Generational Perspectives on Human-Centered Digital Transformation: A Comparative Study of Cadets and Veteran Seafarers

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Abstract
Maritime digital transformation generates generationally differentiated experiential realities: cadets entering the profession in digitally transformed environments construct entirely different relationships with maritime technology than veteran seafarers who navigated the transition from analog to digital professional practice over decades of sea service. These generational differences — in digital transformation attitudes, technology trust calibration, and concern about traditional seamanship skill displacement — have direct implications for intergenerational knowledge transfer quality, mentorship effectiveness, and institutional curriculum design, yet have not been empirically examined within any Indonesian maritime education context. This study examines generational perspectives on human-centered digital transformation through a mixed-methods comparative design across 60 participants — 30 cadets and 30 veteran seafarer experts across Port and Shipping Management (PSM), Deck Nautical (DN), and Marine Engineering (ENG) programs at STIP Jakarta. Independent-samples t-tests reveal significant generational differences on all three variables: Digital Transformation Attitude Index (Cadets M=4.12 vs. Experts M=3.47; t(58)=3.94, p<.001, d=1.02), Technology Trust Score (Cadets M=3.91 vs. Experts M=3.24; t(58)=3.42, p=.001, d=0.88), and Traditional Skills Preservation Concern (Experts M=3.82 vs. Cadets M=2.64; t(58)=-5.17, p<.001, d=1.33). Qualitative FGD sub-group analysis generates three themes — Technology as Tool vs. Environment, Competency Anchor Points, and Intergenerational Mentorship Asymmetry — whose integration with the quantitative findings produces a nuanced generational portrait directly informing STIP Jakarta's mentorship design and intergenerational knowledge transfer strategy.

1. Introduction

The concept of the digital native — the individual who has grown up in a world where digital technology is not an acquired professional skill but an environmental constant, as natural as electricity or running water — and its counterpart, the digital immigrant — the individual who encountered digital technology in adulthood and must deliberately learn and adapt to digital environments that natives inhabit unreflectively — was introduced by Prensky [1] in 2001 to describe a generational divide in digital technology relationship that

had no historical precedent. While the sharp digital native/immigrant dichotomy has been critiqued as overly deterministic [2], the underlying observation — that individuals who have grown up within fully digitalized environments construct qualitatively different relationships with digital technology than those who transitioned to digital environments in adulthood — retains substantial empirical support and has generated productive research across educational, organizational, and professional development contexts. The maritime professional community presents a particularly vivid instantiation of this generational technology relationship difference: the veteran seafarer who spent formative years navigating by sextant and paper chart, maintaining engines without predictive analytics, and communicating through VHF radio and paper manifests before digital systems progressively restructured each of these professional practices inhabits a fundamentally different relationship with maritime digital transformation than the cadet who has never known professional maritime practice without ECDIS, digital monitoring, and platform-mediated logistics.

This generational difference is not merely an interesting sociological observation but a practically consequential institutional challenge for maritime education. At STIP Jakarta, veteran seafarers serve as lecturers and expert practitioners whose professional formation narratives and implicit competency standards were constructed within analog-to-digital transition experiences that the digital-native cadet generation has never shared. The quality of mentorship, knowledge transfer, and professional formation that this intergenerational encounter produces depends substantially on how well the two generations understand each other's digital transformation relationship — whether veteran seafarers can transmit the adaptive professional judgment developed through their own technology transition experience, and whether digital-native cadets can receive the traditional seamanship foundations that veteran mentors regard as essential even in digitally transformed professional environments [3]. Neither transmission nor reception is guaranteed when the generational experiential gap is as wide as it is between today's maritime academy cadets and the veteran practitioners who form them.

The human-centered digital transformation dimension is specifically relevant to this generational analysis. Human-centered technology design philosophy, as elaborated across the human-computer interaction and responsible AI literature [4], holds that technology adoption's ultimate measure of success is not capability deployment but human-experience quality — whether technology serves human professional flourishing, reinforces human dignity and agency, and preserves the human dimensions of professional practice that technology cannot and should not replace. Applied to maritime digital transformation, this framework predicts generationally differentiated human-centered technology concerns: veterans, for whom the human dimensions of seamanship — judgment, adaptability, sensory awareness of vessel behavior — were constructed without digital mediation, may perceive digital transformation's human-centeredness challenge primarily as the risk of displacing skills they built with difficulty and value profoundly; cadets, for whom digital mediation of professional practice is foundational rather than overlaid, may be insufficiently aware that displacement risk exists.

Three objectives guide this study: first, to measure generational differences in Digital Transformation Attitude, Technology Trust, and Traditional Skills Preservation Concern through validated quantitative comparison; second, to examine between-major variation within each generation, identifying the program-specific generational patterns most relevant to program-differentiated curriculum and mentorship design; and third, to investigate, through qualitative FGD sub-group analysis, the specific experiential narratives and professional identity frameworks that generate the observed generational attitude differences.

