Article

Research on Skill Gaps and Talent Cultivation Alignment in Foreign Trade Positions under AI Tool Iteration

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Abstract: This study investigates the evolving misalignment between workforce capabilities and occupational demands in foreign trade positions amid rapid iteration of artificial intelligence tools. Drawing on empirical field observations, structured interviews with industry practitioners, and longitudinal task analysis across import-export operations, customs documentation, cross-border logistics coordination, and multilingual client engagement, the research identifies systematic skill gaps emerging from AI-driven workflow transformations. Findings reveal that while automation has significantly reduced demand for routine data entry, manual document formatting, and basic translation tasks, it has concurrently intensified requirements for contextual judgment, AI tool oversight, intercultural negotiation fluency, and adaptive regulatory interpretation. The study further documents a pronounced lag in talent cultivation pathways---particularly within vocational training programs and university curricula---where pedagogical frameworks remain anchored in pre-AI operational paradigms. A three-tiered competency framework is proposed to distinguish foundational, augmented, and autonomous skill layers required at different stages of AI integration. Results indicate that professionals who engage in continuous, practice-embedded upskilling demonstrate higher task resilience and role versatility, whereas those relying solely on static credentialing exhibit accelerated functional obsolescence. The research concludes that sustainable alignment hinges not on replacing human expertise but on redefining its strategic interface with intelligent systems---emphasizing interpretive authority, ethical stewardship, and cross-domain synthesis over procedural execution.

Keywords: skill gap; AI integration; foreign trade; talent development

1. Introduction

1.1. Contextual Imperative of AI-Driven Transformation

The rapid integration of artificial intelligence tools into foreign trade operations has precipitated a structural recalibration across functional domains. Automated customs declaration systems now process documentation with subsecond latency, while real-time multilingual negotiation assistants mediate cross-border commercial dialogues without human linguistic intermediation [1]. Predictive logistics optimizers dynamically adjust shipment routing based on geopolitical risk indices, port congestion metrics, and real-time weather data streams. Concurrently, dynamic tariff classification engines apply granular Harmonized System code mappings using contextual product descriptors and regulatory amendment histories. These capabilities collectively compress decision cycles, reduce permissible error margins, and redistribute accountability from individual practitioners to algorithmic governance frameworks. Task architectures have shifted from procedural execution toward oversight, exception management, and interpretive validation. Human roles increasingly demand meta-cognitive competencies---such as AI output auditing, model assumption interrogation, and cross-system interoperability design---rather than domain-specific procedural fluency alone [2]. This transformation renders traditional talent development paradigms insufficient, necessitating urgent alignment between pedagogical scaffolds and emergent operational ontologies. The

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resulting skill gap manifests not in technical deficiency but in epistemic misalignment between legacy curricula and AI-mediated workflow logics.

1.2. Core Problem Statement

The central problem lies in the systemic misalignment between existing workforce capabilities and the rapidly evolving cognitive, relational, and regulatory requirements embedded in AI-augmented foreign trade operations [3]. This misalignment is not characterized by wholesale skill deficits but rather by structural incongruence---where educational curricula, certification frameworks, and organizational training pathways fail to anticipate or integrate the layered competencies demanded by iterative AI tool deployment. As intelligent agents increasingly mediate negotiation protocols, compliance verification, cross-border logistics coordination, and real-time risk assessment, practitioners face novel demands: adaptive reasoning under algorithmic uncertainty, human-AI collaborative judgment calibration, and contextualized interpretation of regulatory updates disseminated through dynamic knowledge graphs [1, 4]. Concurrently, talent development ecosystems remain anchored in static competency models, privileging discrete technical proficiencies over meta-cognitive agility, intercultural orchestration, and ethical governance literacy. The consequence is a widening operational latency---where frontline trade professionals possess foundational domain knowledge yet lack the situated fluency required to co-orchestrate workflows with intelligent systems [4, 5]. Without deliberate recalibration of pedagogical architectures and industry-academia feedback loops, this misfit will intensify, constraining both organizational innovation capacity and national competitiveness in digitally mediated global commerce [6].

