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Uruguay's 2023 Web-Based Census: Achieving 60% Digital Participation in a Latin American Context

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Abstract

Uruguay's 2023 Population Census achieved 60% digital participation through Computer-Assisted Web Interviewing (CAWI); a rate unmatched in Latin America and comparable to those of developed countries on their initial large-scale digital census implementations. This paper addresses the question of which operational factors enabled this outcome, discussing their relative contributions and assessing their transferability to other developing-country contexts. Drawing on detailed operational data from the census, we examine four interacting elements: the strategic use of the national electricity utility's meter database as a near-universal household register and authentication mechanism; the development of a mobile-first digital platform capable of sustaining over 75,000 daily submissions (approximately 5% of all households); a phased, multi-channel communication campaign; and a comprehensive pre-census cartographic validation producing a verified address frame. We provide evidence of the direct relationship between specific communication campaign events and daily submission rates, demonstrating that peaks of 40,000–75,000 responses coincided precisely with campaign milestones. We compare Uruguay's results with international benchmarks across the Americas, Oceania, and Europe within a structured analytical framework, and discuss the prerequisites and sequencing of investment that other countries would likely need to replicate comparable outcomes.

Keywords: CAWI; digital census; online enumeration; census methodology; Uruguay; Latin America; administrative data; mobile-first design; behavioral economics.

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1. Introduction

Population censuses remain fundamental instruments of demographic statistics, yet the traditional model of universal face-to-face enumeration has come under increasing strain. Rising costs, declining household response rates, and coverage gaps associated with population mobility have led national statistical offices worldwide to explore mixed-mode collection designs, with Computer-Assisted Web Interviewing (CAWI) occupying an increasing central role in recent census modernization strategies [1, 2, 3].

The global CAWI adoption picture is strikingly uneven. According to a United Nations survey of 155 countries/areas that conducted censuses in the 2020 round, 78% used Computer-Assisted Personal Interviewing (CAPI) as a collection method and 44% used CAWI — but the latter figure masks enormous regional variation [3]. In Europe, 80% of countries used CAWI, whereas in the Americas, 76% continued to rely on CAPI; CAWI played at most a secondary role there and was used in 55% of countries. This divergence cannot be attributed to internet access alone. In Latin America, digital access levels point to the existence of a minimum infrastructure conducive to the implementation of online data-collection modes. In 2021, 95% of urban households in the region had at least one member with access to a smartphone, while roughly two thirds of households had fixed internet connections [4]. These figures suggest that, especially in urban settings, the availability of connected devices and internet access was broad enough to enable the use of digital tools such as CAWI. Yet across Latin America, CAWI participation generally stayed under 15%, with only Argentina and Uruguay surpassing that level, even when digital census options were technically available and actively promoted.

This paper asks a specific question. What operational factors enabled Uruguay to achieve 60% CAWI participation in 2023, on its first large-scale attempt, while the regional norm remained far lower? We are interested not in a comprehensive census evaluation (Uruguay's combined census methodology, including the integration of administrative registers that accounted for a 10.3% of the final population count, is documented in detail elsewhere [5, 23]) but specifically in the CAWI participation outcome and the factors that shaped it.

We argue that Uruguay's result reflected the convergence of four interacting elements: a near-universal household register derived from an electricity utility database, which solved simultaneously the authentication, geocoding, and coverage monitoring challenges common to CAWI implementations; a mobile-first platform designed for the smartphone-dominant internet access landscape; a phased, multi-channel communication campaign treated as operational infrastructure rather than ancillary activity; and a verified address frame produced by a systematic pre-census cartographic operation. We provide operational evidence bearing on the relative contribution of each factor and discuss the conditions under which the approach is transferable.

The paper is organized as follows. Section 2 reviews the international CAWI adoption literature and situates Uruguay within it. Section 3 describes the preparatory infrastructure. Section 4 analyses the technology platform. Section 5 examines the communication strategy. Section 6 presents quantitative results. Section 7 discusses counterfactual considerations, limitations, and transferability. Section 8 concludes.

2. The Global Trajectory of CAWI Census Adoption

2.1 Developed Country Experience

The developed-country trajectory of CAWI adoption illustrates that high digital participation is achievable but typically requires iterative investment across multiple census cycles. Canada's progression is instructive. From 18% online response in its first digital census of 2006, Statistics Canada systematically refined the online experience, shifted default expectations toward digital participation, and invested in communications across successive census cycles, reaching 84% online response in 2021 [6, 7]. Australia’s experience illustrates a different lesson [8, 9, 10]. When the first Australian eCensus was introduced in 2006, the official online participation rate was 8.7%. Australia later moved to a digital-first model in 2016, but the census suffered a high-profile system failure on Census night, showing that infrastructure resilience is a precondition for public trust. Australia recovered strongly in 2021, achieving about 79% online response with flawless performance.

European experience is more heterogeneous but points in a consistent direction. The United Kingdom reached 89% in its 2021 census through design choices (digital as the primary and most prominently presented mode) that positioned online completion as the expected default behavior [11]. Portugal offers a continental European example. In the 2021 Census, the internet response rate reached 87.5% of the resident population [12]. Nordic countries have moved beyond the question of CAWI participation entirely, having developed register-based census systems that replace traditional enumeration [13]. In the UNECE framework, CAWI may form part of a combined census model that serves as an intermediate step toward greater reliance on administrative sources [14] — a framing directly relevant to Uruguay's ambitions for the 2030 round.

The key patterns from developed-country evidence are: (i) CAWI participation typically requires multiple census cycles to reach very high levels; (ii) platform reliability is a precondition for sustained participation growth; (iii) positioning digital completion as the default expected mode rather than an option yields systematically higher participation; and (iv) communication investment consistently appears as an important feature of high-participation census implementations.

2.2 Latin American Context

The Latin American context presents a persistent gap between digital access capacity and CAWI census participation. Brazil, Colombia, Chile, Ecuador and Mexico all reported single-digit or low-teen CAWI shares in the 2020 census round (Table 1) despite digital options being technically available.