1.1 Theoretical Framework

Three theoretical frameworks provide the conceptual architecture for this generational comparative study. Prensky's [1] digital native/immigrant framework, while appropriately qualified by subsequent scholarship [2] to avoid deterministic generational categorization, provides the foundational vocabulary for understanding why maritime cadets and veteran seafarers construct different default digital technology orientations. The framework's most productively applicable insight is not the sharp native/immigrant boundary but the concept of digital fluency calibration: individuals whose professional identity formation

occurred within digital environments develop a qualitatively different intuitive relationship with technology-mediated professional practice than those whose professional identity was formed without it. For STIP Jakarta, this calibration difference is most consequential for the mentorship encounter between veteran lecturer-practitioners and digital-native cadets, where the implicit assumptions each brings to the interaction about what constitutes competent professional practice may diverge in ways that neither party has developed the conceptual vocabulary to articulate.

Howe and Strauss's [5] generational cohort theory, developed through their analysis of Millennial characteristics and subsequently extended to Generation Z, provides the sociological grounding for treating cadet and veteran expert populations as meaningfully distinct generational cohorts rather than merely age groups, establishing that generational cohort formation through shared historical experience — specifically, the presence or absence of digital technology during formative professional development — generates systematically different values, attitudes, and cognitive orientations that persist across individual variation. Applied to the maritime context, this framework predicts not merely average attitude differences between cadets and veterans but qualitatively different meaning-making frameworks for what it means to be a competent maritime professional — frameworks whose misalignment can undermine the intergenerational knowledge transfer that maritime professional formation depends on.

Rhoades and Eisenberger's [6] perceived organizational support theory provides the institutional dimension, establishing that organizational context substantially mediates the degree to which generational attitude differences are expressed or suppressed within institutional settings. Applied to STIP Jakarta, this framework predicts that the degree to which the institution creates institutional spaces and mechanisms for authentic intergenerational dialogue — rather than simply deploying veteran practitioners as authority transmitters and cadets as passive recipients — will substantially determine whether generational attitude differences constitute a productive intergenerational knowledge transfer resource or a suppressed tension that reduces mentorship and curriculum quality.

2. Method

This study employed a sequential mixed-methods design combining quantitative generational attitude comparison with qualitative FGD sub-group interpretation, applied to 60 STIP Jakarta participants from August 2025 to March 2026. The design pools the cadet and expert respondent groups from the broader STIP Jakarta Digital Transformation dataset while focusing analysis on the generational comparison between these groups [7], using different variables and analytical focus from the companion DIGITS studies that use one or both of these groups.

The participant population comprised 30 Level 2 cadets (10 per program: PSM, DN, ENG) and 30 expert practitioners (10 per program), the same participant groups used in companion DIGITS studies but assessed here through a different instrument targeting generational attitude variables. The primary quantitative instrument comprised three subscales administered as a single survey to both generational groups: Digital Transformation Attitude Index (DTAI, 6 items measuring overall positive or negative orientation toward maritime digital transformation, scored 1=Strongly Negative to 5=Strongly Positive); Technology Trust Score (TTS, 5 items measuring trust in digital systems for professional maritime decision support); and Traditional Skills Preservation Concern (TSPC, 5 items measuring perceived threat to valuable traditional seamanship skills from progressive digitalization). All items were worded to be interpretable by both cadet and expert populations. Internal consistency was established at $\alpha=0.79$ across all subscales. Statistical analysis employed independent-samples t-tests comparing cadet and expert group means for each variable, and one-way ANOVA for between-major analysis within each generational group [8]. Qualitative FGD sub-group sessions were conducted separately with cadet and expert sub-samples (one session per group, 15 participants each, cross-major), using a protocol addressing participants' personal technology relationship narratives, mentorship and knowledge transfer experiences, and views on traditional versus digital skill balance in maritime professional formation. Thematic analysis [9] was applied and integrated with quantitative findings through narrative synthesis [10].

3. Results and Analysis

3.1 Quantitative Generational Comparison

Table 1 presents means, standard deviations, and independent-samples t-test results for the three attitude variables across the two generational groups, documenting the magnitude and direction of generational differences.

