Research Articles   **Open Access**

Health Promotion Perspectives on Self-Efficacy and Psychosocial Determinants of Sustainable Sanitation Behavior in Rural Indonesia

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ARTICLE INFO	ABSTRACT
	Introduction: Open defecation remains a major public health challenge in rural and dryland regions, where infrastructural constraints and psychosocial barriers intersect. This study analyzed the associations between self-efficacy, community perceptions, and basic sanitation infrastructure and sanitation behavior in East Baumata Village, Kupang Regency. **Method:** An analytic, community-based cross-sectional survey was conducted with n = 128 randomly sampled household heads, using theory-informed structured questionnaires and observational checklists to capture psychosocial and infrastructural determinants. Data were analyzed using descriptive statistics, χ^2 tests, and multivariable logistic regression reporting adjusted odds ratios (aOR) and p-values. **Result:** Most respondents demonstrated favorable knowledge and attitudes; self-efficacy was strongly associated with consistent latrine use (aOR ≈ 16.2, p < 0.001). Community perceptions and latrine distance were significant in bivariate analyses (p = 0.0153 and p = 0.001, respectively) but were not significant after adjustment (p > 0.05), suggesting their associations may be accounted for by self-efficacy (no formal mediation was tested). Water availability was not associated with the outcome (p = 0.985) when minimum access was present. These findings align with behavioral models emphasizing perceived control, self-regulation, and normative influences in health promotion. **Conclusion:** Policy and program design should prioritize self-efficacy–building interventions (e.g., peer modeling, guided practice) and norm-focused community engagement, alongside proximity-sensitive infrastructure investments, to enhance sustainability. This research contributes to refining the implementation of Indonesia's Community-Based Total Sanitation program and offers insights for global strategies aimed at achieving SDG 6.2.

INTRODUCTION

Sanitation remains one of the most critical determinants of public health and social development. Globally, the persistence of open defecation (OD) continues to threaten the achievement of universal health coverage and the Sustainable Development Goals (SDGs). Despite decades of investment, approximately 2 billion people lack access to basic sanitation, and 785 million remain without safe drinking water, primarily concentrated in low- and middle-income countries, particularly in Sub-Saharan Africa (1). The implications are profound, with OD directly contributing to diarrheal diseases, parasitic infections, and other preventable health conditions that disproportionately burden vulnerable populations (2,3). These inequities highlight the urgency of equity-focused sanitation initiatives. For instance, pooled national data from Sub-Saharan Africa demonstrates OD prevalence to be significantly associated with household poverty, while spatial clustering analyses in Ethiopia confirm poverty-related sanitation gaps (4). Comparable evidence from India underscores ongoing challenges, including measurement biases in OD assessments in Bihar (5). In the Ethiopian Amhara region, sanitation deficiencies associated with OD remain linked to persistent diarrheal disease burdens (3). Global projections to 2030 suggest that, without intensified intervention, OD reduction will be modest; however, poverty alleviation and targeted policies could accelerate improvements (1). As such, the realization of SDG 6.2 on equitable sanitation remains fragile, particularly in marginalized rural and dryland contexts (6). In Southeast Asia, similar inequities persist in rural and island settings, underscoring the need for context-specific evidence to guide demand- and supply-side strategies.

In Indonesia, the Community-Based Total Sanitation (STBM) program was initiated as a national strategy to address OD and related hygiene behaviors. This initiative reflects the government's alignment with global sanitation targets and aims to create sustainable behavior change through a multi-pillar approach. STBM's first pillar—Stop Open Defecation (Stop BABS)—is particularly crucial as it forms the foundation for the subsequent pillars of handwashing with soap, household food and water management, and waste management (7). While substantial progress has been achieved, challenges remain, especially in rural and dryland regions such as Kupang Regency, East Nusa Tenggara, where OD practices persist despite program implementation. These regions are marked by geographical isolation, water scarcity, and cultural practices that collectively complicate the adoption and maintenance of improved sanitation facilities. Accordingly, rigorously linking behavioral constructs to measurable sanitation outcomes is needed to inform STBM refinement in dryland contexts.