1.3. Scope and Purpose of Inquiry

This study delimits its scope to mid-level foreign trade positions---specifically trade compliance officers, export documentation specialists, cross-border logistics coordinators, and international sales support personnel---where operational decision-making intersects directly with AI tool deployment. It deliberately excludes senior strategic roles and entry-level administrative functions to maintain analytical focus on the functional capability layer where iterative AI tools most acutely reshape task execution, judgment criteria, and professional accountability [7]. The inquiry centers exclusively on functional capability evolution: how practitioners adapt cognitive routines, interpret algorithmic outputs, reconcile conflicting system recommendations, and exercise contextual discretion amid shifting automation boundaries [8, 9]. It does not examine technical architecture of AI tools, vendor-specific implementation roadmaps, or macroeconomic projections of trade volume or labor market elasticity. Rather, it interrogates the dynamic recalibration of professional competence---the knowledge, judgment, and procedural fluency required to operate effectively within increasingly hybrid human--AI workflows. This bounded focus enables precise mapping of skill depreciation, emergence, and reconfiguration across discrete occupational clusters, thereby informing targeted curriculum design, certification frameworks, and organizational upskilling strategies grounded in empirical workflow analysis rather than speculative technological determinism.

2. Literature Review

2.1. Historical Trajectories of Trade Skill Evolution

The evolution of foreign trade competencies reflects successive technological inflection points that systematically reconfigure human skill requirements [5]. Early paper-based documentation demanded meticulous manual processing, procedural fidelity, and deep familiarity with regulatory formularies. The adoption of Electronic Data Interchange introduced structured syntax literacy, cross-system interoperability awareness, and error-detection rigor in standardized message formats [10]. Subsequent migration to cloud-based trade platforms shifted emphasis toward real-time data interpretation, API-mediated workflow orchestration, and dynamic compliance

monitoring across jurisdictional boundaries [11]. Each transition compressed routine cognitive load while amplifying demands for contextual judgment, adaptive problem framing, and cross-domain integration. These historical patterns establish a clear precedent: technological maturation does not merely augment existing roles but fundamentally redistributes the locus of value from executional precision to strategic sensemaking. As AI tools accelerate iteration cycles, the velocity of skill obsolescence increases, demanding pedagogical frameworks that prioritize meta-competency scaffolding---such as algorithmic literacy, ethical boundary negotiation, and iterative learning agility---over static knowledge acquisition [12]. This trajectory underscores that talent cultivation must anticipate not just current tooling but the epistemic architecture underlying next-generation trade infrastructure.

2.2. Contemporary AI Tool Capabilities in Trade Operations

Contemporary AI tools deployed in foreign trade operations exhibit a three-tier functional architecture [2, 8]. Rule-based automation handles deterministic tasks such as auto-filling Harmonized System (HS) code fields, validating document syntax, and enforcing regulatory checklists through predefined logic trees. Probabilistic prediction systems leverage statistical learning to estimate outcomes under uncertainty---for instance, forecasting duty liability across jurisdictional variants or modeling customs clearance delays using historical throughput data and real-time port congestion signals [1, 6]. Generative assistance constitutes the most advanced tier, employing large language models fine-tuned on multilingual trade documentation to draft negotiation correspondence, localize compliance statements, and synthesize cross-border contractual clauses while preserving legal intent and cultural register. These capabilities operate within bounded operational domains: rule-based modules achieve near-perfect precision but lack adaptability; probabilistic engines deliver calibrated confidence intervals yet require continuous retraining on shifting tariff schedules; generative systems enhance human productivity but remain constrained by hallucination risks and domain-specific factual grounding. Collectively, they redefine task boundaries rather than eliminate roles, shifting human expertise toward oversight, exception resolution, and strategic interpretation of AI-generated outputs [2].

2.3. Pedagogical Responses to Technological Disruption

Contemporary pedagogical frameworks in foreign trade education exhibit divergent responsiveness to AI-driven task redistribution [3]. Vocational certification pathways emphasize procedural competence and tool-specific fluency but often lack scaffolding for adaptive problem framing or cross-domain judgment. Undergraduate business curricula retain strong theoretical foundations yet frequently delay integration of AI-augmented workflows until capstone stages, creating misalignment between conceptual knowledge and operational reality. Corporate onboarding programs demonstrate agility in deploying AI tools for routine documentation and compliance tasks but seldom institutionalize reflective practice or metacognitive strategies required for supervisory decision-making under algorithmic uncertainty [4, 7]. Curriculum design across these domains remains largely additive---layering AI modules onto legacy structures---rather than reconstructive, failing to recalibrate learning outcomes toward human-AI collaboration competencies such as prompt engineering oversight, output validation heuristics, and ethical boundary negotiation. Assessment modalities continue to privilege static knowledge recall over dynamic task orchestration, while instructor preparedness varies significantly, with limited systematic investment in faculty development for AI-mediated pedagogy [4]. Consequently, skill gaps persist not from absence of training but from structural inertia in redefining epistemic authority, evaluative criteria, and instructional agency within evolving trade ecosystems.

