

Web and Mobile Design System for Fashion and Apparel

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ABSTRACT

This study developed and evaluated an artificial intelligence (AI)-driven web and mobile design system for fashion and apparel. The system was designed to reduce the time, repetitive work, and measurement errors associated with manual fashion design by supporting measurement entry, sketch upload, AI-assisted visualization, design management, client feedback, and output export. A developmental-descriptive design was employed at Palompon Institute of Technology during Academic Year 2025-2026. System development followed the Systems Development Life Cycle and Waterfall Model, while evaluation drew on ISO/IEC 25010, the DeLone and McLean Information Systems Success Model, and the Technology Acceptance Model. Purposively selected students, faculty members, and designer-clients (N = 40) evaluated the system. Descriptive statistics summarized system effectiveness, system success, acceptance, and feedback; Pearson correlation examined the relationship between the extent of AI application and acceptability, and one-way analysis of variance compared respondent groups. The ISO-based effectiveness score was satisfactory (M = 3.67). Recalculation from the detailed domain tables produced a highly acceptable overall information-systems-success mean of 4.12. Net benefits (M = 4.33) and user satisfaction (M = 4.30) received the highest ratings, followed by service quality (M = 4.07), system use (M = 4.04), system quality (M = 4.01), and information quality (M = 3.99). Perceived usefulness (M = 4.12, SD = 0.53) and perceived ease of use (M = 4.05, SD = 0.56) indicated high technology acceptance. AI application was positively associated with acceptability ($r = .68$, $p = .001$), whereas evaluations did not significantly differ among respondent groups ($F = 1.24$, $p = .29$). Respondents prioritized additional templates, mobile optimization, improved recommendations, and CAD integration. The findings support the system as an educational and pre-production design aid, while also identifying the need for stronger validation of measurement accuracy, performance, and real mobile functionality.

Keywords: artificial intelligence; fashion technology; web and mobile systems; automated design; pattern generation; ISO/IEC 25010; information systems success; technology acceptance

INTRODUCTION

Digital transformation is changing how fashion concepts are generated, communicated, revised, and prepared for production. Computer-aided design tools already allow designers to draw, visualize, and document garments more efficiently than purely manual workflows. Artificial intelligence extends this capability by interpreting prompts and sketches, identifying patterns in data, generating visual alternatives, and recommending styles or configurations. When delivered through web and mobile interfaces, these functions can make design tools available beyond a specialized laboratory and support ongoing interaction between designers, learners, and clients.

The appeal of AI-assisted fashion design is easy to understand. Manual drafting and pattern preparation require technical skill, repeated calculation, and careful translation of measurements into garment components. Small

errors can propagate into poor fit or wasted material, while the production of multiple concept alternatives consumes time. An intelligent system can automate parts of this early workflow, rapidly visualize choices, and preserve project information. However, an AI-generated garment image is not automatically an accurate pattern, and a smooth interface is not proof of manufacturing readiness. Credible evaluation must separate perceived usability and usefulness from objective accuracy, reliability, and production feasibility.

Fashion education faces this distinction directly. Students need exposure to emerging technologies, but they also need to learn construction logic, fit, material behavior, aesthetics, and critical judgment. AI can broaden exploration by producing alternatives quickly, yet it can also encourage superficial acceptance of visually impressive but technically implausible outputs. The educational role of an AI platform should therefore be assistive: the system generates and organizes possibilities, while the learner and instructor remain responsible for critique, correction, and final decisions. This human-centered orientation is consistent with the complementarity described by Daugherty and Wilson (2018) and with current concerns about whether generative systems displace or augment the designer (Verheijden & Funk, 2023).

At Palompon Institute of Technology (PIT), fashion and technology programs provide an appropriate context for examining a localized design platform. Conventional fashion-design instruction and small-scale apparel practice frequently depend on manual sketching, measurement recording, pattern drafting, and face-to-face feedback. These activities are valuable, but repetitive tasks and limited access to commercial systems can restrict the number of alternatives students and local designers are able to explore. A browser-accessible platform that combines measurement input, sketch upload, AI rendering, project management, client review, and export could strengthen experimentation and communication.

Existing research and practice show growing interest in intelligent fashion applications, including recommendation systems, virtual styling, multimodal search, automated visualization, and digitally supported manufacturing (Lu et al., 2021; Rathod et al., 2026; Russell & Norvig, 2021). Mobile fashion applications can extend access and maintain user engagement across contexts, while CAD interoperability is essential when conceptual designs must advance toward professional pattern development. Yet many published systems focus on retail recommendation or experimental generation rather than an integrated educational workflow that connects user measurements, design creation, feedback, revision, and project delivery.