Table 1. Web response rates in Latin American population censuses

Country	Census year used	Web response rate	Basis of the figure	Source status
Argentina	2022	50.3%	Digital census completion rate	Officially published (preliminary results)
Brazil	2022	0.3%	Share collected via internet self-enumeration	Calculated from official figures reported when census coverage had reached 80%
Chile	2024	6.2%	Share of persons enumerated through CAWI	Officially published
Colombia	2018	11.4%	Calculated as 5,048,492 eCenso persons / 44,164,417 enumerated persons	Calculated from officially reported figures
Ecuador	2022	13.6%	Calculated as 2.3 million online respondents / 16,938,986 total population counted	Calculated from officially reported figures
Mexico	2020	0.2%	Approximate share of occupied private dwellings answered online	Calculated from official figures
Uruguay	2023	60.0%	Share of households responding through the web questionnaire	Officially published

Sources: [16, 17, 18, 19, 20, 21].

The standard explanations for this gap — inadequate infrastructure, low digital literacy, weak administrative data systems — are partially accurate but insufficient [1]. A comparative analysis of the conditions that distinguish successful CAWI implementations from failed ones suggests that infrastructure is a necessary but not sufficient condition, and that the critical differentiating variables are: whether a reliable household-level authentication mechanism exists; whether the platform is genuinely mobile-optimized; whether communication investment is high enough; and whether digital completion is positioned as the primary expected mode rather than an alternative.

Argentina's 2022 census constitutes the critical regional antecedent. Argentina achieved approximately 50% CAWI participation — demonstrating for the first time that high digital census participation is achievable in a large, geographically diverse Latin American country. Uruguay's 2023 result, surpassing Argentina's by 10 percentage points on a first attempt, establishes a new regional benchmark and warrants systematic analysis.

2.3 UNSD Framework for Digital Census Implementation

The United Nations' *Principles and Recommendations for Population and Housing Censuses* [1] and related United Nations guidance on census operations and electronic data collection [22] increasingly treat digital data collection as part of modern census design. In particular, United Nations guidance indicates that successful CAWI implementation depends on several operational preconditions, including an accurate and comprehensive address or household frame, a unique identifier to support authentication and prevent duplication, a platform that is accessible and easy to use, and a communication strategy capable of generating sufficient public awareness and response.

Uruguay's design directly operationalized each of these requirements, as we demonstrate in sections 3 through 5.

3. Preparatory Infrastructure

3.1 The Electricity Meter Database as Census Infrastructure

The most distinctive technical innovation in Uruguay's CAWI implementation was the use of the national electricity utility's (UTE) customer database as the census household register and authentication mechanism. UTE, a state-owned utility providing electricity service to over 99% of Uruguayan households, maintains a continuously updated database of all service addresses, each identified by a unique meter number. This database is georeferenced, linking each address to coordinates within Uruguay's national spatial data infrastructure, and is updated in near-real time as connections are established or terminated.

The decision to anchor the CAWI authentication system on UTE meter numbers solved three distinct operational problems simultaneously. First, it provided a near-universal household identifier available to essentially all households in the country via their monthly electricity bill — a document with which virtually every household has routine engagement. Second, the two-factor authentication (meter number plus national identity document number, followed by a one-time SMS/email code) prevented duplicate submissions without requiring households to create or manage census-specific credentials. Third, automatic geocoding linked every submission to a precise enumeration area without requiring respondents to enter or verify address information, eliminating a common source of data quality degradation in CAWI implementations.

The operational flow was as follows. Households navigated to censo2023.uy, entered their UTE meter number and national identity document number, received a one-time code by SMS or email, authenticated, and completed the questionnaire. On completion, the system generated a unique completion code that field enumerators subsequently collected during their visits to confirm CAWI-enumerated households and focus in-person enumeration on non-respondents. This completion code mechanism also served as a population-level check on CAWI uptake, as unverified codes provided an independent estimate of field non-response rates [5].

Figure 1: Steps for responding to Uruguay's 2023 Digital Census. Households first enter the census website, provide the electricity service customer number and an email address or mobile number, then enter the verification code received electronically. The questionnaire can be completed on a computer, mobile phone, or tablet. After submission, the system generates a completion code, which is later requested by an enumerator during the household visit. Adapted from Uruguay's digital census response process.

The UTE meter database was not used directly as the census frame without validation. The initial UTE database (March 2023) contained slightly under 1.7 million addresses. The pre-census field operation, described in section 3.2 below, confirmed 99% concordance between the UTE database and field-verified addresses, validating the database as an essentially complete census frame.

It is worth noting what this approach does not require. Countries considering analogous implementations do not need a central population register, a national address database built from scratch, or unique personal identifiers of census-specific provenance. What is required is a utility, agency, or institution with near-universal household coverage and a reliable, georeferenced address database — and an institutional framework enabling data sharing for statistical purposes. Countries with state-owned electricity, water, or postal services covering most of the population possess the raw material for this approach.

3.2 The Pre-Census Cartographic Operation

The UTE database's practical utility as a census frame depended on systematic field validation. Between February and March 2023, INE conducted a comprehensive pre-census cartographic operation covering 653 urban localities, deploying approximately 1,500 field workers coordinated by 23 departmental supervisors.

The operation was organized through a dedicated mobile application (APP Precenso) with automated zone assignment and real-time monitoring dashboards. Approximately 38 planner-controller pairs managed daily operations, rerouting teams and adjusting zone assignments based on live progress data. The operation was designed around specific productivity targets (approximately 1,000–1,300 addresses per worker) and defined time parameters (approximately 12 minutes of travel per zone, 4 minutes per address verification).

The quantitative results confirmed the UTE database's quality while identifying specific corrections: of slightly under 1.6 million residential addresses verified in the field, only approximately 1% differed from the preliminary administrative frame. Approximately 18,000 dwellings were found in the field that were absent from the UTE database (predominantly newer developments and informal settlements); approximately 12,000 database entries no longer corresponded to actual dwellings. Approximately 500 zones previously unmapped were identified and added; fewer than 900 zones remained uncovered, mostly in areas designated as security concerns, subsequently addressed through special operations during the main census.

