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The Invisible Users: Gender-Differentiated UX Failures in Municipal Digital Services and the Child-Rearing Penalty in Public Information Access

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ABSTRACT

Public digital services operate under an assumption of universal accessibility that empirical evidence rarely supports. This paper investigates a specific and underexamined dimension of public sector UX inequity: the structural disadvantage experienced by child-rearing women when navigating municipal web portals designed, implicitly, for unhurried, PC-based browsing. In a study conducted with a Japanese municipality undergoing web portal redesign, a behavioral targeting methodology was used to survey task-motivated citizens — those who had demonstrated active information-seeking behavior on the portal. The resulting dataset exposed a pronounced and statistically significant gender gap in service experience. The overall Net Promoter Score (NPS) was –52.3, but disaggregation by demographic segment revealed a critical disparity: women reported an NPS of –58.1, with women in their thirties registering –73.8 and women in their forties registering –62.3. Journey map and qualitative analysis identified the cognitive mechanism underlying this gap: female users in child-rearing years accessed the portal predominantly via smartphone, in time-constrained contexts, seeking specific procedural information. The portal's architecture — optimized for desktop browsing at an unhurried pace — imposed a disproportionate cognitive load on this segment, consistent with established Cognitive Load Theory. A subsequent redesign prioritizing smartphone-first architecture and simplified navigation hierarchies produced the strongest satisfaction improvements among precisely the groups previously most disadvantaged. This paper introduces the concept of the "child-rearing penalty" in public digital services — the measurable experiential disadvantage imposed on time-constrained caregivers by systems designed for average, unhurried users — and proposes gender-disaggregated UX analysis as a methodological prerequisite, rather than a supplementary step, in public sector human-centered design.

Keywords: Inclusive design, Gender and UX, Cognitive load, Municipal digital services, Citizen experience, Human-centered public sector design

INTRODUCTION

The design of public digital services is frequently described in terms of universality: portals are built to serve all citizens, guidelines mandate accessibility compliance, and redesign projects invoke the language of inclusion. In practice, the aggregation of diverse user populations into a single design target tends to

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produce systems calibrated for a hypothetical average user who, in contexts of genuine demographic heterogeneity, corresponds to very few actual citizens.

Human Factors research has long recognized that design for the average conceals systematic disadvantage for those whose characteristics, behaviors, or contexts of use deviate from the assumed norm (Clarkson, Coleman, Keates, & Lebbon, 2003). The same dynamic applies in digital contexts, though the exclusion mechanisms are cognitive and informational rather than physical.

This paper presents findings from a Japanese municipality's web portal evaluation and redesign project, in which gender-disaggregated satisfaction data revealed a pattern of systematic service disadvantage affecting women, particularly those in child-rearing years. The findings are not attributable to individual design oversights but to a structural mismatch between the portal's implicit user model — desktop-based, unhurried, browsing-oriented — and the actual context in which a significant portion of its users needed to interact with it: mobile, time-pressured, and task-specific.

The paper makes two principal contributions. The first is empirical: a demonstration, with granular NPS and behavioral data, of how gender-undifferentiated design produces measurable disparities in public service experience. The second is conceptual: the introduction of the "child-rearing penalty" as a diagnostic construct for identifying and addressing the particular disadvantage experienced by time-constrained caregivers in systems designed for average, unhurried users.

THEORETICAL BACKGROUND

Gender, Technology Adoption, and Digital Service Use

Research on gender differences in digital service use has consistently shown that adoption decisions and usage patterns diverge not because of capability differences but because of the interaction between design characteristics and socially patterned contexts of use (Van Dijk, 2006). For public digital services — which citizens typically have no choice but to use — gender-based access barriers constitute a form of involuntary service failure rather than a voluntary adoption decision, a distinction with significant implications for institutional accountability.

The specific intersection of gender, caregiving, and digital service use has received limited systematic attention in the Human Factors literature, despite the well-documented association between child-rearing responsibilities and time scarcity, particularly among women in their thirties and forties (Bianchi, Robinson, & Milkie, 2006). This population tends to interact with government services in contexts characterized by high task urgency, limited time, frequent interruption, and dependence on mobile devices — conditions that amplify the experiential cost of poor information architecture and inadequate mobile optimization.

Cognitive Load and Time-Constrained Information Seeking

Sweller's (1988) cognitive load theory distinguishes between intrinsic load — the inherent complexity of the content being processed — and extraneous load, which is a function of presentation format and navigation design and

can, in principle, be reduced through improved interface design. In public information portals, the relevant concern is extraneous load: the cognitive overhead imposed by a poorly structured information architecture on users who are already operating under the resource constraints of time pressure and task urgency.