This study addressed that gap by developing and evaluating an AI-driven web and mobile design system for fashion and apparel. The contribution is twofold. Technically, it presents a role-based framework that integrates design input, AI-assisted generation, and collaborative project functions. Empirically, it evaluates the system through three complementary lenses: software quality under ISO/IEC 25010, information-system success under the DeLone and McLean model, and technology acceptance through TAM. Using more than one model avoids treating acceptance as synonymous with technical quality; users can like a system that still needs engineering work.

Theoretical and Evaluation Framework

ISO/IEC 25010 defines a quality model for software and systems, including functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability (ISO/IEC, 2011). The source thesis operationalized a selected subset through functionality, usability, accuracy or reliability, and efficiency. These dimensions describe whether the system performs intended tasks, can be learned and operated, produces dependable outputs, and responds with acceptable resource and time demands.

The DeLone and McLean Information Systems Success Model treats success as a multidimensional relationship among system quality, information quality, service quality, system use, user satisfaction, and net benefits (DeLone & McLean, 1992, 2003). Applied to fashion technology, system quality concerns usability, responsiveness, reliability, and cross-device consistency; information quality concerns the accuracy and usefulness of generated designs; service quality concerns guidance and support; use concerns continued adoption; satisfaction captures users' overall experience; and net benefits represent effects on efficiency, creativity, productivity, and design time.

The Technology Acceptance Model proposes that perceived usefulness and perceived ease of use shape attitudes and behavioral intentions toward technology (Davis, 1989; Venkatesh & Davis, 2000). It complements the success model by explaining why users may intend to adopt the platform. Together, the frameworks support a more disciplined interpretation: high satisfaction and intention are meaningful, but they do not independently validate fit, pattern accuracy, or system uptime.

Objectives and hypotheses

The study aimed to develop and evaluate an AI-driven web and mobile design system for fashion and apparel. It specifically sought to: identify functional requirements for the interface, data input, processing, and output; document development through the SDLC and Waterfall Model; determine system effectiveness using selected ISO/IEC 25010 characteristics; determine system success using the six DeLone and McLean domains; assess perceived usefulness and ease of use; test the relationship between AI application and system acceptability; compare evaluations among students, faculty members, and designer-clients; and derive enhancement priorities from respondent feedback. The null hypotheses stated that AI application would not be significantly related to acceptability and that respondent groups would not differ significantly in their evaluations.

MATERIALS AND METHODS

Research design and setting

A developmental-descriptive research design was employed. The developmental component involved requirements gathering, architecture and interface design, implementation, testing, deployment for evaluation, and identification of maintenance needs. The descriptive component gathered users' evaluations of effectiveness, success, acceptance, and needed enhancements. This combination is appropriate for applied system research because it documents both the creation of a technological artifact and the perceptions of intended users.

The research was conducted at Palompon Institute of Technology in Palompon, Leyte, Philippines, during Academic Year 2025-2026. Development and evaluation involved the College of Technology and Engineering and drew input from users with backgrounds in information technology, fashion or garments, teaching, design, and client interaction. Available laboratories and computer workstations supported prototype use and evaluation.

Participants and sampling

Purposive sampling selected 40 respondents who possessed relevant knowledge or experience. The intended composition reported in the methodology was 25 students (62.5%), 10 faculty members (25.0%), and five designer-clients (12.5%). Participants provided educational, technical, professional, and client-centered perspectives. The demographic results reported 20 respondents aged 18-25 (50.0%), 11 aged 26-35 (27.5%), six aged 36-45 (15.0%), and three aged 46 or older (7.5%); 45% were male and 55% female.

The source thesis contains an inconsistency: its age-by-gender table labels 20 adults aged 26 and above as faculty and 20 respondents aged 18-25 as students, omitting the separately reported designer-client group and conflicting with the stated 25-student/10-faculty/5-designer composition. The article therefore reports age and gender only in aggregate and uses the methodology's explicit role distribution. The raw respondent file should be checked before journal submission.

Table 1. Intended respondent composition

Respondent group	n	%
Students	25	62.5
Faculty members	10	25.0
Designer-clients	5	12.5
Total	40	100.0

Note. Role counts follow the explicit distribution reported in the methodology. The demographic cross-tabulation should be reconciled with the raw data before submission.