This near-complete concordance (approximately 99% between UTE database and field verification) had a significant operational implication. It confirmed that the meter-based authentication approach would provide essentially universal household coverage, with the residual gaps addressable through field operations. The pre-census also produced the zone-level baseline that enabled real-time coverage monitoring during the CAWI phase, allowing the operations center to identify geographic areas of below-expected participation and target them for additional communication or field resources.

4. Technology Platform

4.1 Architecture and Infrastructure

The technology platform for the 2023 census was designed around a central operational requirement: reliable performance under extreme and unpredictable concurrent demand. The architecture combined a government cloud environment (ANTEL's national infrastructure, Tier III certified) hosting core systems and databases, with applications deployed as containerized microservices on an OpenShift/Kubernetes cluster in the internet-facing DMZ for public access.

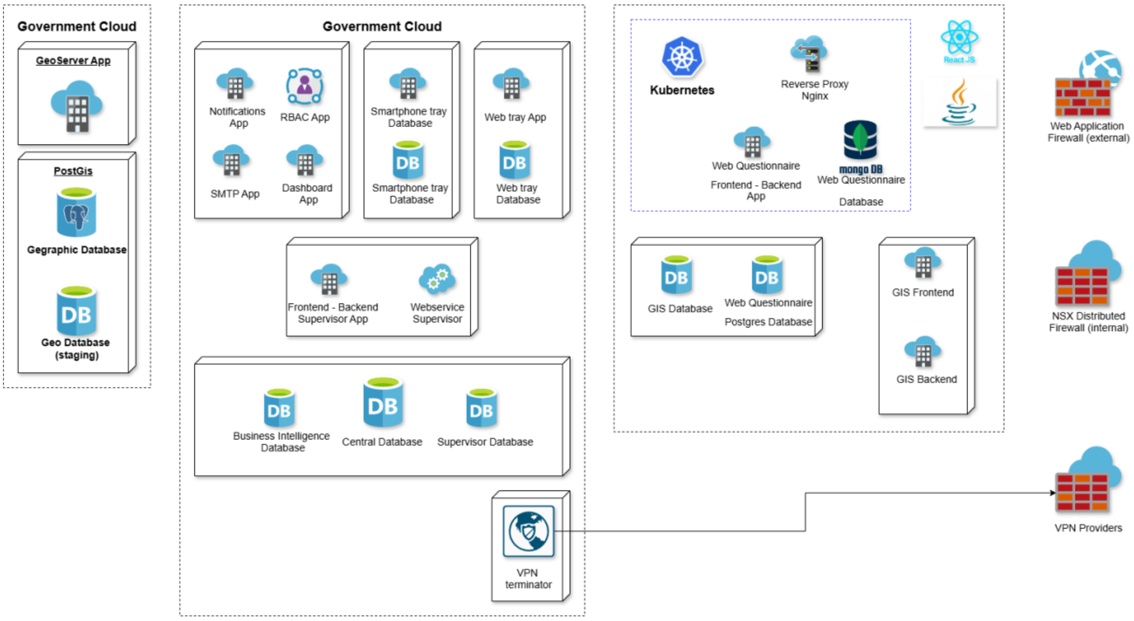

Figure 2: High-level system architecture supporting Uruguay's 2023 Digital Census. The diagram illustrates a cloud-based, modular infrastructure composed of multiple environments, including geospatial services, census management applications, and web questionnaire platforms. Core components include backend and frontend services, database systems for census and GIS data, and integration layers deployed within a Kubernetes environment. Security is ensured through multiple firewall layers (external web application firewall and internal distributed firewall) and controlled access via VPN gateways. The architecture enables scalable data collection, processing, and monitoring of census operations.