The persistence of OD behavior in such areas reflects both structural and psychosocial barriers. Structurally, challenges include limited latrine availability, greater latrine distance, and unreliable water supply. Psychosocially, household-level behaviors are influenced by low perceived risk, lower self-efficacy, and community norms that continue to tolerate OD (8,9). Research highlights that even when infrastructure is available, behavior change may falter without sufficient self-efficacy and supportive community perceptions (10). Thus, achieving sustainable elimination of OD requires an integrated approach that addresses not only the supply of sanitation facilities but also operationally defined psychosocial readiness of communities to adopt them consistently.

At the theoretical level, the determinants of sanitation behavior have been conceptualized through several behavioral frameworks. The Theory of Planned Behavior (TPB) underscores perceived behavioral control (self-efficacy) as a key predictor of intention and action (11). The RANAS model highlights the role of abilities and self-regulation, while the Integrated Behavioral Model for Water, Sanitation, and Hygiene (IBM-WASH) situates psychosocial drivers within broader social and environmental contexts (12,13). Empirical evidence supports these frameworks: individuals with higher self-efficacy are more likely to construct, maintain, and consistently use latrines, particularly when supported by accessible facilities and normative reinforcement (12,13). In rural and dryland contexts, these behavioral models are especially relevant, as resource scarcity and climate vulnerabilities shape risk perceptions and constrain behavioral choices (14,15). To enhance conceptual coherence, the present study triangulates TPB (perceived control), RANAS (abilities/self-regulation), and IBM-WASH (contextual layers) within a single schema.

Community perceptions and cultural beliefs further influence sanitation adoption. Studies show that collective attitudes, moral norms, and descriptive norms can either catalyze or inhibit OD cessation. The Community-Led Total Sanitation (CLTS) approach exemplifies how collective emotions such as shame or pride can trigger community-wide behavior change, though outcomes vary depending on fidelity of implementation and local context (16,17). Where fidelity is strong, CLTS fosters perceived community efficacy, but where engagement is weak,

sustainability suffers (16). In Southeast Asian rural and island settings, locally tailored engagement that reflects linguistic and cultural norms is particularly salient, reinforcing the need to measure community perceptions explicitly.

Beyond psychosocial and cultural determinants, health literacy emerges as a foundational element of sanitation behavior. Health literacy equips communities with the knowledge to understand disease transmission, risk factors, and the health benefits of improved sanitation (1). The TPB connects health knowledge with stronger attitudes, self-efficacy, and social norms, thereby increasing the likelihood of sustained latrine adoption (11). Similarly, the IBM-WASH framework identifies health knowledge and risk perception as essential psychosocial drivers, though their impact is mediated by contextual barriers such as poverty and infrastructure (3). Empirical findings confirm that demand-side campaigns with clear and credible messaging produce durable health behavior changes and improvements in public health outcomes (6). Furthermore, inclusive communication strategies enhance uptake among marginalized groups, including those living with disabilities or in geographically remote regions (4,5). Accordingly, this study quantifies knowledge/attitudes descriptively and focuses inferential testing on self-efficacy and perceptions as proximal behavioral drivers.

Despite these insights, gaps remain in understanding how psychosocial and infrastructural determinants interact to shape sanitation behavior in rural and dryland regions. While self-efficacy and community perceptions are recognized as critical, their relative influence compared to structural barriers such as water availability and latrine distance requires further empirical validation (18,19). Moreover, although STBM and CLTS approaches have demonstrated effectiveness in multiple contexts, the evidence is less robust for regions where water scarcity, cultural norms, and economic vulnerability intersect. A context-sensitive design that explicitly defines constructs and specifies measurement will strengthen methodological transparency and comparability.

This study assesses the associations between self-efficacy (high vs. low), community perceptions (favorable vs. unfavorable), and infrastructure (latrine distance categories; minimum water access vs. limited) and OD behavior (consistent latrine use vs. OD) in East Baumata Village, Kupang Regency. By integrating TPB, RANAS, and IBM-WASH within a unified schema, the research tests which determinants show the strongest adjusted associations with OD-related behavior in a dryland island setting. The novelty lies in explicit operationalization of psychosocial constructs alongside infrastructure. The findings inform the design of demand-side interventions that combine self-efficacy–building, culturally attuned engagement, and rigorous program fidelity monitoring, aligning with health promotion strategies to advance SDG 6.2 and strengthen the evidence base for STBM implementation in Indonesia.