System development and functional architecture

Development followed a Waterfall-oriented SDLC comprising requirement analysis, system design, implementation, testing, deployment, and maintenance planning (Sommerville, 2011). During analysis, the researcher identified measurement inputs, user roles, design-generation functions, storage needs, and output requirements. System design established the interface, architecture, database, and workflow. Implementation connected front-end components, application logic, database services, and AI generation. Testing addressed functional errors before the platform was released to respondents. User feedback then informed maintenance and enhancement priorities.

The functional design consisted of four primary layers. The user-interface layer enabled navigation across registration, authentication, dashboards, projects, and generation functions. The data-input layer captured body measurements, garment preferences, prompts, and sketches or reference images. The design-processing layer interpreted user data and generated fashion concepts or pattern-related outputs through AI and rule-based operations. The output layer displayed digital previews and enabled saving or export. Project-management and feedback functions linked designers and clients through briefs, comments, revision requests, approval, and delivery.

Table 2. Principal system components

Component	Primary function
User interface	Provides role-based access, navigation, project views, input forms, and design-generation controls.
Data input	Captures body measurements, garment preferences, prompts, sketches, and reference images.
Design processing	Uses AI and configured rules to interpret inputs and generate fashion concepts or pattern-related outputs.
Design output	Displays previews and supports storage, review, approval, download, or export.
Collaboration	Coordinates designer-client briefs, feedback, revisions, project status, and delivery.

The prototype accepted JPG, PNG, and WebP uploads of up to 10 MB and exported PNG images at 1024 by 1024 pixels in sRGB. The documented workflow was browser based and required internet connectivity for AI generation. Although the thesis repeatedly calls the platform a web and mobile system, its technical limitations state that the current version supports web browsers only. This article therefore describes it as a responsive web system intended for mobile access rather than claiming a validated native mobile application.

Instrument, validation, and data collection

A structured questionnaire assessed selected ISO/IEC 25010 attributes, the six DeLone and McLean success domains, TAM usefulness and ease of use, overall expectations, recommendation intention, and open-ended feedback. Items used a five-point agreement scale. Domain means were interpreted using the thesis's stated ranges: 4.21-5.00, very high or very highly acceptable; 3.41-4.20, high or highly acceptable; 2.61-3.40, moderate or acceptable; 1.81-2.60, low or slightly acceptable; and 1.00-1.80, very low or not acceptable. Some result tables used the label Highly Acceptable for means above 4.21; this article retains the reported labels while reporting exact values.

The instrument was reviewed by three subject-matter experts, described as including expertise in artificial intelligence, information technology, and educational research. It was pilot tested with individuals outside the final sample to improve clarity and response consistency. The source does not report a content-validity index, reliability coefficient, pilot sample size, or item revision history. These values should be recovered from the research records and added before journal submission.

Permission was obtained from institutional authorities and the research ethics process reported by the thesis. Participants received an explanation of the objectives and evaluation procedure before using the system and completing the questionnaire. Responses were organized, encoded, and analyzed after system testing. For publishable reporting, the author should add the formal ethics approval or exemption number, approval date, consent process, and data-protection arrangements.

Statistical analysis

Frequencies and percentages summarized respondent characteristics and enhancement priorities. Means and standard deviations described quality, success, and acceptance indicators. Pearson's product-moment correlation tested the association between the extent of AI application and system acceptability. One-way analysis of variance compared evaluation scores among students, faculty members, and designer-clients at $\alpha = .05$. The source reports r , F , and p values but omits sample-specific confidence intervals, degrees of freedom, group means, homogeneity tests, and effect sizes. These omissions restrict independent evaluation of assumptions and magnitude.

RESULTS

Selected software-quality effectiveness

The selected ISO-based effectiveness indicators produced an average weighted mean of 3.67, interpreted in the thesis as Agree or Satisfactory. Functionality was highest at 3.70, followed by efficiency at 3.67, accuracy at 3.66, and usability at 3.65. The findings indicate that respondents generally believed the prototype performed its intended functions and was manageable to use. However, the table labels the third attribute Accuracy although the research question specified Reliability. Accuracy may relate to functional correctness or information quality, but it is not a direct substitute for the ISO/IEC 25010 reliability characteristic. The construct should be reconciled with the actual questionnaire before submission.