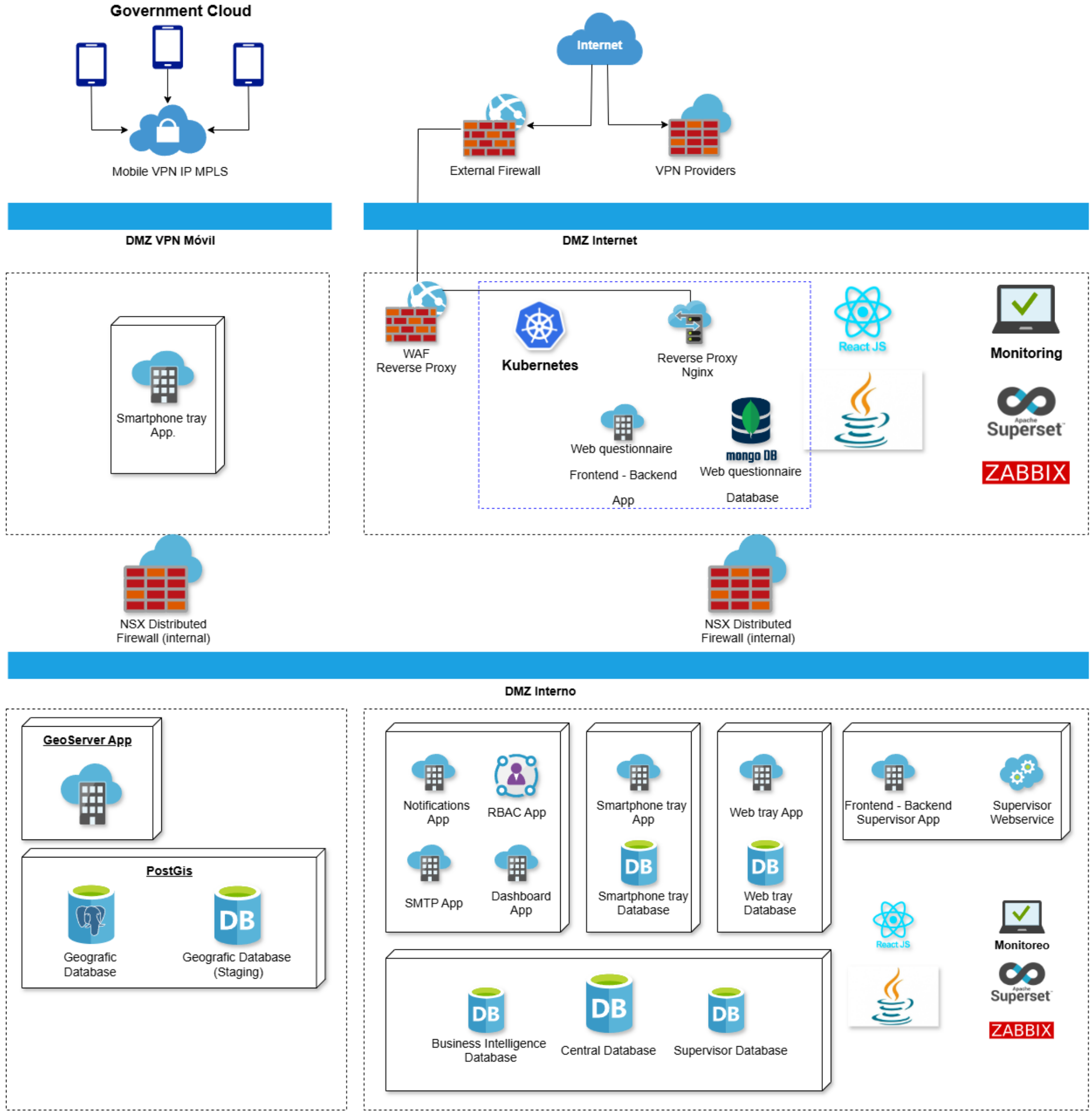

Figure 3: Detailed network and system architecture of the digital platform supporting Uruguay's 2023 Census. The diagram shows a multi-layered infrastructure organized across secure zones, including mobile VPN access, external internet-facing services (DMZ Internet), and internal systems (DMZ Interno). User access flows through external firewalls, VPN providers, and a web application firewall (WAF) into a Kubernetes-based environment hosting the census web questionnaire and associated backend services. Internal layers include application servers, geospatial services (GeoServer and PostGIS), operational databases, and business intelligence systems. Security is reinforced through distributed internal firewalls, while monitoring and analytics tools (e.g., Zabbix and Superset) support system performance and operational oversight.

The five-domain logical architecture separated citizen-facing components (questionnaire frontend in React.js, backend in Java, with MongoDB for high-speed response storage) from internal government systems (PostgreSQL-based analytical databases, GeoServer for spatial data, RBAC for access control) via controlled interfaces. This separation served both security and scalability objectives. Citizen-facing components could scale horizontally through Kubernetes pod replication without affecting or exposing internal systems.

The system was specified to handle 50,000 concurrent users — deliberately set well above anticipated peak demand. Load and stress testing prior to launch simulated high concurrent usage scenarios. Three independent rounds of ethical hacking were conducted: one targeting the CAWI platform, one targeting the field enumerator communication network, and one targeting cloud data storage. The platform achieved ISO 27001 certification following independent security audit. All data transmission used TLS 1.3 encryption; data at rest was encrypted with AES-256.

Throughout the 24-day CAWI period (April 29 to May 22), the platform processed an average of approximately 28,000–30,000 household submissions per day, with a peak of 75,000 on a single day, without system degradation or interruption. This operational performance validated the architecture choices.

4.2 Mobile-First Interface Design

The decision to optimize the CAWI interface for smartphone users was made explicitly and early in the design process, on the basis that smartphone penetration in Uruguay exceeded desktop computer ownership, particularly in lower-income households whose census participation was historically lower. A specialized usability firm conducted user experience testing throughout the design process, and the questionnaire underwent successive refinement through pilot tests (web usability pilot in July-August 2021; field pilot in November 2021; experimental census in October-November 2022) before the final version was deployed.

The questionnaire comprised 82 questions organized in nine thematic sections, designed to be completed in approximately 30 minutes. As shown in Figure 4, the questionnaire design was guided by six main usability criteria, including simplicity, responsiveness, concise wording, limited help features, simplified alerts, and accessibility. Progressive disclosure principles presented one question or a small related cluster at a time (Figure 5). Touch targets were sized for finger input. Mobile-native form controls were used throughout. Multi-level help was embedded at the question level through expandable information icons, accessible without navigating away from the questionnaire. Real-time validation flagged inconsistent or implausible entries immediately. A save-and-resume feature preserved progress across devices and sessions.

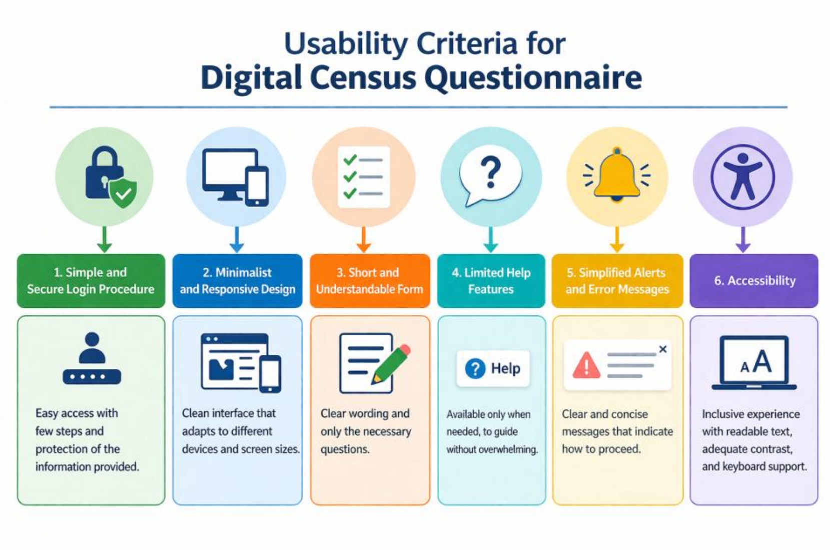

Figure 4: Usability criteria applied in the design of Uruguay's 2023 digital census questionnaire. The diagram summarizes six key principles: (1) a simple and secure login procedure, (2) a minimalist and responsive design adaptable to multiple devices, (3) a short and understandable form, (4) limited and context-specific help features to avoid user burden, (5) simplified alerts and error messages to guide completion, and (6) accessibility to ensure an inclusive user experience.

