

**Hybrid Service Agency: Human-Robot Collaboration and Workforce
Transformation in Hospitality and Tourism**

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Hybrid Service Agency: Human-Robot Collaboration and Workforce Transformation in Hospitality and Tourism

Abstract

Service organisations deploying robots into frontline operations face a challenge beyond employee acceptance: whether human-robot teams can generate outcomes unattainable by either partner alone. This paper introduces Hybrid Service Agency (HSA), defined as the capacity of human-robot teams to create synergistic workforce and service outcomes, and identifies the conditions under which HSA emerges, persists, or breaks down. Using hospitality and tourism as a high-contact service context, we conducted a PRISMA-compliant systematic quantitative literature review of 129 peer-reviewed articles (Scopus, 2017–2026). The analysis combined keyword co-occurrence mapping, bibliographic coupling, Louvain community detection, and inductive thematic synthesis. Six bibliometric communities emerged, spanning service triad dynamics, collaboration antecedents, employee adaptation, identity reconstruction, workforce threat appraisal, and organisational governance. The resulting HSA framework advances four propositions centred on psychological empowerment, triadic role design, organisational governance, and threat appraisal as a breakdown pathway. Findings offer transferable governance insights for healthcare, retail, and professional services.

Keywords: Hybrid Service Agency; service robots; workforce transformation; human–robot collaboration; employee well-being; triadic role design; organisational governance; systematic review; hospitality and tourism

中文（普通话／简体中文）翻译

混合服务能动性：酒店与旅游业中的人机协作与劳动力转型

摘要

服务型组织在将机器人部署到一线运营时，面临的不仅是员工接受度问题，还需要考量人机团队能否创造任何一方单独行动时都无法实现的成果。本文提出“混合服务能动性”（Hybrid Service Agency, HSA）概念，将其定义为人机团队创造协同型劳动力与服务成果的能力，并识别 HSA 形成、持续或失效的条件。

本文以酒店与旅游业这一高接触型服务情境为研究背景，对 2017—2026 年间收录于 Scopus 数据库的 129 篇同行评审文章开展了符合 PRISMA 规范的系统性定量文献综述。研究综合运用关键词共现分析、文献耦合分析、Louvain 社区发现算法和归纳式主题综合方法。

研究识别出六个文献计量学研究群组，分别涉及服务三元关系动态、协作前因、员工适应、身份重构、劳动力威胁评估和组织治理。在此基础上构建的 HSA 框架提

出了四项命题，重点关注心理赋能、三元角色设计、组织治理，以及作为 HSA 失效路径的威胁评估。研究结果还为医疗保健、零售和专业服务等领域提供了可借鉴和迁移的治理启示。

关键词： 混合服务能动性；服务机器人；劳动力转型；人机协作；员工福祉；三元角色设计；组织治理；系统综述；酒店与旅游业

1. Introduction

Artificial intelligence and robotics are moving from pilot projects into frontline service operations, and hospitality and tourism are among the sectors furthest along in deploying them (Tuomi et al., 2021). Early research asked whether customers would accept robotic service; the more consequential management question now is how human and robotic workers, operating together in the same encounter, produce value that neither could deliver alone. This is a workforce question as much as a technological one, because it reconfigures job roles, skills, and the conditions under which frontline employees can work well alongside machines (Albannai and Raziq, 2025). We refer to the capacity of a human–robot team to generate such joint value as Hybrid Service Agency (HSA), and this paper asks under what conditions it emerges, is sustained, or breaks down.

The literature that speaks to this question is substantial but fragmented, with existing streams addressing different parts of the problem rather than the team-level capacity itself. Customer-acceptance research explains adoption and service-quality perceptions but treats outcomes as flowing from robots rather than from human–robot teams (Choi et al., 2020; Sharma et al., 2026). Employee-adoption research extends technology-acceptance models to frontline workers but leaves the sustained consequences of co-work underdeveloped (Xu et al., 2023). Organisational-adoption research establishes the strategic contingency of deployment without linking it to team and employee outcomes (Ivanov et al., 2020), and existing multilevel frameworks retain individual acceptance as the primary outcome (Bankins et al., 2024; Sharma et al., 2024). Each stream has assembled evidence at a different level, individual, encounter, or organisational, but none integrates them, and none names or specifies the *team-level* capacity that determines whether a human–robot team generates value at all. This is the gap the present study addresses: it cannot be closed by extending any single stream, because integration requires a construct pitched at the level where the streams intersect, the working team.