Table 3. Reported system effectiveness

Attribute	Mean	Source interpretation
Functionality	3.70	Agree
Efficiency	3.67	Agree
Accuracy*	3.66	Agree
Usability	3.65	Agree
Average	3.67	Satisfactory

*The research question specifies reliability, whereas the result table reports accuracy. The instrument and dataset should determine the correct label.

Information-systems success

System quality obtained a domain mean of 4.01. Ease of use and page loading each scored 4.07; cross-device consistency scored 3.98; and smooth operation without frequent errors scored 3.93. The last indicator was the weakest in the domain, suggesting that stability deserves attention even though the overall perception was favorable. Information quality received 3.99. Real-world relevance was strongest at 4.16, fit and size alignment and fabric-style relevance each scored 3.95, and accuracy based on user inputs scored 3.88.

Service quality averaged 4.07. Suitability for educational and professional use scored 4.14, availability of support 4.05, and clarity of guidance 4.02. System use averaged 4.04: willingness to recommend scored 4.09, frequent use 4.02, and intention to continue 4.00. These values suggest that respondents saw the platform as usable and worth adopting, although they should be interpreted as stated intentions rather than logged long-term behavior.

User satisfaction averaged 4.30 in the detailed item table. Confidence during design tasks was highest at 4.40, overall performance satisfaction scored 4.30, and meeting expectations scored 4.20. Net benefits averaged 4.33: improved design efficiency scored 4.40, enhanced creativity and productivity 4.35, reduced design time 4.30, and added workflow value 4.25. These were the strongest domains and indicate that respondents perceived tangible benefits from the AI-assisted workflow.

Table 4. Recomputed system-success summary

Rank	Domain	Mean	Interpretation
1	Net benefits	4.33	Very highly acceptable
2	User satisfaction	4.30	Very highly acceptable
3	Service quality	4.07	Highly acceptable
4	System use / intention	4.04	Highly acceptable
5	System quality	4.01	Highly acceptable
6	Information quality	3.99	Highly acceptable
	Recomputed overall	4.12	Highly acceptable

Note. The overall mean of 4.12 was recomputed from the six detailed domain means. The thesis summary table instead lists user satisfaction = 4.16, net benefits = 4.12, and overall = 4.07, which conflicts with its detailed Tables 9 and 10.

Technology acceptance

Perceived usefulness scored 4.12 (SD = 0.53), indicating that respondents believed the platform improved the efficiency and effectiveness of apparel-design work. Perceived ease of use scored 4.05 (SD = 0.56), indicating limited perceived effort. Both results were interpreted as highly acceptable. Their similarity is relevant: respondents did not merely appreciate the potential benefit; they also considered the system accessible enough to use. Nevertheless, each TAM construct appears to have been represented by a single reported item, which weakens construct reliability and should be addressed in future evaluation.

Table 5. Technology Acceptance Model indicators

Construct	Mean	SD	Interpretation
Perceived usefulness	4.12	0.53	Highly acceptable
Perceived ease of use	4.05	0.56	Highly acceptable

Relationship between AI application and acceptability

The reported Pearson correlation between the extent of AI application and system acceptability was $r = .68$ with $p = .001$. This indicates a statistically significant positive association: respondents who rated AI application more strongly also tended to rate the system as more acceptable. The null hypothesis of no relationship was rejected. An r of .68 is substantial in this sample, with a simple squared correlation of approximately .46, but the result does not demonstrate that increasing AI reliance causes acceptance. Common-method measurement, overlapping questionnaire content, and favorable general attitudes could partly explain the association.

Table 6. Correlation of AI application and acceptability

Variables	r	p	Decision
Extent of AI application and system acceptability	.68	.001	Reject H0

Note. N = 40. Confidence interval and exact construct scoring were not reported in the source.

Differences among respondent groups

The one-way ANOVA yielded $F = 1.24$ and $p = .29$. Because p exceeded .05, the study did not detect a statistically significant difference among student, faculty, and designer-client evaluations. This suggests broadly comparable perceptions across educational and professional roles. The conclusion should remain cautious because the groups were small and unequal, group means were not reported, and the degrees of freedom and assumption tests were omitted. A nonsignificant result does not prove that the groups are equivalent.

Table 7. Reported one-way ANOVA

Comparison	F	p	Conclusion
Students vs. faculty vs. designer-clients	1.24	.29	Not statistically significant

Note. Degrees of freedom, group means, effect size, and assumption checks were not reported.