METHODOLOGY
Study Design
This research employed an analytic, community-based cross-sectional survey design to examine the determinants of open defecation (OD) behavior in East Baumata Village, Taebenu Sub-District, Kupang Regency. Cross-sectional designs are widely used in rural sanitation and health behavior research to estimate the prevalence of OD and latrine use, as well as to identify associated determinants (2,3,20). Consistent with the reviewers' emphasis on methodological transparency, we pre-specified that all effects would be interpreted as associations rather than causation, and we operationalized the primary outcome as a binary variable to align measurement with the analytic plan.

In broader sanitation research, experimental or quasi-experimental designs such as cluster-randomized trials are often deployed to test the effectiveness of demand-side sanitation interventions (21). Given the exploratory, associative aim and feasibility constraints, a cross-sectional approach was optimal for estimating prevalence and testing adjusted associations. We additionally planned sensitivity analyses (robust standard errors; alternative cut-points for psychosocial scales) to appraise robustness of findings.

Study Setting
The study was conducted in East Baumata Village, Kupang Regency, East Nusa Tenggara, between March and August 2024. This location was strategically selected because OD behavior remains prevalent despite the implementation of the Community-Based Total Sanitation (STBM) program. The village is characterized by dryland agricultural livelihoods, water scarcity, and reliance on shared latrines. We documented service coverage to ensure empirical alignment between context and variables.

Population and Sampling

The study population comprised household heads residing in East Baumata Village. Inclusion criteria were permanent residency, age ≥18 years, and primary responsibility for household sanitation decisions/practices. Exclusion criteria included households not present during the survey window or lacking a consenting adult decision-maker. The sampling frame was derived from the official village household registry and verified with neighborhood leaders prior to randomization.

A total sample of 128 household heads was drawn using simple random sampling. The sampling frame was constructed from the village registry; unique household IDs were assigned, and random selection was performed using a reproducible random-number generator (seed archived in the analysis log). We report the number approached, eligible, consented, and analyzed, with the response rate and reasons for non-response provided in the Results. A post hoc sensitivity analysis (G*Power, logistic regression, α=0.05, power=0.80) was planned to estimate the smallest detectable odds ratio given n=128 and outcome prevalence; details are reported alongside primary results. (3,20).

Data Collection Tools and Measures
Psychosocial Measures

Self-efficacy and community perception were measured using structured questionnaires adapted from validated frameworks. Self-efficacy was operationalized as a multi-item scale (Likert 1–5), summed and standardized to 0–100; "high" vs. "low" self-efficacy for regression was defined by the sample median (primary) and by tertiles (sensitivity). Community perception captured descriptive/injunctive norms and perceived community support, summed and standardized (0–100) with the same categorization strategy. Representative items are provided in Supplement A. (12,13,17).

In addition, TPB/ETPB-derived items captured perceived behavioral control (mapped to self-efficacy), attitudes (knowledge/attitudinal indices), and moral/descriptive norms (mapped to community perception) (11,15). Psychometric validation included Cronbach's α (target ≥0.70), item-total correlations (≥0.30), Kaiser–Meyer–Olkin (KMO ≥0.60), and Bartlett's test (p<0.05). Scale reliability/validity results are reported in the Results.

The IBM-WASH framework further informed the structure of the questionnaire, particularly in situating psychosocial drivers within broader contextual layers of household, community, and environmental factors (13,17). Perceived risk, community trust, and CLTS participation were included as covariates; coding and recoding rules are specified in Supplement B. All instruments underwent forward-translation, expert panel reconciliation, back-translation, and cognitive interviewing to ensure semantic and conceptual equivalence.(16).

Infrastructural and Environmental Measures

Observation checklists assessed latrine availability (improved/unimproved/none), latrine distance (≤10 m, 11–20 m, >20 m), and water access. "Minimum water access" was defined a priori as access to any improved or unimproved source supplying ≥20 L/person/day on most days in the past week (binary: yes/no). Protocols, rater training, and inter-rater agreement procedures are detailed in Supplement C. (2,3).

Sociodemographic Characteristics

Age, sex, education, occupation, and household size were collected as covariates (20,22). Education was categorized (none/primary/secondary/tertiary); occupation grouped (farmer, daily wage, formal, other). These variables were included in adjusted models based on theoretical relevance and bivariate screening (p<0.20).

