travel and time is perceived immediate economic value. Despite having the most usability, Habit had the lowest mean of the constructs indicating that users aren't yet ingrained in using the portal as part of their routine. This aligns with Venkatesh *et al.* (2012) who determined that habit was a long-term consequence of continued use of a system, not an immediate determinant of behavior.

Additionally, the uncertainty responses suggest to me that users may still utilize traditional transaction channels, supporting Ameen *et al.* (2021), who found that adoption of services in government systems was gradual as users become accustomed to the system. Users exhibited significant Behavioral Intention, as evidenced by their indication to continue using the portal (mean=4.17) and to recommend it to others (mean=4.46). From the results, this it indicates strong potential adoption and satisfaction, supporting findings from Maqbool *et al.* (2024), which demonstrated that perceived usefulness and trust result in a positive behavioral intention toward digital service environments. The findings also support the results of Ameen *et al.* (2021), who identified that BI mediated between perceptions of usability and continued e-service use, which provides evidence for acceptance of ATOP among the user base.

The usability dimension as a whole had one of the highest ratings, with strong agreement on clarity (mean = 4.69) and satisfaction (mean = 4.66). This matches the results we reported using the new System Usability Scale (SUS), which affirms that ATOP meets the characteristics and user needs for effectiveness, efficiency, and satisfaction, which are congruent with aspects of ISO 25010 (2023) quality levels. Research by Hyzy *et al.* (2022) and Khan *et al.* (2025) acknowledges that systems with a mean usability score (or equivalent) above 4.5 on a Likert scale yield better outcomes for adoption and user trust. Thus, ATOP's usability, design quality, and user responsiveness collaborated well to substantiate ATOP's general acceptance and satisfaction.

In general, the results of the UTAUT2 analysis indicate that Performance Expectancy, Price Value, and Usability/Satisfaction are the most significant predictors of ATOP adoption, although Habit was the least significant, but it also stands to get better over time as constant usage develops a behavioral elaboration. Overall, this analysis supports the recent work of Ameen *et al.* (2021), Maqbool *et al.* (2024), and Hyzy *et al.* (2022), each of which showed that usability, value, and enjoyment jointly determine ongoing use of e-services. In combining these constructs, it is reinforced that ATOP has exhibited superior functional performance and reported usability, but will need strategies to further promote ongoing habitual use.

System usability of the ATOP using SUS

From the overall mean SUS score of 75.17, this signals a grade of B and an adjective rating of "Good," according to the adjective rating system developed by (Bangor *et al.*, 2009). This suggests that at least some users' general impression was that the ATOP was usable, effective, and satisfactory in carrying out intended tasks. The score also exceeds the reference SUS score of 68 which is the global average to evaluate acceptable usability (Sauro and Lewis, Quantifying the User Experience: Practical Statistics for User Research, 2012) (Hyzy *et al.*, 2022). Therefore, as a whole, ATOP has above-average usability, suggesting that the interface is designed to support user interaction with the system and facilitate navigation. These variations in the means align

with more recent usability tests of e-government and public service systems that position differences among users as an important dimension affecting usability perceptions (Maqbool and Herold, 2024) (Aldrees and Gračanin, 2023). When examining systems that citizens use across age categories and backgrounds in technology, the mean SUS scores across user categories may demonstrate moderate to high mean values yet show outliers among first-time users and users who are less familiar with technology (Hyzy *et al.*, 2022).

In relevant studies, a SUS means between 70 and 80 is understood as “Good” to “Excellent” usability in public sector or web-based service systems (Hyzy *et al.*, 2022; Maqbool and Herold, 2024). Hyzy *et al.* (2022), for example, reported a mean SUS score of 74.3 for digital government platforms, while Ameen (2021) reported a similar mean SUS score when evaluating national e-service portals, reiterating that these scores mean that users are likely to accept and navigate efficiently. The results indicate that the Aparri Townsmen Online Portal demonstrates a commendable usability level in alignment with global norms for citizen-facing digital systems. The mean SUS score of 75.17 scores the ATOP system in the upper quartile of usability, suggesting that its designs for interface, navigation flow, and feedback are effective.

Qualitative responses on the best features of the ATOP

Usability and ease of use

Most respondents were complementary about the portal's ease of navigation and usability, and how the design allows for both finding forms and service requests as well as official announcements with ease. Responses regarding first-time visitors such as, "the portal is easy to use for first time users" or "the navigation was simple, clear, and straightforward" indicate a strong sense of usability. This aligns with Brooke (1996), who proposed user satisfaction of the usability of systems is highly driven by and based on navigation and clarity of the user's tasks based on the System Usability Scale (SUS).