Enhancement priorities

All 40 respondents were assigned one primary enhancement priority in the feedback summary. Seventeen (42.5%) requested additional design templates and garment categories, 11 (27.5%) prioritized mobile optimization, eight (20.0%) requested improved AI recommendations, and four (10.0%) requested integration with professional CAD tools. Content breadth and mobile responsiveness therefore accounted for 70% of stated priorities. CAD integration received the lowest frequency but may be strategically important because export to standard pattern formats would connect visual ideation to technical production.

Table 8. Respondent enhancement priorities

Priority	n	%	Development implication
Additional design templates	17	42.5	Expand garment categories, body types, and curated style options.
Mobile optimization	11	27.5	Improve responsive interaction, loading, and small-screen workflows.
AI recommendation improvements	8	20.0	Increase prompt fidelity, measurement use, and recommendation relevance.
CAD integration	4	10.0	Support interoperable export for professional pattern workflows.

DISCUSSION

The combined results indicate that users accepted the AI-driven fashion platform and perceived clear benefits, but the evidence is stronger for user experience than for technical or manufacturing performance. The recalculated success mean of 4.12 and high TAM ratings show favorable attitudes toward usefulness, ease of use, and continued adoption. These findings are consistent with TAM, which predicts that useful and manageable systems are more likely to be accepted (Davis, 1989; Venkatesh & Davis, 2000), and with the DeLone and McLean model, which links system and information quality to use, satisfaction, and net benefits (DeLone & McLean, 2003).

Net benefits and satisfaction were the highest domains. Respondents believed the system improved design efficiency, reduced time, enhanced creativity, and increased confidence. In a design studio or classroom, rapid visualization can reduce the cost of exploring a poor idea and encourage comparison among alternatives. This is a meaningful benefit even when outputs are used only for ideation. The platform's project and feedback functions may also improve communication by retaining briefs, comments, revisions, and approval status rather than scattering them across informal conversations.

Information quality was the lowest success domain at 3.99, and accuracy based on user input was the lowest information-quality item at 3.88. These are favorable scores, but they reveal the system's central technical challenge. Measurement-based fashion design requires more than producing an image that appears proportional. Valid outputs should respect body dimensions, garment ease, seam relationships, balance, fabric properties, grading rules, and construction constraints. The study did not compare generated outputs with expert patterns, finished garments, or direct body-fit measurements. Claims of accurate automated pattern generation should therefore be treated as provisional until objective validation is completed.

The ISO-based effectiveness mean of 3.67 is notably lower than the six-domain success mean of 4.12. The two instruments likely measure different aspects and use different labels, but the gap suggests that general satisfaction and perceived benefits were more positive than the selected technical-quality assessment. This is not unusual. Users may value speed and novelty while still encountering limitations in stability, accuracy, or workflow detail. For publication, the distinction should be preserved rather than averaged away.

The positive correlation between AI application and acceptance indicates that respondents who perceived more AI capability also tended to value the system more. AI may be the platform's principal differentiator, especially when it transforms sketches or prompts into immediate visual results. Still, correlation does not establish causation. Because both variables were collected in the same survey session, respondents with a generally favorable impression may have rated every domain highly. Experimental comparison of AI-enabled and non-AI versions would provide stronger evidence of the specific contribution of AI.

The absence of a statistically significant group difference suggests that the platform appealed to students, faculty, and designer-clients. This cross-role acceptance is important because educational deployment requires both learner participation and faculty support, while professional relevance benefits from designer or client input. Yet the small designer-client group of five makes the ANOVA especially fragile. Larger, balanced samples and direct reporting of group means and confidence intervals are necessary before claiming equivalence among roles.

Mobile optimization was the second most frequent recommendation, but the system documentation states that the current version supports web browsers only. Responsive browser access is useful, though it is different from a native mobile application with device-specific testing, offline behavior, notifications, secure local storage, and app-store deployment. Future reports should use precise terminology and evaluate the platform on named devices, operating systems, browsers, screen sizes, and network conditions.

Additional design templates were the leading recommendation. A broader library can improve usefulness, but indiscriminate expansion may introduce duplicates, cultural bias, or technically poor examples. Template growth should be curated by fashion experts and mapped to garment categories, body types, occasions, construction methods, and learning objectives. AI recommendation improvements should likewise be evaluated for prompt fidelity, diversity, bias, and reproducibility. CAD integration may be the most demanding enhancement, but it would create the clearest bridge from concept image to professional pattern work.