Table 1. *Generational Attitude Comparison — Cadets vs. Experts (n = 60)*

Variable	Cadets (n=30) M (SD)	Experts (n=30) M (SD)	t(58)	p-value	Cohen's d	Direction
Digital Transformation Attitude Index (DTAI)	4.12 (0.74)	3.47 (0.88)	3.94	< .001	1.02	Cadets more positive
Technology Trust Score (TTS)	3.91 (0.82)	3.24 (0.94)	3.42	.001	0.88	Cadets higher trust
Traditional Skills Preservation Concern (TSPC)	2.64 (0.91)	3.82 (0.86)	−5.17	< .001	1.33	Experts more concerned

All three generational comparisons are statistically significant with large effect sizes, confirming that cadet-expert generational differences in digital transformation attitudes are not sampling artefacts but robust and practically consequential orientational differences. TSPC shows the largest generational effect (d=1.33), indicating that concern about traditional skill displacement is the attitude dimension most strongly differentiated between generations — more sharply so than general DT attitude (d=1.02) or technology trust (d=0.88).

Table 2. *Between-Major Analysis Within Generational Groups — DTAI Scores (n = 60)*

Major	Cadets M (SD)	Experts M (SD)	Cadet-Expert Gap
PSM	4.32 (0.68)	3.68 (0.82)	0.64
DN	3.96 (0.82)	3.29 (0.94)	0.67
ENG	4.08 (0.74)	3.44 (0.88)	0.64
All Programs	**4.12 (0.74)**	**3.47 (0.88)**	**0.65**

The between-major DTAI analysis in Table 2 reveals a remarkably consistent cadet-expert generational gap (0.64–0.67 points) across all three program majors, indicating that the generational attitude difference is not program-specific but a cross-program generational phenomenon whose magnitude is essentially equivalent in PSM, DN, and ENG contexts. PSM cadets record the highest within-generation DTAI (4.32), consistent with the PSM program's logistics and digital business orientation providing the most positive professional context for digital transformation attitude formation, while DN cadets record the lowest (3.96) — and DN experts the lowest overall (3.29) — confirming the Deck Nautical program context's consistently most conservative digital transformation orientation across all companion DIGITS studies.

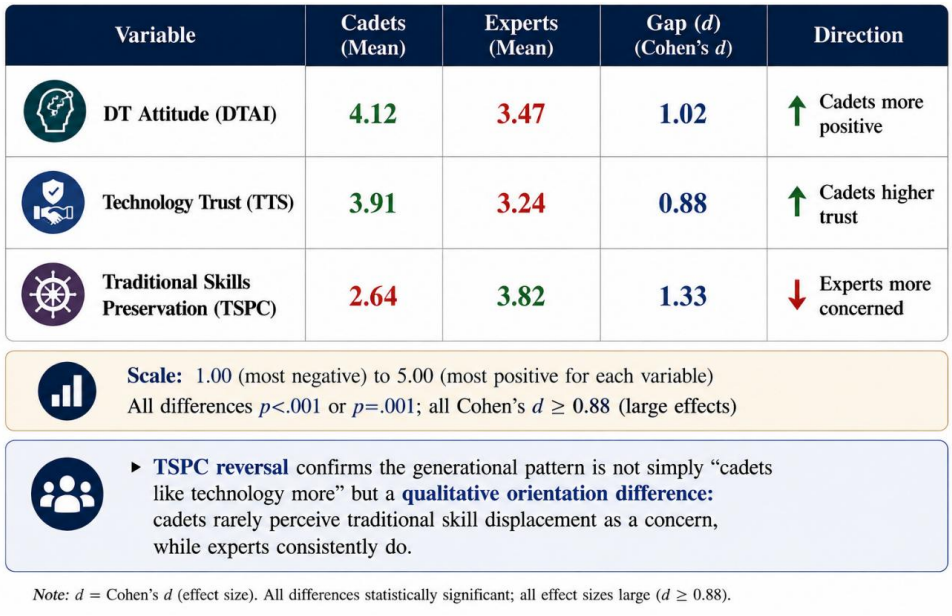

Fig 1. *Generational Attitude Profile — Cadets vs. Experts Across Three Variables*

3.2 Qualitative FGD Themes: Generational Experiential Narratives

Thematic analysis of the cross-major cadet FGD (n=15) and cross-major expert FGD (n=15) generated three themes whose interpretive content explains the quantitative generational gap through the experiential narratives underpinning each generation's attitude configuration.

Theme 1: Technology as Tool vs. Technology as Environment. This theme captures the most fundamental generational orientation difference, articulated with striking clarity by participants in both FGD sessions. Expert participants consistently described maritime digital technology — ECDIS, engine monitoring systems, digital documentation — through a tool metaphor: "I pick it up, I use it, I put it down. I know how to do the job without it." Cadet participants, by contrast, could not readily articulate the "without it" scenario: "I've learned navigation on ECDIS. I know how to read a paper chart and understand its principles, but that's not how I've ever actually navigated in practice." The tool-versus-environment distinction is not merely semantic: it describes different relationships to technology dependence, different cognitive architectures for professional practice, and different vulnerability profiles for skill erosion under technology failure conditions — differences whose professional safety implications the expert group articulated explicitly and the cadet group largely had not previously considered.