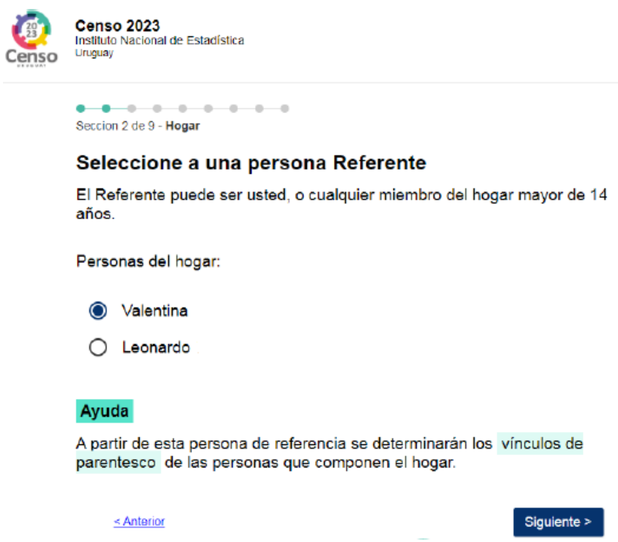

Figure 5: Screenshot of Uruguay's 2023 digital census questionnaire interface, illustrating the platform's clean, minimalist, and user-friendly design. The form presents a simple household reference-person selection screen with clear instructions, limited response options, a visible progress indicator, contextual help, and straightforward navigation buttons. These features reflect the questionnaire's emphasis on usability, accessibility, and ease of completion across digital devices.

The outcome validated the design choice; 75% of all CAWI responses were completed on smartphones, 20% on desktop computers, and 5% on tablets. A desktop-optimized interface with mobile as an afterthought would have created a systematic participation barrier for the demographic groups (younger, lower-income urban residents) most likely to use smartphones as their primary internet access device and most historically underrepresented in traditional census operations.

4.3 Real-Time Monitoring

An operations and monitoring center was established throughout the census period, monitoring real-time dashboards of system performance metrics, geographic coverage rates, and submission volumes. This operational infrastructure served three functions: technical performance monitoring (enabling the team to detect and address emerging capacity constraints before they affected users); geographic coverage monitoring (enabling targeted deployment of additional communication resources to areas of below-expected participation); and user support (a routing system directed technical questions to IT specialists, content questions to subject matter experts, and general inquiries to customer service staff).

The user support function was substantial. The census call center (0800-2023, operational 12 hours per day, 7 days per week) received over 54,000 inquiries during the census period, with peaks exceeding 1,400 per day. The most common inquiries involved authentication difficulties (primarily users who could not locate their UTE meter number), questionnaire content questions, and requests for the completion code after finishing the questionnaire. A structured response system categorized inquiries in real time, enabling the conceptual area team to update online help content and communication messages in response to observed confusion patterns.

5. Communication Strategy

5.1 Strategic Framing and Budget Allocation

Uruguay allocated approximately 9% of the total census budget to communication. This allocation reflected an explicit strategic judgment, documented in the census methodology [1, 14], that in a CAWI-primary census the communication campaign effectively performs the function that field enumerators perform in a traditional census. It initiates, motivates, and sustains the participation behavior that generates the data. This framing (communication as operational infrastructure rather than ancillary activity) had consequences for how the campaign was designed, managed, and resourced.

The 9% figure included both paid media placement and the estimated value of public service airtime donated by media partners. The combination of purchased and donated space allowed coverage at this budget share to reach an estimated 99% of the target population.

5.2 Phased Campaign Design and Timeline

The communication campaign began approximately two years before the census enumeration, following a phased structure aligned with operational milestones.

An institutional sensitization phas**e** (approximately two years before) targeted decision-makers and institutional leaders rather than the general public. INE teams visited parliamentary committees, met with party leaders across the political spectrum, and engaged ministries, intendancies (departmental governments), and municipalities. This phase secured cross-party political endorsement and opened channels for institutional partnerships. It also established a norm of transparent public communication about census complexity (setting realistic expectations about an operation that, however well executed, cannot achieve 100% coverage) to reduce the risk of public criticism when inevitable operational imperfections emerged.

A recruitment and pre-census awareness phase (3–6 months before) began public-facing communication with messages directed at potential census workers and, secondarily, building general public awareness of the upcoming census.

A CAWI launch campaign (2 weeks before the online window opened) marked the transition to intensive public outreach. Television spots aired multiple times daily during prime viewing hours. Radio advertisements covered commercial, community, and public stations. Digital advertising saturated major social media platforms. The messaging was concrete and action-oriented, emphasizing the three items needed to authenticate (meter number, identity document, mobile phone or email) and the 30-minute completion time.

During the CAWI window (April 29 to May 22), communications maintained pressure through daily updates on participation progress, social norm messaging ("join your neighbors"), and progressive urgency as the deadline approached. A "false closing" event generated a distinct participation surge of 75,000 submissions on a single day. The final days of the CAWI window were framed as the last opportunity to complete the census without a household visit, a framing designed to motivate procrastinating households by making the opportunity cost of non-response concrete.