Additionally, (Aldrees and Gračanin, 2023) studied e-government systems and noted a direct correlation of intuitiveness of the interface as it relates to the user developing trust and a decrease in apprehension of using technology as it relates to users who are less digitally literate e.g., citizens.

Functional accuracy / Reliability

Participants noted the app "works as expected" and that "it provides correct and accurate municipal information". Moreover, several users stated that forms and the sections or barangay service requests "worked without error". These statements seem to reinforce both functional suitability and performance efficiency, both laden with values of ISO 25010 software quality valuation, specifically as it relates to correctness and reliability as important attributes as it relates to perceived quality as one study (Amar, 2025), noted users improved confidence in digital public services when reliance and accuracy of the output was undeniable as it relates to the user experience.

Accessibility and compatibility with devices

Another positive aspect that was frequently mentioned by participants was how accessible the portal was across different types of devices. Respondents reported that they were able to "access the site on their phone or computer with no trouble", which indicated high levels of compatibility and portability. The accessibility of a digital service like this reinforces the value of digital inclusion and is designed for benefit users from different socio and technology backgrounds. This finding aligns with (Pribeanu *et al.*, 2010), who noted how usage of local e-government systems was significantly attributable to multi-device compatibility for users from rural and developing contexts.

Convenience and time savings value

Participants shared multiple accounts of how convenient ATOP was, as well as saved them time, they described it as "a fast and useful way to use an LGU". The point about being able to carry out tasks without having to visit the municipal hall was one

of the most valued components associated with the portal. This aligns with the Performance Expectancy and Price Value dimensions of the UTAUT2 model (Venkatesh *et al.*, 2012), both value perceived usefulness and efficiency as variables to influence technology adoption. To support this notion, Dwivedi *et al.* (2020) found that e-government users are more likely to maintain their use of portals, perceiving the gain to be that of reduced time spent on transaction, increased convenience, and improved access to services.

Qualitative responses on areas needing improvement in the ATOP

System responsiveness and loading speed

Several participants described slow loading time on the portal during heights in usage or when opening forms with attached files.

Feedback such as “sometimes it takes too long for a page to load" and "the response time could be faster," indicate serious performance efficiency concerns — a performance efficiency sub-characteristic of efficiency under ISO 25010. Most literatures states that responsiveness is associated with user satisfaction and perceived usability, and that delays or lag times interferes with task flow, e.g. a disruption of cognitive load. Similarly, Agarwal and Venkatesh (2002) argue that feedback systems enhance users' perception of control and confidence with technology use, and these factors are a key construct in ongoing attempted user adoption within the UTAUT framework. A possible option would be to address usability with improved backend performance, as well as add lighter frameworks for internet bandwidth associated with rural areas.

Completeness of content and coverage of services

Several participants stated some sections on the portal were “still limited” or “not updated”. For example, some barangay services or form requests were "not yet functional" or "pending activation." This suggests that a gap in functional completeness still exists, an important quality characteristic within the functional suitability dimension of ISO 25010. According to (Sørum *et al.*, 2012), thorough and updated content is important in contributing to public trust in e-government platforms and continued use. If users see that key services are incomplete or not updated, their key usability judgment falls even if the system's interface is functioning well. Therefore, keeping services and modules up to date is critical in order to maintain users' interest in using the services.

Visual appearance and design consistency

Some of the participants stated that the layout of the portal could be “upgraded to look more up-to-date” or “be more aesthetically pleasing”. A few of the users suggested color combinations and/or icons that might enhance the visual appeal of the user interface and make it less text heavy. Although aesthetics is frequently seen as secondary to functionality, (Venkatesh *et al.*, 2012) showed that aesthetic design can provide advantages for perceived usability and emotional engagement, which may improve first impressions and long-term user satisfaction.

Technical issues and mobile accessibility

Participants indicated that they encountered sporadic technical issues, such as being unable to submit a form or errors in display/screen size on smaller mobile working surfaces. These problems allude to the dimensions of reliability and portability when coded during the quantitative data analysis, where a feature of "system smoothness during updates" received the lowest score of any of the constructs. This corresponds with Venkatesh *et al.* (2012) under UTAUT2, where the intention to continue using a system is a multi-faceted experience for users, stemming from performance expectancy and effort expectancy; users expect a similar ease of use or task completion in achieving their goals without technical barriers affecting usability. Kumar *et al.* (2022) further identified that seamless use across device platforms is important for maintaining inclusivity, particularly with users located in rural areas who predominantly use their smartphones to transact online.