Paas, Renkl, and Sweller (2003) synthesized evidence that extraneous cognitive load is particularly damaging to task performance when users are operating under cognitive resource depletion — including time pressure, multitasking, and attentional fragmentation. The smartphone form factor compounds this dynamic: Hoehle and Venkatesh (2015) identified navigation efficiency and visual information density as the primary determinants of mobile usability, with mobile users significantly less tolerant of informational complexity and navigational friction. For citizens accessing a government portal under competing demands — a child in the room, a deadline approaching, a smartphone as the only available device — the extraneous load imposed by a poorly structured architecture can push total cognitive load past the threshold of effective task completion.

Inclusive Design and the Limits of Average-Based Practice

Inclusive design foregrounds the identification of specific excluded groups and the mechanisms of their exclusion, rather than applying generic accessibility standards (Persson, Åhman, Yngling, & Gulliksen, 2015). This distinction is methodologically significant here: compliance with established web accessibility guidelines addresses a defined set of physical access barriers but does not address the cognitive and contextual barriers that produce the gender disparities documented in the present study. Evaluation methods that produce only aggregate satisfaction data are structurally incapable of detecting this form of inequity.

METHODOLOGY

Study Context

The study was conducted within a municipal web portal redesign project in Japan. The municipality serves a demographically diverse citizen population, with substantial proportions of family-age residents and correspondingly high demand for child welfare, educational, and daily life information services. Prior to the study, the portal had received sustained citizen feedback indicating poor usability, concentrated particularly in the areas devoted to welfare, childcare, and residential services — the categories of greatest relevance to the population subsequently identified as most disadvantaged.

Behavioral Targeting and Survey Administration

A behavioral targeting protocol was implemented through a real-time analytics platform integrated into the portal infrastructure. Survey eligibility was triggered by a scroll depth threshold indicating purposeful, task-motivated engagement. The NPS survey instrument was supplemented by

demographic items (age range, gender) and a visit purpose item allowing respondents to self-categorize their visit goal.

The protocol yielded 561 valid responses: 240 male respondents (42.8%) and 321 female respondents (57.2%). Among female respondents, 87 were in their thirties and 74 were in their forties — the two cohorts identified in the analysis as most severely disadvantaged. This design enabled disaggregation of NPS data by demographic segment and visit purpose, producing the gender and age-stratified findings reported below. The behavioral targeting methodology is described in fuller detail in a companion paper (Nishina, 2026a).

Journey Map Analysis

Journey maps were constructed for demographically distinct user segments, with particular attention to differences in device type, visit purpose, and navigation path between male and female users. The journey map framework followed Rosenbaum, Losada Otalora, and Contreras Ramírez (2017), supplemented by session-level behavioral data to identify the specific navigation points at which male and female users diverged in task completion rates. Qualitative analysis of open-comment survey responses was conducted using thematic coding, with themes derived inductively from the data and validated by independent rater agreement.

RESULTS

Overall NPS and Demographic Disaggregation

The aggregate NPS across the behaviorally-targeted survey sample was –52.3, confirming a strongly net-negative citizen experience. Disaggregation by gender revealed a significant disparity: male users (n = 240) reported an NPS of –44.2, while female users (n = 321) reported -58.1 — a gap of approximately 14 points that aggregate analysis would have obscured entirely. Further disaggregation by age produced the study's most striking finding: women in their thirties (n = 87) reported an NPS of –73.8, and women in their forties (n = 74) reported –62.3. These values are not merely low; they represent a level of service failure functionally equivalent to systematic exclusion from effective access.

These scores were not distributed uniformly across portal sections. Users visiting the "Health, Welfare, and Child-Rearing" category reported NPS values above the site average, suggesting that the content in this area was valued by those who found it. The severe overall dissatisfaction among women in child-rearing years was attributable not to the content itself but to the difficulty of locating and accessing it within the portal's navigation structure — a finding that implicates architecture rather than content quality.

Cognitive Mechanism: Context of Use and Extraneous Load

Cross-referencing NPS data with session-level device logs revealed that female users in their thirties and forties accessed the portal via smartphone at substantially higher rates than male users of comparable age. The portal

had not been optimized for smartphone access; smartphone users reported NPS values 3.8 points lower than PC users overall, a gap amplified among the female, child-rearing-age segment given their disproportionate mobile reliance.

Qualitative analysis of open-comment responses identified a consistent failure pattern in this segment: users knew what information they needed, arrived at the portal with specific task goals, and were unable to locate the relevant content within the time available. This pattern is diagnostic of high extraneous cognitive load in Sweller's (1988) terms: the information architecture imposed navigational friction that consumed cognitive resources required for the task itself. In conditions of time pressure and mobile-only access, this friction proved sufficient to prevent task completion.