Theme 2: Competency Anchor Points. This theme documents the different foundational competency reference points that each generation uses to assess professional maritime adequacy. Expert participants described their competency anchor points as sea-time accumulated through pre-digital or early-digital professional experience — the years in which professional judgment was built without technological mediation and whose product is a professional self-confidence that does not depend on digital system functionality. "When I know I'm competent, I know it because I've handled situations that technology couldn't handle — heavy weather, equipment failure, situations where you're alone with your judgment." Cadet participants described their competency anchor points as formal certification achievement and academic performance — appropriate for their career stage but indicating an as-yet unanchored professional self-concept that relies on institutional validation rather than accumulated experiential confidence. Neither anchor point is superior; they are developmentally appropriate for each career stage. But the difference has direct mentorship implications: expert practitioners' competency anchor point narratives may not translate productively to cadets whose professional confidence is not yet experience-grounded.

Theme 3: Intergenerational Mentorship Asymmetry. This theme, the most institutionally actionable finding of the qualitative analysis, documents a mutual inadequacy in mentorship capacity that both generations acknowledge but neither knows how to resolve. Expert participants described feeling unable to mentor effectively on the digital tools and platforms that cadets increasingly use and that younger graduates will rely on: "They're better than me on the systems. I have nothing to teach them there." Cadet participants described feeling unable to receive mentorship on the traditional seamanship dimensions that expert practitioners most want to transmit: "When [senior lecturer] talks about navigation by star sight, I understand it conceptually but it doesn't feel real to me in the way ECDIS does. I don't know how to learn from that experience when I haven't had it." The mutual mentorship inadequacy — experts unable to give on digital, cadets unable to receive on traditional — creates a knowledge transfer void at precisely the intergenerational boundary where the complementary knowledge bases of the two generations should be most productively exchangeable.

3.3 Discussion

The quantitative finding that Traditional Skills Preservation Concern shows the largest generational effect size (d=1.33) — larger than either Digital Transformation Attitude or Technology Trust — is the study's most theoretically significant result and directly positions this generational comparison within the human-centered technology development discourse that the DIGITS conference's digital society theme addresses. The large TSPC generational gap does not merely document a difference in nostalgic attachment to pre-digital practices; it documents a substantive professional competency concern whose resolution — whether the traditional seamanship skills that experts fear are being displaced by digital systems are genuinely being lost from professional formation, or are being preserved in transformed digital-context-relevant forms — determines the long-term safety and adaptability quality of the maritime workforce that digital transformation produces [3].

The Technology as Tool vs. Technology as Environment qualitative theme provides the deepest explanatory account of the quantitative generational pattern, connecting the TSPC gap to a cognitive architectural difference rather than merely a preference difference. Cadets who have always used ECDIS have not merely failed to develop paper chart navigation as an alternative mode; they have formed their navigational cognitive architecture around ECDIS affordances — its trajectory prediction, automatic positioning, and collision avoidance recommendation functions — in ways that create professional cognitive dependencies that the expert generation's maritime professional formation specifically avoided creating. Whether these cognitive dependencies constitute a safety concern or a natural professional evolution is an empirically open question that neither generation can resolve from within its own experiential horizon [1], [2].

The Intergenerational Mentorship Asymmetry theme's institutional implication is the most directly actionable: STIP Jakarta's mentorship architecture, which places veteran practitioner lecturers in authority positions relative to digital-native cadets without structuring the knowledge exchange around both generations' complementary strengths, systematically wastes the most valuable knowledge transfer opportunity the institution possesses. A redesigned mentorship framework explicitly valuing digital fluency knowledge that cadets can transmit to veteran lecturers alongside seamanship experience that veteran lecturers transmit to cadets — a bidirectional, reciprocal mentorship architecture rather than a unidirectional expert-to-novice transmission model — would more accurately reflect the generational complementarity that the quantitative data document [5], [6].

4. Conclusion

This study has documented large, significant generational differences in Digital Transformation Attitude (d=1.02), Technology Trust (d=0.88), and Traditional Skills Preservation Concern (d=1.33) between STIP Jakarta cadets and veteran seafarer experts, with the TSPC reversal — experts significantly more concerned than cadets about traditional skill displacement — constituting the most practically consequential finding. Qualitative analysis reveals the Technology as Tool vs. Environment orientation difference as the

foundational generational experiential divergence, Competency Anchor Point difference as its professional identity manifestation, and Intergenerational Mentorship Asymmetry as its most institutionally addressable consequence. These findings contribute the first empirically grounded generational perspective comparison in Indonesian maritime vocational education and provide STIP Jakarta with specific evidence for redesigning mentorship and knowledge transfer architectures to exploit rather than waste the complementary knowledge strengths that each generation uniquely possesses.

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