The qualitative feedback indicates that while the ATOP effectively delivers accessible and convenient public services, enhancements in speed, completeness, design, and technical reliability would further elevate user satisfaction and sustained adoption. These findings corroborate the quantitative results of the SUS and ISO 25010 assessments, where constructs like performance efficiency and portability received relatively lower mean ratings.

Addressing these areas aligns with ISO 25010's continuous improvement framework and the UTAUT2 emphasis on user-centric system refinement. Ultimately, iterative updates focusing on optimization, content expansion, and design enhancement can ensure that ATOP evolves into a more responsive, inclusive, and sustainable e-government service for the people of Aparri.

CONCLUSION

The research entitled "User Acceptability and Level of Usability of the Developed Aparri Townsmen Online Portal: Sustaining Access and Improving Delivery of Key Information Services" indicates that the Aparri Townsmen Online Portal (ATOP) generally has high user satisfaction, usability, overall acceptability, including the software quality according to ISO 25010:2023 and user acceptability using the Unified Theory of Acceptance and Use of Technology (UTAUT2 model). Users generally perceive that the portal is useful, efficient, cost-effective, and enjoyable. The System Usability Scale (SUS) with an overall score of 75.17 (Grade B "Good") meets industry quality standards for user experience. Throughout the dimensions of ISO 25010, ATOP was scored positively in functional suitability, performance efficiency, compatibility, usability, and portability, all of which reinforce ATOP's technical soundness and reliability of a public-facing digital system. However, moderate scores in maintainability and security indicate continued updates are needed, along with a transparent measure for data protection, and the creation of feedback loops, which would be important for ensuring confidence of users in resilience of the system.

RECOMMENDATIONS

1. It may be beneficial for the Aparri Local Government Unit (LGU) to put together a scheduled maintenance and version control plan in order to update, fix bugs, and optimize performance on a regular basis. A user feedback and issue-tracking system will be an efficient means of addressing technical matters and will also create a means of participatory system improvement. Regular, ongoing updates, consistent with ISO/IEC 25010:2023, help keep the system reliable and secure, thus leading to confidence and satisfaction among citizens.
2. With the project team, the LGU may consider policies or steps to provide visible and transparent features, such as multi-factor authentication, encryption notices, and privacy policies that can be taken from public-facing portals. It would also help considerably to hold campaigns about information security to educate users on data safety and security practices. User trust also signifies respect for enforcement of Data Privacy Act of 2012 (RA 10173) that furthers the ethical and legal framework for protecting citizen data.
3. Maximizing access, the LGU should consider establishing dedicated access points or digital kiosks in barangay halls, public libraries, or local government offices for citizens without internet service or devices. A technical support hotline or chat service can be developed dedicated to users needing assistance with troubleshooting issues. For optimal user participation in digital government systems, sufficient infrastructural and technical support must be established.
4. With the extension program CICSIMPROVES of CSU Aparri, the LGU may implement digital literacy intervention programs and incentive-based campaigns (e.g., quicker transaction processing or digital certificates presented to registered users) to endorse repeated use of the portal. Continued promotional efforts of ATOP through social media feeds, barangay information drives, and offering online general municipal information integrated with other municipal features (such as online permits or

online announcements) will further support habitual engagement.

5. Ongoing usability testing, heuristic evaluations, and accessibility testing should take place to continue to engage and enhance client experience. Integration of Human-Computer Interaction (HCI) principles like visual hierarchy, responsive design, and easy-to-navigate interface can support usability over multiple devices. Continuous UX assessments provide actionable findings to improve designs and task completion. Each of these attributes reinforces user acceptance and intension to use a digital system.

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REFERENCES

Aldrees A, Gračanin D. 2023. UX in e-government services for citizens: A systematic literature review. Journal of User Experience **18**(3), 133–169. https://dl.acm.org/doi/10.5555/3605526.3605529

Amar JC. 2025. Development and evaluation of a technology-based barangay management system. International Journal of Science and Research **14**(3), 104–107. https://www.ijsr.net/getabstract.php?paperid=SR25303115701

Bangor A, Kortum P, Miller J. 2009. Determining what individual SUS scores mean: Adding an adjective rating scale. Journal of Usability Studies **4**(3), 114–123. https://dl.acm.org/doi/10.5555/2835587.2835589

Digital.gov. n.d. Usability. https://digital.gov/topics/usability

Fonseca D, García-Peñalvo FJ, Camba JD. 2020. New methods and technologies for enhancing usability and accessibility of educational data. Universal Access in the Information Society. https://doi.org/10.1007/s10209-020-00776-x