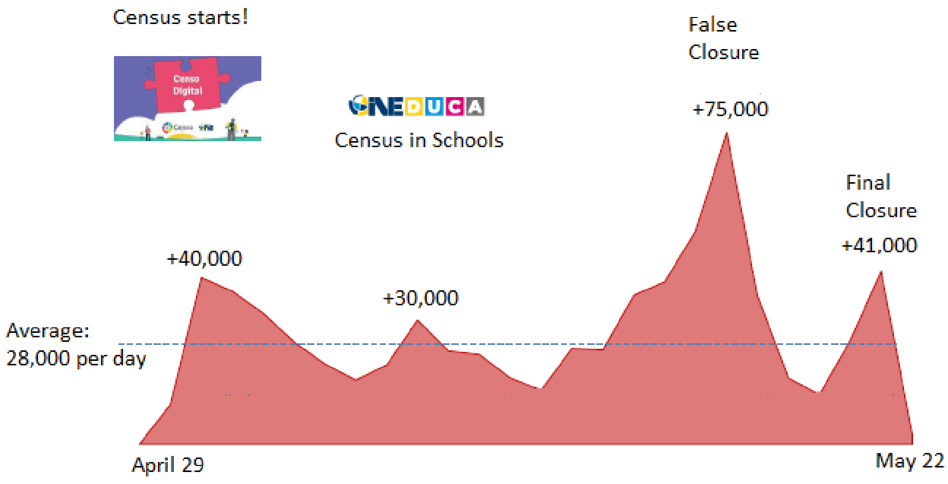

Figure 6: Daily number of online census (CAWI) responses in Uruguay between April 29 and May 22, 2023. The figure highlights key communication milestones, including the launch of the digital census and the "Census in Schools" initiative, and their impact on response volumes. Daily submissions averaged approximately 28,000, with notable peaks following major

outreach events and announcements, including a surge associated with the announced "false closure" (~75,000 responses) and a final increase at the official closing (~41,000 responses).

A transition phase (final week of CAWI window) prepared households for field enumeration, reminding those who had completed online to retain their completion code and informing those who had not that field enumerators would visit shortly.

5.3 Channel Strategy and Quantitative Scope

The campaign deployed across all available media and institutional channels. On the paid media side: 4 hours per day on average of purchased radio and television time across the CAWI period, 28 distinct audiovisual pieces produced, and 13 radio advertisements. An average of 4 hours per day of paid advertising on radio and television provided sustained presence beyond the campaign spikes associated with individual events.

Mass messaging channels reached the addressable population directly. SMS messages to all mobile phone subscribers via telecommunications operators; email to all public servants via the civil service system; and census information inserted into UTE electricity bills sent to every connected household.

A behavioural economics element was included in the communications campaign. Households that completed the census online were entered into a lottery to win one year of free electricity service, as well as mobile phone prizes. This incentive, promoted through all campaign channels, provided a concrete material motivation supplementing civic obligation framing — particularly effective in reaching households that were capable of completing online but had not yet prioritized doing so.

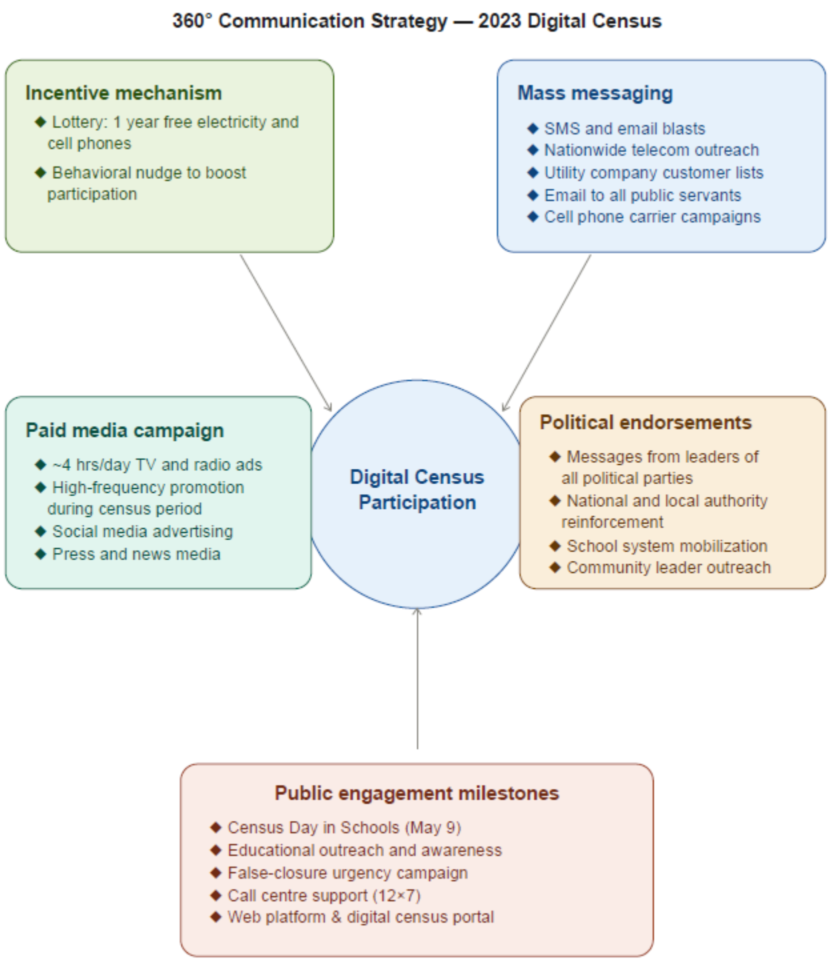

Figure 7: 360° communication strategy implemented for Uruguay's 2023 Digital Census. The diagram presents five coordinated components aimed at maximizing online participation: (1) an incentive mechanism offering a lottery of one year of free electricity and cell phones, (2) large-scale mass messaging through SMS and email campaigns, (3) intensive paid media advertising on television and radio, (4) political and institutional endorsements reinforcing trust and legitimacy, and (5) key public engagement milestones such as "Census Day in Schools." All components jointly contributed to increasing digital census response rates.

Institutional partnerships multiplied reach through established, trusted channels. Key partners included: UTE (electricity bills, account communications); all mobile operators in Uruguay (SMS); the Ministry of Education (Census Day in Schools, May 9, mobilizing the entire primary and secondary school system nationwide); the National Civil Service Office (ONSC, reaching public employees); UNFPA (international technical validation and public endorsement); and political leaders of all major parties who actively encouraged participation through their own communications.