Disaggregation of NPS by visit purpose confirmed this interpretation. Users visiting the portal with a specific information-retrieval goal — the purpose category most associated with time-constrained task behavior — reported the lowest NPS of any purpose category. Users visiting for "news and updates," a browsing-oriented behavior pattern, reported higher satisfaction, reflecting the portal's implicit optimization for unhurried browsing rather than directed search.

Gender-differentiated analysis of information needs revealed further structural differences. Male users disproportionately sought new municipal information through open-ended browsing; female users expressed stronger need for rapid access to specific procedural information on childcare, residential services, and welfare entitlements. This divergence in information-seeking mode was not reflected in the portal's information architecture, which presented all content categories with equivalent navigational depth and complexity.

Post-Redesign Outcomes

The redesign prioritized three structural changes derived from the behavioral targeting evaluation: smartphone-first interface architecture, AI-assisted search functionality to reduce dependence on categorical navigation, and structural simplification of the portal areas generating the highest negative feedback among the disadvantaged segment. Post-launch citizen feedback confirmed improvements across the targeted dimensions. Notably, the strongest positive feedback — specifically commending improvements in visual clarity, simplified navigation, and search performance — was concentrated among the demographic groups that had previously reported the most severe service failure. This distributional pattern is consistent with the inclusive design literature's finding that improvements targeted at the most disadvantaged users tend to produce gains for the entire user population (Clarkson et al., 2003).

DISCUSSION

The Child-Rearing Penalty in Public Digital Services

The concept of a structural penalty imposed on specific groups by institutional design has precedents in both employment research — where Correll, Benard, and Paik (2007) documented a measurable wage and hiring disadvantage associated with motherhood — and in accessibility research, where barriers

to physical participation by disabled users are treated as institutional rather than individual failures. The present study extends this logic to digital public information access.

The "child-rearing penalty," as formulated here, refers to the measurable experiential disadvantage — quantifiable in NPS terms — imposed on citizens in time-constrained caregiving contexts by public digital services implicitly designed for unhurried, desktop-based users. This disadvantage is not a consequence of individual technical deficiency or lack of motivation. It is a structural product of design choices that aggregate user needs into a single model whose assumed user is effectively male, PC-based, and not operating under time pressure.

The penalty is detectable only through demographic disaggregation of satisfaction data. Aggregate NPS measures, random-sample surveys, and standard usability audits produce no signal from which it can be inferred. Its systematic invisibility in conventional evaluation practice is, in itself, a finding: public sector UX evaluation frameworks must be extended to include demographic disaggregation as a standard analytical step, not an optional refinement.

Implications for Public Sector Inclusive Design Practice

The inclusive design literature has historically emphasized physical and sensory accessibility, with cognitive accessibility receiving attention primarily in the context of users with defined cognitive impairments. The findings of this study argue for an expansion of inclusive design practice to encompass contextual accessibility — the degree to which a service is accessible to users operating under conditions of time pressure, mobile device dependency, and attentional fragmentation. This expansion is particularly urgent for local government services, where the citizen populations most dependent on procedural information are disproportionately composed of parents, caregivers, and others operating under precisely these contextual constraints.

Persson et al.'s (2015) distinction between inclusive design and accessibility compliance is directly relevant. Compliance with established web accessibility guidelines is necessary but not sufficient for contextual accessibility. The portal examined in this study was compliant with applicable accessibility standards; its failure was not one of standards violation but of user model impoverishment. Designing for a richer, demographically-differentiated user model, informed by behavioral data and demographic disaggregation, is the practical implication of these findings for public sector design practice.

Limitations

The study is based on a single Japanese municipality, and the demographic composition of the affected user segment may not generalize to other national contexts where caregiving responsibilities are distributed differently between genders. The NPS instrument, while producing clear and interpretable disparity data, does not capture the full texture of the user experience; contextual inquiry with users in child-rearing situations would enrich the

findings considerably. Future research should investigate whether the child-rearing penalty replicates across different government service types and whether it interacts with other demographic characteristics — income, educational attainment, and linguistic background, in particular.

CONCLUSION

This paper has documented a structural pattern of gender-differentiated service failure in a Japanese municipal web portal, driven by the mismatch between a design user model calibrated for unhurried, PC-based browsing and the actual context of use of a significant and identifiable user population. The child-rearing penalty — an NPS gap of nearly 30 points between women in their thirties and the male user average — is not an anomaly but a predictable consequence of average-based design practice applied to a demographically heterogeneous user population.

The methodological implication is direct: aggregate satisfaction measurement is insufficient for equitable public service design. Behavioral targeting and demographic disaggregation should be standard components of any evaluation framework applied to public digital services, not optional refinements reserved for well-resourced agencies. The conceptual implication is equally direct: inclusive design in the digital public sector must extend beyond physical and sensory accessibility to encompass the contextual accessibility needs of time-constrained caregivers — the invisible users whose service failures have, until now, been invisible precisely because the evaluation tools employed were not designed to find them.

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