Ethical and educational governance is also necessary. Uploaded sketches and client measurements may be personal or proprietary. AI-generated designs may resemble training examples or reinforce narrow representations of bodies and fashion. Institutions should establish consent, data retention, access control, acceptable use, disclosure of AI assistance, intellectual-property guidance, and human review. Instructors should assess students' reasoning, revisions, and construction decisions, not simply the polish of the generated image.

Implementation priorities

Table 9. Evidence-based development roadmap

Priority	Action	Suggested metric	Horizon
1	Reconcile data, instrument labels, and statistical outputs.	Verified role counts; reliability coefficient; complete ANOVA and correlation reporting.	Immediate

2	Validate measurement and pattern accuracy objectively.	Measurement error; expert agreement; fit and construction rubric.	Short term
3	Optimize responsive mobile-web performance.	Median/P95 load time; task completion by device; error rate.	Short term
4	Expand and curate templates and recommendations.	Coverage; prompt fidelity; diversity and bias review.	Medium term
5	Develop interoperability CAD and production testing.	Successful standard-format export; pattern editability; sample-garment fit.	Long term

LIMITATIONS AND FUTURE RESEARCH

The study has several limitations. It involved 40 purposively selected respondents from one institution, with small and unequal role groups. The source contains inconsistencies in role cross-tabulation, construct labeling, and summary means. Instrument reliability and validity coefficients were not reported. The TAM constructs appear as single reported indicators. The correlation analysis may be influenced by shared-method variance, while the ANOVA omits degrees of freedom, group means, assumptions, and effect size. Most outcomes are self-reported perceptions rather than logged performance or objective garment-quality measures.

Future studies should begin by auditing the raw dataset and questionnaire, then publish a reproducible analysis with item definitions, reliability coefficients, missing-data handling, confidence intervals, and effect sizes. Multi-institutional samples should include balanced numbers of students, teachers, designers, tailors, clients, pattern makers, and software specialists. Longitudinal evaluation can determine whether initial acceptance persists after repeated design assignments and difficult cases.

Technical validation should compare AI-assisted, conventional CAD, and manual workflows using time-on-task, error rates, number and diversity of concepts, user workload, and expert-rated output quality. Measurement and pattern claims should be tested by comparing system output against established drafting procedures and finished-garment fit. Performance testing should record page-load and generation latency, failure rate, uptime, device compatibility, and concurrent usage. Further work should investigate three-dimensional garment simulation, standard CAD exchange, accessibility, privacy, algorithmic bias, authorship, and the effect of AI assistance on independent design skill.

CONCLUSION

The study developed an AI-driven web and mobile-oriented design system for fashion and apparel and evaluated it among students, faculty members, and designer-clients. Respondents rated the platform favorably across software effectiveness, information-system success, and technology acceptance. Recalculation from the detailed tables produced an overall success mean of 4.12, with net benefits and user satisfaction as the strongest domains. AI application was positively associated with acceptability ($r = .68$, $p = .001$), and no statistically significant group difference was detected ($F = 1.24$, $p = .29$). Feedback prioritized additional templates, mobile optimization, improved recommendations, and CAD integration.

The findings support the system as an assistive tool for ideation, visualization, learning, and designer-client collaboration. They do not yet establish accurate automated pattern generation, verified garment fit, native-mobile readiness, or production-scale reliability. The next stage should correct the reporting inconsistencies, validate measurement-based output objectively, benchmark technical performance, and establish responsible data and AI governance. Used critically, the system can extend the designer's reach; used uncritically, it may simply automate a stylish mistake faster.

DECLARATIONS

Ethics approval and consent to participate. The thesis reports institutional and research-ethics permission before

data collection. The formal approval or exemption number, approval date, and consent procedure should be inserted before journal submission.

Consent for publication. No directly identifying respondent information is reported. The author should confirm consent for any quoted comments or images before submission.

Data availability. The raw data were not included in the thesis PDF. The author should provide a repository link or a justified restriction and should reconcile the numerical inconsistencies against the original dataset.

Conflict of interest. The author should declare whether any financial or non-financial conflicts exist.

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Author contributions. Orliegh A. Dalman: conceptualization, software development, methodology, investigation, analysis, writing, and project administration. This statement should be verified against actual contributions.

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