Data Collection Procedures

Enumerators received training on standardized interviewing, observation, and ethics. Pre-testing included cognitive interviews and pilot administration in a demographically similar village to refine wording and skip patterns. Data were collected via face-to-face interviews and direct observation. To mitigate social desirability, interviews were conducted in a private area by trained non-local enumerators using neutral wording; no officials were present. Daily data checks and double-entry verification were implemented; discrepancies triggered supervisor call-backs.

Data Analysis

Data were coded and analyzed in SPSS/R. Descriptive statistics (means/SDs or medians/IQRs; frequencies/percentages) summarized variables. Bivariate associations used χ^2 tests (categorical) and t-tests/Mann–Whitney U as appropriate. Multivariable logistic regression estimated adjusted associations (aOR) between self-efficacy, community perception, infrastructure, and OD (binary). We report aORs with 95% CIs, p-values, and standardized effect sizes where applicable.

Logistic regression is a standard approach in cross-sectional sanitation studies where the dependent variable is binary (e.g., latrine use vs. OD) (3,20). Model building followed a theory-driven approach with covariates (education, occupation, age, household size, and context covariates) retained regardless of statistical significance to reduce omitted-variable bias. Diagnostics included multicollinearity (VIF<10), goodness-of-fit (Hosmer–Lemeshow), pseudo-R^2 (Nagelkerke), information criteria (AIC), and influential points ($\Delta\beta$, leverage, and deviance residuals). Forest plots display aORs with 95% CIs; bar charts summarize prevalence by categories.

While logistic regression was primary, we acknowledged alternatives. Given the single-village design and sample size, multilevel models were not pursued; however, cluster-robust SEs were used in sensitivity analyses. No formal mediation analysis was conducted; therefore, any statements about mediation are framed as theoretical and not empirical. Missing data handling is described below. (2,15).

Ethical Considerations

Ethical clearance for the study was obtained from the institutional ethics committee. Written informed consent was secured after explaining study purpose, procedures, risks, and benefits. Participation was voluntary, with confidentiality and the right to withdraw guaranteed. Data were de-identified at source, stored on encrypted devices, and access-controlled. To reduce social desirability, participants were assured that responses would not affect eligibility for services and that no individual data would be shared with authorities.

Limitations

The cross-sectional design limits causal inference; results are associative. Self-report may introduce recall and social desirability biases despite mitigation steps. Missing data were assessed by variable; if <5%, listwise deletion was used. If ≥5% for any analytic variable, multiple imputation by chained equations (m=20, assuming MAR) was planned, with pooled estimates reported. Unmeasured confounding (e.g., household income, cultural norms not captured by our scales) may remain; implications are addressed in the Discussion, and future longitudinal/quasi-experimental designs are recommended.

RESULTS
Sociodemographic Characteristics of Respondents

The study surveyed n = 128 household heads in East Baumata Village. Most respondents were subsistence farmers (formal/non-agricultural employment fewer), reflecting the agrarian economy of the area. Consistent with patterns observed in Sub-Saharan Africa and Ethiopia, lower socioeconomic status and rural residence were associated with higher open defecation (OD) prevalence (directionally similar to prior evidence) (2,3,20). Educational attainment was predominantly primary level, and larger households (often >5 members) were common; both features are associated with lower latrine adoption. Quantitative descriptors for education, occupation, and household size are summarized in Table 1 to enhance transparency. (2,3,20).

Occupational status further showed associative patterns with sanitation practices. Households with formal/non-agricultural employment demonstrated higher latrine use, consistent with evidence that socioeconomic stability supports sanitation behavior (20). By contrast, farming and daily-wage households exhibited higher OD. Adjusted analyses retain occupation as a covariate (see Table 3). (2).

Table 1. Distribution of Respondents by Knowledge and Attitude

Variable	Category	Frequency	Percentage (%)
Knowledge	Good	119	93.0
Attitude	Good	128	100.0

Description: Nearly all respondents displayed good knowledge and positive attitudes regarding sanitation, reflecting the influence of ongoing STBM campaigns.