A 12-hours-per-day, 7-days-per-week call center operated resolved technical and content queries throughout the census period. The call center served simultaneously as a user support service, a real-time source of intelligence about public confusion (which informed content updates), and — for callers who reached the center with partially completed questionnaires — a direct completion facilitation mechanism.

6. Results

6.1 CAWI Participation Rate and Device Usage

The 2023 census achieved 60% CAWI participation — meaning that 60% of all households completed the census questionnaire entirely through the online platform during the CAWI window or the subsequent recovery phase, without requiring in-person interview. This represents the highest CAWI participation rate achieved by any Latin American country in a national census to date (Table 1), and is comparable to developed-country first-attempt benchmarks.

Of total CAWI responses, 75% were completed on smartphones, 20% on desktop computers, and 5% on tablets. The smartphone share substantially exceeded initial expectations and validated the mobile-first design decision. The average questionnaire completion time was approximately 30 minutes, consistent with design targets.

6.2 The Communication–Participation Relationship

The daily submission data from the CAWI period provides unusually direct evidence of the communication–participation relationship. During the 24-day CAWI window (April 29 to May 22), daily submissions averaged approximately 28,000 households (minimum approximately 9,500 per day on low-activity days).

Four identifiable communication events generated discrete submission surges that are clearly visible in the daily series (Figure 6 above):

- Census launch (April 29, evening): The platform opened at 9pm. Initial surge to approximately 40,000 submissions.
- Census Day in Schools (May 9): Nationwide school activities with students as household messengers; subsequent surge to approximately 30,000 submissions.
- "False closing": Announcement of an imminent deadline (subsequently extended); surge to 75,000 submissions on the peak day — approximately 5% of all households in Uruguay completing the census in a single day.
- Final closing (May 22): True deadline messaging; surge to approximately 41,000 submissions.

The directness and immediacy of this relationship — visible within hours of each campaign event — provides the clearest available evidence that communication investment translated into participation behavior. It also suggests a testable hypothesis. Submission volumes on days without major campaign events converged to a "baseline" rate determined by residual awareness and ongoing low-level media presence, while campaign events produced multiplicative surges above this baseline. The consistent shape of the response curve across four distinct events, with surges appearing within hours and decaying over subsequent days, is consistent with a model in which each campaign event activates a pool of households in a "capable but not yet motivated" state.

This pattern has a direct implication for campaign design. The concentration of major campaign events near the deadline (the "false closing" and final closing events generated the two largest single-day submission counts) suggests that urgency framing is particularly effective at converting this latent pool, consistent with behavioral economic principles regarding deadline salience.

6.3 Geographic Variation

Geographic variation in CAWI participation reveals the influence of digital access gradients that are not primarily attributable to platform or communication factors. While the national average was 60%, CAWI participation in rural areas reached approximately 30% — still substantially above the rate that would be expected given conventional assumptions about rural digital census participation. Urban areas averaged closer to the national figure, with some variation by municipality that roughly tracked internet penetration rates.

This geographic pattern has two interpretations. On one hand, the 30% rural CAWI rate represents a substantial achievement relative to typical developing-country rural digital engagement, and likely reflects the combination of mobile network coverage (the design choice to fully optimize for smartphones, which are more widespread than fixed broadband in rural areas), the communication campaign's deliberate inclusion of radio (the dominant rural medium), and the awareness-building work of field enumerators who, when visiting rural areas, encouraged households with internet access to complete online before or instead of the in-person interview. On the other hand, the rural–urban differential underscores that the CAWI-primary strategy necessarily creates differential mode experience across the population, with implications for potential mode effects on data quality (a point we return to in section 7.2).

6.4 Data Quality

Several data quality indicators support the conclusion that CAWI responses were of comparable or superior quality to CAPI responses across assessed dimensions. The design choices (real-time consistency validation, skip logic, and embedded help) reduced logical error rates relative to the 2011 census. The automatic geocoding via meter number authentication produced higher spatial precision than address-based geocoding in prior census rounds. The call center received approximately 54,000 inquiries over the census period, providing evidence of active engagement rather than passive participation, and the monitoring team was able to update help content and clarify confusing questions in response to observed inquiry patterns.

The questionnaire's 82-question scope, completed in approximately 30 minutes on average, resulted in low abandonment rates.

7. Discussion

7.1 Factors and Their Relative Contributions

The four factors identified in section 1 — electricity meter authentication, mobile-first platform, communication campaign, and pre-census frame validation — contributed to the 60% outcome and interacted with each other in important ways.

The electricity meter authentication mechanism addressed what the UN framework identifies as the most fundamental requirement for a successful CAWI census: a reliable, household-level identifier enabling authentication and geocoding. Without this mechanism, the platform would have required manual address entry (introducing geocoding errors) and lacked the duplicate-prevention architecture that made the 60% figure meaningful. This element is therefore best understood as a necessary condition rather than a sufficient one. It solved the structural problems that have limited CAWI in other developing-country contexts, but participation required active motivation.

The mobile-first design was similarly enabling rather than causal. It removed a participation barrier that would otherwise have systematically disadvantaged smartphone users. The 75% smartphone share of CAWI responses indicates that without genuine mobile optimization, a substantial fraction of the population would have faced material difficulty completing the questionnaire. Design quality matters. The usability testing conducted across three rounds of pre-census validation produced a questionnaire that reached its 30-minute completion target and generated low abandonment rates.

The communication campaign was the most directly activating factor. The daily submission data demonstrates that CAWI participation was not primarily driven by households independently deciding to participate; it was driven by specific campaign events that converted households from a latent capable-but-inactive state to active completion. Without the campaign investment, the structural enabling conditions (authentication, mobile design) would have been present but participation would likely have been far lower — perhaps comparable to countries where CAWI options exist but are not actively driven to participation by intensive communication.