Hyzy M, Bond R, Mulvenna M, Bai L, Dix A, Leigh S, Hunt S. 2022. System usability scale benchmarking for digital health apps: Meta-analysis. JMIR Mhealth Uhealth **18**(2). https://doi.org/10.2196/37290

ISO. 2023. Systems and software engineering—Systems and software quality requirements and evaluation (SQuaRE) – Product quality model. Switzerland: ISO Copyright Office. https://cdn.standards.iteh.ai/samples/78176/13ff8ea97048443f99318920757df124/ISO-IEC-25010-2023.pdf

Ivanovs S. 2025. Nielsen's usability heuristics: 10 principles to enhance the user experience. https://www.testdevlab.com/blog/nielsens-usability-heuristics-10-principles

Jornadal ML, Forca AF, Putra GR. 2025. Evaluation of developed alumni information management system (AIMS) using ISO 25010:2015. Jurnal Informatika dan Rekayasa Perangkat Lunak (JATIKA) **6**(2). https://doi.org/10.33365/jatika.v6i2.134

Khan Q, Hickie IB, Loblay V, Ekambareshwar M, Zahed IU, Naderbagi A, LaMonica HM. 2025. Psychometric evaluation of the system usability scale in the context of a childrearing app co-designed for low- and middle-income countries. Digit Health. https://doi.org/10.1177/20552076251335413

Krol K. 2024. Retrospective analysis of municipal geoportal usability in the context of the evolution of online data presentation techniques. ISPRS International Journal of Geo-Information **13**(9). https://doi.org/10.3390/ijgi13090307

Lnenicka M, Nikiforova A, Wang D, Bernardini F. 2025. UX competitive analysis of smart city open data portals: Usability framework, design recommendations, and a roadmap for sustainable data ecosystems. Telematics and Informatics. https://doi.org/10.1016/j.tele.2025.102284

Maqbool B, Herold S. 2024. Potential effectiveness and efficiency issues in usability evaluation within digital health: A systematic literature review. Journal of Systems and Software 208. https://doi.org/10.1016/j.jss.2023.111881

Marikyan D, Papagiannidis S. 2025. Unified theory of acceptance and use of technology (UTAUT): A review. TheoryHub Book. https://open.ncl.ac.uk

Molodtsov F, Nikiforova A. 2024. An integrated usability framework for evaluating open government data portals: Comparative analysis of EU and GCC countries. 5th Annual International Conference on Digital Government Research (DGO 2024), 10. Taipei. https://doi.org/10.1145/3657054.3657159

Nielsen J. 1994. Enhancing the explanatory power of usability heuristics. CHI '94: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 152–158. https://dl.acm.org/doi/10.1145/191666.191729

Nikolopoulou K, Nikolopoulou K, Lavidas K. 2021. Habit, hedonic motivation, performance expectancy and technological pedagogical knowledge affect teachers' intention to use mobile internet. Computers and Education Open 2. https://doi.org/10.1016/j.caeo.2021.100041

Pribeanu C, Marinescu RD, Iordache DD, Gheorghe-Moisii M. 2010. Exploring the usability of municipal web sites: A comparison based on expert evaluation results from four case studies. Informatica Economica.

Raman A, Don Y. 2013. Preservice teachers' acceptance of learning management software: An application of the UTAUT2 model. International Education Studies **6**(7), 157–167. https://doi.org/10.5539/ies.v6n7p157

Ranganathan PS, Karun RS, Alawadi AM, Khamdamova VS, Rajalakshmi B. 2023. Human-computer interaction: Enhancing user experience in interactive systems. E3S Web of Conferences **399**, 04037. https://doi.org/10.1051/e3sconf/202339904037

Sauro J, Lewis JR. 2012. Quantifying the user experience: Practical statistics for user research. San Francisco: Morgan Kaufmann Publishers Inc. https://dl.acm.org/doi/10.5555/2222513

Sauro J, Lewis JR. 2016. Quantifying the user experience: Practical statistics for user research (2nd edition). ScienceDirect. https://www.sciencedirect.com/book/9780128023082/quantifying-the-user-experience

Shneiderman B, Plaisant C, Cohen M, Jacobs S, Elmqvist N, Diakopoulos N. 2016. Designing the user interface: Strategies for effective human-computer interaction. Pearson. https://dl.acm.org/doi/10.5555/3033040

Sørum H, Andersen KN, Vatrapu RK. 2012. Public websites and human-computer interaction: An empirical study of measurement of website quality and user satisfaction. Behaviour & Information Technology **31**(7), 697–706. https://doi.org/10.1080/0144929X.2011.577191

Venkatesh V, Thong JY, Xu X. 2012. Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology (UTAUT2). MIS Quarterly **31**(6), 157–178.