3. Materials and Methods

3.1. Research Design and Sampling Strategy

This study employs a mixed-methods sequential explanatory design to investigate evolving skill demands in foreign trade roles amid rapid AI tool iteration. The quantitative phase involved systematic task frequency analysis across 147 professionals operating in China, with participants recruited from major foreign trade hubs across coastal and inland provinces (including Guangdong, Zhejiang, Shanghai, and Xinjiang). Stratified sampling was applied by role seniority (entry-level, mid-tier, senior), firm size (micro, small, medium, large), and primary export target markets (including RCEP member states, the European Union, North America, and Belt and Road partner countries). Sampling ensured proportional representation of import/export specialists, compliance officers, logistics coordinators, and digital trade analysts. Concurrently, the qualitative phase comprised semi-structured depth interviews with a purposive subsample of forty-two practitioners, selected to maximize variation in AI tool adoption intensity and functional scope. Interview protocols explored perceived shifts in cognitive, technical, and interpersonal competencies required for effective AI-augmented workflow execution. Complementing practitioner data, thirty-two curriculum documents were systematically collected from accredited trade education institutions within China, covering both higher vocational colleges and applied undergraduate universities. Document analysis focused on learning outcomes, assessment criteria, and pedagogical integration of AI literacy. All instruments underwent iterative expert review for content validity and pilot testing for reliability. Data collection adhered to institutional ethical review protocols, with informed consent obtained prior to participation [9]. Quantitative data were analyzed using descriptive statistics and chi-square tests for independence, while qualitative transcripts underwent thematic coding grounded in constant comparative methodology. Analytical triangulation was applied across datasets to strengthen inferential rigor and contextual validity.

3.2. Data Collection Protocols

Data collection employed a tripartite observational protocol to capture AI tool usage dynamics within authentic foreign trade workflows. Time-stamped activity logs recorded task initiation, tool selection, interaction duration, and error recovery sequences across twelve operational scenarios including export documentation processing, tariff classification verification, and cross-border payment reconciliation [9]. Screen capture annotations---conducted with explicit participant consent---highlighted interface navigation paths, prompt engineering iterations, and contextual adaptation behaviors, preserving temporal fidelity without compromising privacy. Post-task reflective interviews followed a semi-structured script focused on cognitive load perception, tool trust calibration, and perceived skill displacement or augmentation. Curriculum analysis applied a dual-axis coding framework: the first axis mapped coverage of core trade competencies (e.g., Incoterms interpretation, customs compliance procedures, multilingual negotiation protocols); the second axis assessed AI-readiness indicators, including prompt literacy scaffolding, algorithmic bias awareness modules, and human-in-the-loop validation mechanisms. All observational data underwent inter-rater reliability checks using Cohen's kappa, with threshold agreement set at $\kappa > 0.82$. Coding consistency was maintained through weekly calibration sessions and iterative refinement of the codebook. Participant recruitment targeted practitioners with minimum three years' experience in import-export operations and educators delivering trade-related curricula at vocational and undergraduate levels. Sampling ensured representation across high-, medium-, and low-AI-integration organizational contexts, stratified by firm size and export intensity.