HSA is that construct: a team-level, emergent capacity rather than an individual attitude, a service channel, or a property of the robot. Because its label is close to constructs in adjacent literatures, particularly the *hybrid service agent* of Gnewuch et al. (2024), we distinguish it explicitly. A hybrid service agent, in their sense, is a customer-facing interface that combines a chatbot and a human; HSA is the emergent capacity a human–robot team may produce. An agent denotes an acting entity; agency denotes the emergent capacity of a configuration of actors to act collectively. We distinguish HSA from the hybrid service agent and from related constructs, namely human–robot collaboration, human–AI teaming, sociotechnical systems, and complementarity, in Table 1 (Section 3.4.2), once the construct has been fully specified.

Understanding HSA requires a multilevel account, because the capacity it names is produced by conditions operating at different levels of the organisation. We develop a framework in which three enabling conditions, namely organisational governance, triadic role design, and psychological empowerment, converge to produce HSA at the level of the team, while a fourth dimension, threat appraisal, specifies the pathway along which it breaks down when those conditions are absent. Locating the construct at the team level is not incidental but necessary: complementarity, the capacity to generate outcomes exceeding either partner's independent performance, is an emergent property of the team in interaction rather than an attribute either partner holds alone (Trist and Bamforth, 1951), and it cannot be explained by frameworks organised around individual adoption.

To develop this framework inductively, we conduct a PRISMA-compliant systematic quantitative review of 129 peer-reviewed articles on service robots in hospitality and tourism, addressing three questions: how the intellectual structure of the field has evolved (RQ1); what its research communities reveal about the mechanisms that enable or undermine workforce and service outcomes (RQ2); and under what organisational, encounter, and individual conditions HSA emerges, persists, or breaks down (RQ3). A three-stage process of temporal mapping, inductive community synthesis, and theory development ensures that the framework emerges from the evidence rather than being imposed on it, with each proposition grounded in one or more bibliometric communities. Because hospitality is further along in robot deployment than most service sectors, the mechanisms that become visible here are a leading indicator for adjacent contexts such as healthcare and retail, giving the framework transferable value beyond its immediate setting.

The study makes three contributions. First, it introduces HSA as a team-level construct that shifts attention from individual technology acceptance to the complementary performance of human–robot–customer triads. Second, it maps six research communities that reveal a decisive shift in the field from consumer-focused to workforce-focused inquiry. Third, it advances four cross-level propositions with explicit mediating mechanisms, feedback loops, and boundary conditions, offering testable predictions absent from prior multilevel frameworks. The remainder of the paper sets out the methodology, presents the HSA framework, and discusses its theoretical and managerial implications.

2. Study Design and Data Collection

This study adopts a Systematic Quantitative Literature Review (SQLR) to synthesise empirical evidence and map the intellectual structure of service-robot research in hospitality and tourism (Tranfield et al., 2003; Littell et al., 2008). The review protocol follows the PRISMA 2020 reporting guidelines (Page et al., 2021) to ensure methodological transparency, replicability, and traceability of all inclusion and exclusion

decisions. This approach is consistent with emerging methodological standards in service research, particularly in *The Service Industries Journal*, where systematic reviews have increasingly combined structured screening protocols with bibliometric techniques to ensure rigour and reproducibility (Mukherjee et al., 2023; Lim et al., 2022; Rasul et al., 2025).

Records were retrieved from the Scopus database in May 2026 to capture the most recent publications in this rapidly evolving field. Scopus was selected as the sole database for three reasons. First, it provides broad coverage of peer-reviewed research in business, management, and the social sciences. Comparative evidence shows that Scopus indexes substantially more journals than Web of Science, including a larger number of unique titles, while also covering most journals indexed by Web of Science (Mongeon and Paul-Hus, 2016). This breadth makes it particularly suitable for an interdisciplinary field such as service robotics, which spans hospitality, tourism, service management, technology, and related areas. Second, using a single database ensures greater consistency in bibliographic records and avoids the deduplication and metadata reconciliation problems that can arise when combining databases with different indexing practices. This is particularly important for bibliographic coupling, where consistency in reference lists directly affects the resulting intellectual structure (Zupic and Čater, 2015). Third, the use of Scopus is consistent with established practice in comparable systematic reviews of service robotics published in this journal and related outlets (e.g., Mukherjee et al., 2023; Rasul et al., 2025).