The pre-census frame validation served a different role. It was primarily operational, enabling the coverage monitoring that allowed the operations center to identify and respond to geographic participation gaps in near-real time. Its contribution to the 60% figure is less direct but non-trivial. Without an accurate baseline frame, the geographic targeting of additional communication and field resources during the CAWI window would have been impossible.

7.2 Limitations and Open Questions

Several limitations of the current analysis warrant acknowledgment. Most importantly, we cannot provide a formal causal estimate of the contribution of individual factors to the 60% outcome, as there is no control condition. The observed communication–participation correlation in the daily submission data is consistent with a causal interpretation but does not rule out confounding by day-of-week patterns, media coverage unrelated to INE campaigns, or social multiplier effects that the data do not allow us to disentangle.

The geographic variation in CAWI participation (approximately 30% rural versus 60% national average) raises the question of whether CAWI and CAPI modes may produce systematically different responses for some variables. Urban households that self-completed online differ from rural households enumerated by field enumerators not only in their census mode but in a range of social and economic characteristics. Assessing mode effects requires a methodological analysis beyond the scope of this paper, and we flag this as an important area for future work; particularly as other countries consider whether to adopt CAWI-primary strategies that will similarly produce mode variation correlated with geography and socioeconomic status.

Finally, the lottery incentive (one year of free electricity service and mobile phones for CAWI respondents) introduces a behavioral economics element whose effect is difficult to separate from the broader communication campaign. International evidence on survey incentives suggests that material incentives can increase participation by several percentage points, although the magnitude of the effect varies by survey mode, target population, and incentive design, and the specific effect in this context is unknown [24].

7.3 Transferability: Prerequisites and Sequencing

The transferability question requires distinguishing between elements that reflect Uruguay-specific conditions and those with broader applicability. Uruguay possessed several specific advantages. A state-owned electricity utility with near-universal coverage; a national identity number in continuous use since 1914; an e-government infrastructure (ANTEL, AGESIC) supporting secure inter-institutional data sharing; and an institutional development trajectory that had built data-sharing relationships over several years before the census.

Countries without state-owned electricity utilities with near-universal household coverage cannot directly replicate the UTE-based authentication approach. However, analogous approaches are feasible wherever a utility, government agency, or other institution maintains a near-universal household database: postal services in countries with high mail service coverage, water utilities, national health insurance enrollment databases, or, in some contexts, voter registration rolls. The technical and institutional requirements are significant but not extraordinary.

The mobile-first design imperative is universally applicable. In any country where smartphones are the dominant internet access device, which describes most of the developing world, census platform design should treat mobile as the primary interface rather than an adaptation of a desktop design.

The communication investment logic is similarly universal. The evidence from Uruguay's daily submission data supports a general principle. CAWI participation in a voluntary census is driven primarily by active motivation, and motivation requires sustained, intensive communication at a budget share that many national statistical offices currently treat as excessive. Countries allocating 2–3% of census budgets to communication should expect proportionally lower CAWI participation, controlling for other factors.

The sequencing of infrastructure investment is critical and deserves emphasis. Uruguay's electricity meter authentication capability, its pre-census cartographic infrastructure, its SIREE-based data integration platform, and its institutional relationships with UTE, ANTEL, and other partners were all products of investment decisions made years before the 2023 census. The lead time between investment and operational capability is long — on the order of 5–10 years for the full infrastructure stack. Countries that have not yet begun this development cycle face a gap of potentially a decade before they can replicate Uruguay's outcomes. The appropriate response is not to defer investment until the pre-census period but to begin institutional and technical development immediately, building the preconditions for the census round that follows.

Table 2. Prerequisites for CAWI implementation at the Uruguayan scale: an assessment framework

Prerequisite	Uruguay 2023	Assessment for adaptation
Household register with ≥95% coverage	UTE meter database, validated at 99%	Analogous databases (postal, water, health) may substitute in other countries
Unique household authentication credential	UTE meter number on monthly bill	Any credential universally held and routinely consulted
Mobile-first platform, ISO 27001 certified	Yes; 75% smartphone completion	Applicable universally in smartphone-dominant contexts
Communication budget ≥5% of total	9% including public service value	Requires political commitment to treat communication as operational infrastructure
Pre-census frame validation	98.3% urban zone coverage	Feasible wherever mobile field teams can be deployed systematically
Operations center with real-time monitoring	Centralized	Key is coverage monitoring capability

8. Conclusions

Uruguay's 2023 Population Census achieved 60% CAWI participation, establishing a new regional benchmark in Latin America and demonstrating that high digital census participation is achievable on a first large-scale implementation in a developing country. The result reflected the convergence of four interacting factors: a near-universal household register (UTE electricity meter database) that solved authentication, geocoding, and frame monitoring challenges simultaneously; a mobile-first platform optimized for smartphone users who constituted 75% of CAWI respondents; a phased communication campaign representing 9% of total census budget that demonstrably drove participation through identifiable campaign events; and a pre-census cartographic operation that produced an accurate and verified address frame enabling real-time coverage monitoring.

Three findings have direct implications for census practitioners. First, the daily submission data provides unusually direct evidence that communication investment activates CAWI participation. This quantifies the operational return to communication investment and supports the recommendation of 5–10% budget allocation for this purpose. Second, the 75% smartphone share of CAWI responses validates the mobile-first design choice and implies that platforms optimized for desktop use impose a systematic participation barrier in smartphone-dominant populations. Third, the rural–urban geographic gradient indicates that CAWI-primary strategies create mode variation correlated with socioeconomic characteristics, an important consideration for data quality assessment and for countries designing communication and field operations around a CAWI-primary model.

The path to replication for other developing countries is neither trivial nor impossible. It requires sustained institutional investment in data integration infrastructure, inter-agency data-sharing relationships, and digital platform capabilities — on a timeline of years, not months — combined with the strategic commitment to treat communication as operational infrastructure rather than overhead. Countries that begin this investment cycle now will be positioned to achieve comparable results in the 2030 census round.

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