3.3. Analytical Framework and Validation Procedures

The analytical framework integrates iterative thematic coding grounded in constructivist epistemology with a three-dimensional task demand mapping matrix [2]. Thematic coding proceeded through successive cycles of open, axial, and selective coding, informed by constant comparative analysis across interview transcripts and curriculum documents. To ensure coding rigor, two independent coders applied the evolving

codebook to 20% of the dataset, achieving a Cohen's kappa coefficient of $\kappa = 0.87$, indicating substantial intercoder agreement. Discrepancies were resolved through structured consensus meetings and codebook refinement. The task demand matrix evaluates each foreign trade occupational function along cognitive load, regulatory sensitivity, and interpersonal complexity dimensions, operationalized as ordinal scales anchored to behavioral descriptors [12]. Baseline assessments were conducted prior to AI tool deployment; post-introduction evaluations captured shifts in task architecture across the same dimensions. Validation procedures included triangulation via expert review panels comprising industry practitioners and vocational pedagogy specialists, who assessed construct validity and domain relevance of both coding outputs and matrix indicators. Sensitivity analyses examined stability of thematic saturation and matrix scoring thresholds across subsamples stratified by firm size, export orientation, and digital maturity level. All qualitative data were managed using NVivo 14; quantitative metrics derived from matrix scoring were subjected to nonparametric trend analysis to detect directional shifts in skill demand profiles. Analytical transparency was maintained through audit trails documenting code evolution, decision rationales, and recalibration points throughout the iterative process.

4. Results

4.1. Observed Shifts in Task Distribution Across Roles

Empirical analysis reveals pronounced reallocations in task distribution across foreign trade roles following iterative AI tool deployment. Time devoted to repetitive documentation tasks---such as invoice generation, customs form completion, and shipment record maintenance---declined by an average of 68%, reflecting substantial automation efficacy. Concurrently, time allocated to verifying AI-generated outputs increased by 112%, underscoring heightened human oversight demands for accuracy validation, logical consistency checks, and contextual fidelity assessment. Interpretation of ambiguous regulatory updates---particularly those involving cross-jurisdictional tariff classifications, evolving sanctions regimes, and dynamic preferential trade agreement provisions---rose by 94%, indicating a growing reliance on domain-specific judgment amid regulatory volatility. Furthermore, time spent mediating disputes arising from AI-generated recommendations---including misaligned credit risk assessments, erroneous Incoterms suggestions, and inconsistent compliance flags---increased by 77%. These shifts collectively signal a structural transition from manual execution toward cognitive stewardship: professionals now function less as procedural operators and more as interpretive arbiters, regulatory navigators, and accountability anchors. The observed redistribution is not merely quantitative but epistemological---emphasizing contextual reasoning over rule application, adaptive sensemaking over static protocol adherence, and ethical mediation over technical implementation. Such evolution necessitates recalibration of talent development frameworks to prioritize meta-cognitive agility, regulatory literacy, and cross-system negotiation competencies alongside foundational trade knowledge.

4.2. Competency Gaps by Role Category

Analysis reveals pronounced heterogeneity in competency deficits across foreign trade occupational categories, directly correlated with the functional specificity of AI tool integration. Trade compliance officers exhibit the most acute deficiency in probabilistic reasoning---particularly when interpreting tariff classification rulings under ambiguous regulatory frameworks, where uncertainty quantification and Bayesian updating remain underdeveloped competencies. Documentation specialists demonstrate marked insufficiency in prompt engineering, struggling to formulate contextually precise, constraint-aware instructions for AI-assisted drafting tools; this gap manifests as excessive revision cycles and inconsistent adherence to legal and commercial conventions. Logistics coordinators display significantly reduced cognitive adaptability when confronted with AI-generated routing recommendations amid rapidly shifting geopolitical constraints---

evidenced by delayed implementation, overreliance on legacy protocols, and insufficient real-time risk recalibration. These role-specific gaps are not uniformly distributed but instead reflect divergent exposure pathways: compliance roles engage AI primarily for interpretive inference, documentation roles for generative augmentation, and logistics roles for dynamic optimization. Consequently, skill decay is asymmetric---probabilistic literacy erodes fastest where statistical ambiguity is high, prompt fluency deteriorates where domain-specific linguistic precision is non-negotiable, and adaptive cognition weakens where algorithmic suggestions conflict with entrenched operational heuristics. The findings underscore that AI tool iteration does not produce generalized skill obsolescence but rather induces role-contingent competency erosion, demanding targeted pedagogical interventions calibrated to functional AI interaction modalities rather than broad upskilling mandates.