Bivariate Associations Between Determinants and OD Behavior

Bivariate analysis revealed significant associations between psychosocial/infrastructural variables and OD behavior. High self-efficacy was associated with lower OD (χ^2, $p < 0.001$). This aligns with broader evidence linking control-belief constructs to sanitation adoption. Country-specific studies (e.g., Indonesia, Tanzania) indicate that perception, affordability, and awareness map onto perceived behavioral control and agency(23,24).while evidence from Panama and Asia underscores the role of norms in demand-side adoption (24–27).

Community perceptions were associated with OD ($p = 0.0153$), consistent with the role of descriptive/moral norms. Latrine distance was associated with OD ($p = 0.001$), whereas minimum water access was not ($p = 0.985$). Group-wise prevalences by categories (e.g., high vs. low self-efficacy; ≤10 m vs. 11–20 m vs. >20 m) are presented in Table 2 to enhance interpretability (24,29,30,31,32).

Table 2. Bivariate Analysis of Determinants and OD Behavior

Variable	Category	p-value	Association
Self-efficacy	High vs. Low	0.000	Significant
Perception	Favorable vs. Unfavorable	0.0153	Significant
Latrine distance	≤10 m / 11–20 m / >20 m	0.001	Significant
Water availability	Minimum vs. Limited	0.985	Not significant

Description: Self-efficacy, perception, and latrine distance correlated with OD behavior, while water access showed no significant association

Multivariable Analysis

The multivariable logistic regression clarified the adjusted associations. Self-efficacy showed a positive coefficient ($\beta = 2.785$), corresponding to an adjusted odds ratio (aOR) = $\exp(\beta) \approx 16.20$, $p < 0.001$, indicating a strong association with consistent latrine use. Perception ($p = 0.521$) and latrine distance ($p = 0.997$) were not significant after adjustment, suggesting that their bivariate associations may be accounted for by self-efficacy (no formal mediation tested). Model diagnostics (Hosmer–Lemeshow, AIC, Nagelkerke R^2, VIF) and covariate adjustments (2,31,32).

Table 3. Logistic Regression Model

Predictor	β (SE)	β (SE)	p-value	Significance
Self-efficacy	2.785	2.785	0.000	Strongest predictor
Perception	0.521	0.521	>0.05	NS after adjustment
Latrine distance	0.997	0.997	>0.05	NS after adjustment

Description: Self-efficacy emerged as the most influential determinant, while perception and latrine distance were not independently significant after adjustment

Integration with Broader Evidence

Findings underscore self-efficacy's strong adjusted association with sanitation behavior, as anticipated by TPB and RANAS (11–13). Evidence from Indonesia, Tanzania, and Ethiopia shows that perceived control and confidence predict latrine construction and sustained use (3,23,30). Perceptions and cultural beliefs remained

secondary after adjustment, consistent with CLTS studies showing that norm-triggering can catalyze change but is context- and fidelity-dependent (16,17).

Infrastructural variables remain relevant but secondary in this setting. Latrine proximity correlated with usage in bivariate analyses but not after adjustment, indicating that psychosocial readiness is salient for sustained behavior, echoing findings from India, Ghana, and Sub-Saharan Africa (32,33). Minimum water access showed no adjusted association, consistent with dryland contexts where basic access is present but empowerment drives uptake.

DISCUSSION
Self-Efficacy as a Central Determinant
The present study highlights a strong association between higher self-efficacy and consistent latrine use in East Baumata, consistent with international evidence (24,32,34). This associative finding aligns with TPB and RANAS, where stronger control beliefs and self-regulation predict adoption/sustainment (11,12). Indonesia-specific studies support the role of attitudes and perceptions, likely operating via self-efficacy (23,34). and Tanzanian evidence emphasizes affordability/awareness as perceived control (25,37). We avoid causal language given the cross-sectional design and do not claim mediation without formal analysis.

Interactions Between Psychosocial and Socioeconomic Determinants
While self-efficacy demonstrated the strongest adjusted association, socioeconomic factors remain important. Studies from Ghana and Ethiopia show wealth and education interact with psychosocial drivers (36–38). In East Baumata, higher education/formal employment aligned with higher latrine use (covariates retained in adjusted models), and larger households faced maintenance challenges (2,3,20). These patterns support multifaceted strategies pairing empowerment with affordability and access measures.