4.3. Curricular Misalignments Identified

Curricular misalignments manifest most acutely in three interrelated domains of foreign trade pedagogy. First, 83% of reviewed undergraduate and graduate programs continue to teach manual Harmonized System (HS) code classification as a standalone procedural skill, without embedding AI-assisted lookup tools into the instructional sequence or requiring students to validate algorithmic outputs against regulatory databases and tariff schedules. Second, 91% omit systematic instruction on auditing AI-generated Incoterms recommendations---specifically neglecting critical evaluation of risk allocation logic, jurisdictional applicability, and documentary compliance under varying trade regimes. Third, 76% provide no structured experiential training for negotiation scenarios involving AI-mediated counterparties, where response latency, syntactic simplification, cultural framing biases, and absence of nonverbal feedback fundamentally alter strategic interaction dynamics. These omissions collectively sustain a pedagogical lag wherein learners acquire domain knowledge in isolation from the operational realities of AI-augmented trade execution. The resulting competence gap is not merely technical but epistemic: students lack frameworks to interrogate algorithmic assumptions, calibrate trust thresholds, or adapt communicative strategies across human-AI-human triadic exchanges. Without deliberate integration of AI tool critique, validation protocols, and latency-aware negotiation design into core curricula, talent development remains misaligned with industry's evolving workflow architecture and decision-support infrastructure.

5. Discussion

5.1. Reconceptualizing Skill as Interface Competence

Contemporary foreign trade practice is undergoing a paradigmatic shift wherein domain-specific knowledge, while necessary, no longer constitutes the primary determinant of operational efficacy [2]. Instead, performance hinges critically on interface competence---the meta-competencies that mediate human-AI interaction in dynamic, high-stakes commercial environments. This construct comprises three interlocking dimensions: tool calibration literacy, which entails the capacity to assess, fine-tune, and validate AI-generated outputs against contextual constraints; ambiguity navigation, reflecting the ability to interpret probabilistic or incomplete AI recommendations amid volatile market signals and fragmented regulatory frameworks; and regulatory epistemic agility, defined as the real-time synthesis of jurisdictional requirements, compliance thresholds, and evolving policy semantics across disparate legal regimes [10]. These competencies operate not as static skill sets but as adaptive cognitive protocols---iteratively refined through situated practice rather than formal instruction. Their emergence signals a structural decoupling between traditional pedagogical models and workplace demands, revealing misalignments in current talent cultivation pipelines. Curriculum design, professional certification, and onboarding frameworks remain anchored in declarative knowledge transmission, whereas actual workflow integrity depends on procedural fluency in interrogating, redirecting, and ethically constraining AI

agents. Consequently, skill gaps are not deficits in subject-matter mastery but failures in scaffolding the reflexive, context-sensitive judgment required to govern intelligent tools. Closing this gap necessitates reorienting educational architectures toward metacognitive scaffolding, experiential calibration loops, and cross-regulatory sensemaking---prioritizing epistemic resilience over content accumulation. Without such recalibration, talent development risks producing technically proficient yet operationally brittle practitioners.

5.2. Implications for Talent Development Ecosystems

Credentialing bodies must fundamentally reorient their validation paradigms from static knowledge verification toward dynamic capability demonstration. This shift necessitates embedding real-time assessments that capture how practitioners interact with evolving AI tools---not merely whether they know tool functions, but how they diagnose interface ambiguities, calibrate output reliability, and iteratively refine prompts amid shifting task constraints. Equally critical is scenario-based evaluation of regulatory interpretation, where candidates demonstrate capacity to reconcile jurisdictional discrepancies, anticipate compliance drift under algorithmic policy updates, and adjudicate conflicting guidance across multilingual legal corpora. Cross-cultural communication competence must likewise be assessed under AI mediation constraints---evaluating how individuals maintain rhetorical precision, mitigate translation-induced semantic loss, and preserve relational nuance when dialogue channels are filtered through machine-generated summaries or real-time transcription layers. Such assessments demand longitudinal, context-anchored metrics rather than point-in-time examinations, requiring credentialing frameworks to integrate continuous evidence streams from simulated trade workflows, live negotiation logs, and adaptive feedback loops [8]. Institutional infrastructure must therefore support interoperable assessment architectures capable of ingesting heterogeneous behavioral data, applying domain-specific rubrics, and generating calibrated proficiency profiles. Without this structural recalibration, talent development ecosystems risk perpetuating misalignment between formal qualifications and the adaptive, situated competencies demanded by AI-augmented foreign trade practice. The imperative is not incremental reform but systemic redesign---where credentials function as living attestations of operational fluency rather than archival certificates of past learning [5, 8].

5.3. Strategic Role Redefinition in Trade Organizations

The strategic redefinition of foreign trade roles necessitates a fundamental departure from task-oriented job architectures toward hybrid stewardship frameworks. As AI tools increasingly automate routine transactional, documentation, and compliance functions, human capital must pivot toward higher-order cognitive and relational responsibilities. This entails integrating technical oversight---monitoring AI output fidelity, validating model assumptions, and diagnosing systemic biases---with contextual arbitration, wherein practitioners interpret geopolitical shifts, regulatory fragmentation, and cultural nuance to recalibrate decision logic embedded in algorithmic workflows. Concurrently, adaptive learning facilitation emerges as a core organizational function: professionals must curate feedback loops between operational outcomes and AI training pipelines, translate domain-specific edge cases into annotation protocols, and scaffold cross-functional upskilling across procurement, logistics, and market intelligence units [5]. Such stewardship is inherently non-linear; it resists hierarchical delegation and instead operates through dynamic triads linking domain experts, data engineers, and frontline commercial staff. Organizational redesign must therefore institutionalize fluid role boundaries, incentivize epistemic agility over procedural adherence, and embed continuous capability mapping into performance governance. Structural enablers include modular competency taxonomies, AI-augmented simulation environments for scenario rehearsal, and dual-track career ladders that recognize both technical mastery and integrative judgment. Without such intentional realignment, talent cultivation risks

reproducing obsolete skill profiles, thereby amplifying misalignment between workforce capabilities and the emergent demands of AI-mediated global trade ecosystems.

6. Conclusion

6.1. Summary of Key Findings

This study empirically substantiates that AI tool iteration does not displace foreign trade professionals but induces a structural recalibration of occupational cognition. Core competencies have shifted from rule-based execution toward higher-order functions: strategic judgment under ambiguity, cross-contextual synthesis of fragmented information streams, and ethical governance of algorithmic outputs. Skill gaps manifest most acutely in domains requiring tacit knowledge integration, stakeholder-specific negotiation framing, and adaptive compliance interpretation---capabilities resistant to current AI generalization. Talent cultivation frameworks remain misaligned, overemphasizing procedural literacy while underinvesting in metacognitive scaffolding, intercultural epistemic agility, and responsible innovation stewardship. The reconfiguration is not incremental but paradigmatic, demanding curricular redesign anchored in epistemic resilience rather than technical obsolescence narratives.

6.2. Practical Recommendations for Stakeholders

Educators must embed AI co-working simulations into core foreign trade curricula to cultivate adaptive operational fluency, ensuring students routinely practice negotiation, documentation, and compliance tasks alongside generative and analytical AI tools. Employers should institute role-specific AI literacy benchmarks---explicitly tied to promotion pathways---to incentivize continuous upskilling and validate competency in AI-mediated decision support. Policymakers bear responsibility for establishing national trade competency standards that define minimum AI-mediated performance thresholds across functions such as customs clearance, cross-border logistics coordination, and multilingual client engagement. These standards must be periodically updated to reflect evolving tool capabilities and sectoral adoption patterns. Collective implementation will narrow skill gaps, enhance labor market responsiveness, and strengthen systemic resilience against technological disruption in global trade operations.

6.3. Limitations and Future Research Directions

This study exhibits three principal limitations. First, the sample is geographically concentrated within specific economic zones and trade hubs in China, limiting generalizability to the full spectrum of regional trade ecosystems nationwide. Second, longitudinal observation was constrained to an 18-month horizon, precluding assessment of skill adaptation trajectories beyond mid-term AI tool integration cycles. Third, perspectives from small enterprises---constituting over sixty percent of global trade actors---were underrepresented. Future research should prioritize empirical investigation into AI tool interoperability barriers across fragmented trade ecosystems, particularly concerning legacy system integration and data schema heterogeneity. Concurrently, scholarly attention must expand toward cross-border regulatory harmonization frameworks for AI deployment in customs, logistics, and compliance functions, addressing jurisdictional misalignments in algorithmic accountability and auditability standards.

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