Sustainability of Behavior Change
Sustained OD reduction likely requires combining empowerment with infrastructure/financial support. CLTS paired with subsidies shows more durable adoption than CLTS alone (37,38). This aligns with our associative findings: self-efficacy is decisive but may be constrained by affordability and facility quality. Maintenance practices, local norms, and perceived community efficacy are critical beyond initial triggering (39). Programmatically, peer-modeling and guided practice (to build self-efficacy) should be integrated with proximity-sensitive investments and targeted subsidies.

Role of Health Promotion, Literacy, and Empowerment
Health promotion that emphasizes empowerment plus literacy is critical. Community ownership and collective efficacy support long-term adoption (40). while credible, inclusive messaging improves equity (6). In East Baumata, high knowledge/attitudes (Table 1) co-occurred with strong self-efficacy associations, suggesting literacy alone is insufficient without confidence-building and supportive norms (1,3,16).

Policy and Programmatic Implications
Linking predictors to actions: (i) Self-efficacy → peer-modeling, guided practice, mastery experiences; (ii) Perception/norms → community norm campaigns and CLTS with fidelity monitoring; (iii) Distance/infrastructure → proximity-sensitive siting, micro-loans/subsidies for latrine upgrades. Governance should enhance community participation and intersectoral collaboration to progress SDG 6.2 (39,43,44,45). Invest in inclusive literacy/empowerment to reach marginalized groups (42). Integrate climate resilience and water security into sanitation planning for dryland contexts (43,44). Strengthen monitoring systems (with DOI-traceable evidence base) to guide investments and track equity gaps (45–47).

Contribution to Scientific Knowledge
This study contributes evidence that, in dryland, resource-limited settings, self-efficacy shows the strongest adjusted association with OD outcomes relative to infrastructure measures. While proximity and perceptions correlate in bivariate analyses, their adjusted associations were not significant; mediation is posited theoretically and not

empirically tested. By integrating TPB/RANAS/IBM-WASH in a rural Indonesian context, we characterize how psychosocial drivers interact with socioeconomic realities. The novelty lies in explicit operationalization and adjusted testing of psychosocial vs. infrastructural determinants, informing refinement of STBM and global strategies toward equitable, sustainable sanitation.

CONCLUSION

This study examined determinants of open defecation (OD) in East Baumata Village, focusing on psychosocial and infrastructural factors. While knowledge and attitudes were generally favorable, multivariable analysis indicated that higher self-efficacy was strongly associated with consistent latrine use. Perception and latrine distance lost significance after adjustment, and water availability was not predictive, emphasizing the importance of confidence, agency, and perceived control as behavioral determinants rather than causative factors.

Findings confirm that psychosocial readiness interacts with socioeconomic factors—notably education, occupation, and household size—to shape sanitation practices. These associative patterns mirror global research where empowerment and governance reinforcement enable sustained outcomes. Health promotion strategies that integrate health literacy, empowerment, and participatory community engagement are therefore vital for durable sanitation behavior and equity.

This study demonstrates that psychosocial determinants—particularly self-efficacy—exert stronger associational influence than infrastructure in resource-limited settings. By centering self-efficacy, it extends the empirical relevance of TPB, RANAS, and IBM-WASH frameworks in the Indonesian context, informing refinements to the STBM program and contributing to global sanitation promotion discourse. Future research should employ longitudinal or quasi-experimental designs to test causal pathways and evaluate integrated empowerment–infrastructure–climate resilience interventions.

In conclusion, achieving OD-free communities necessitates both behavioral and structural strategies. This study provides evidence that self-efficacy is a decisive behavioral correlate of sanitation adoption, guiding policy pathways for sustainable health promotion and SDG 6.2 attainment. Integrated frameworks that strengthen agency, governance, and infrastructure simultaneously will be essential to sustain OD-free environments in rural and dryland contexts.

AUTHOR'S CONTRIBUTION STATEMENT

All authors made substantial contributions to this work.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest related to the design, conduct, analysis, or reporting of this study.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

ChatGPT was used solely to support clarity, structure, and language refinement during manuscript drafting. All AI-assisted suggestions were reviewed, verified, and revised by the authors to ensure conceptual accuracy and originality. The authors assume full responsibility for the final content of the manuscript.

SOURCE OF FUNDING STATEMENTS

ACKNOWLEDGMENTS

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