The search strategy was structured around three concept blocks corresponding to the study's aims: (1) robotics and AI technologies (e.g., "service robot*", "social robot*", "cobot*", "AI-enabled service*", "chatbot*"); (2) workforce and employee constructs (e.g., "employee*", "workforce", "job insecurity", "well-being", "knowledge hiding", "burnout", "work engagement"); and (3) hospitality and tourism contexts (e.g., "hospitality", "hotel*", "restaurant*", "tourism", "accommodation"). Boolean operators were applied across titles, abstracts, and keywords (see Supplementary Materials for the full Scopus query string).

The PRISMA-compliant selection process is summarised in Figure 1. The initial Scopus search returned 612 records. Application of subject area filters (Business, Management, Social Sciences), document type restrictions (peer-reviewed journal articles only), and English-language requirements reduced the pool to 232 records eligible for full-text screening.

Full-text screening was conducted by two independent raters (Rater 1 and Rater 2), who assessed each of the 232 articles against the pre-specified inclusion and exclusion criteria below. Raters worked independently without access to each other's decisions, following double-blind parallel coding best practice (Littell et al., 2008). Inter-rater

agreement was assessed using Cohen's κ prior to conflict resolution, yielding $\kappa = 0.79$, indicating substantial agreement (Landis and Koch, 1977). All disagreements were resolved by discussion with a third reviewer (Rater 3), whose decision was binding.

Inclusion criteria (all must be met):

- Published in a peer-reviewed journal, in English
- Explicit hospitality or tourism context (hotel, restaurant, airline, cruise, travel, accommodation, food service)
- Includes a service robot, AI-enabled automation, or collaborative robot (cobot) as a primary variable or intervention
- Addresses at least one workforce/employee-related outcome (psychological, behavioural, or well-being), OR an organisational/strategic service implementation perspective

Exclusion criteria (any one sufficient for exclusion):

- Customer-focused study with no employee or organisational perspective
- Pure engineering or computer science paper with no service management or HR relevance
- Conference paper, book chapter, or non-peer-reviewed source
- Primary context outside hospitality or tourism (e.g., healthcare, education, manufacturing)

After full-text screening, 103 articles were excluded (see Figure 1 for exclusion reasons). The dominant exclusion reason was a customer-only focus with no employee or organisational perspective, accounting for 69% of exclusions.

To address concerns about methodological heterogeneity in the included corpus, particularly the risk that high-citation but methodologically weak papers could disproportionately shape conclusions, each of the 129 articles was subjected to a formal quality appraisal using a five-dimension scoring matrix rated on a 1–5 scale:

- **T** (*Theoretical Rigour*): depth and explicitness of theoretical grounding
- **M** (*Methodological Quality*): appropriateness of research design, sampling, and analytical procedures
- **E** (*Employee-Centricity*): centrality of employee and workforce outcomes to the study

- **X** (*Cross-Sector Transferability*): applicability of findings beyond the hospitality context
- **F** (*SIJ Fit*): relevance to The Service Industries Journal's editorial mandate on service systems and innovation

This quality appraisal approach extends established practice in service management SLRs (Lim et al., 2022; Mukherjee et al., 2023) and responds directly to calls for quality-weighted synthesis in bibliometric reviews (Tranfield et al., 2003). Both raters independently scored all 129 articles against the five quality dimensions. Disagreements exceeding one point on any dimension were resolved through discussion until consensus was reached. Across the 129 included articles, mean quality scores were: T = 3.98, M = 4.00, E = 4.43, X = 3.81, and F = 4.47. The relatively lower cross-sector transferability score ($\bar{X} = 3.81$) confirms the need for the structured transferability conditions framework developed in Section 4 of this review. Within the PRISMA 2020 framework, this appraisal documents the methodological rigour of the included studies and informs the confidence placed in their evidence; it characterises the corpus rather than functioning as a screening criterion. It was therefore applied to all 129 included articles to inform interpretive emphasis in the synthesis, and no article was excluded from the review on the basis of its appraisal score. The final corpus, therefore, comprises N = 129 peer-reviewed articles spanning 2017 to 2026.

The 129 included articles reflect methodological diversity appropriate for a maturing field: 35% use quantitative survey designs (n = 45), 25% mixed methods (n = 32), 19% qualitative approaches (n = 24), 9% experimental designs (n = 12), 7% systematic or meta-analytic reviews (n = 9), and 5% conceptual/theoretical contributions (n = 7). Geographically, China is the dominant context (29%, n = 37), followed by multi-country studies (13%, n = 17), the USA (12%, n = 16), Southeast Asia (12%, n = 15), and Europe (11%, n = 14). This geographic concentration, particularly towards Chinese institutional affiliations, is acknowledged as a limitation and discussed in Section 4.3. Figure 1 summarises the full selection process.

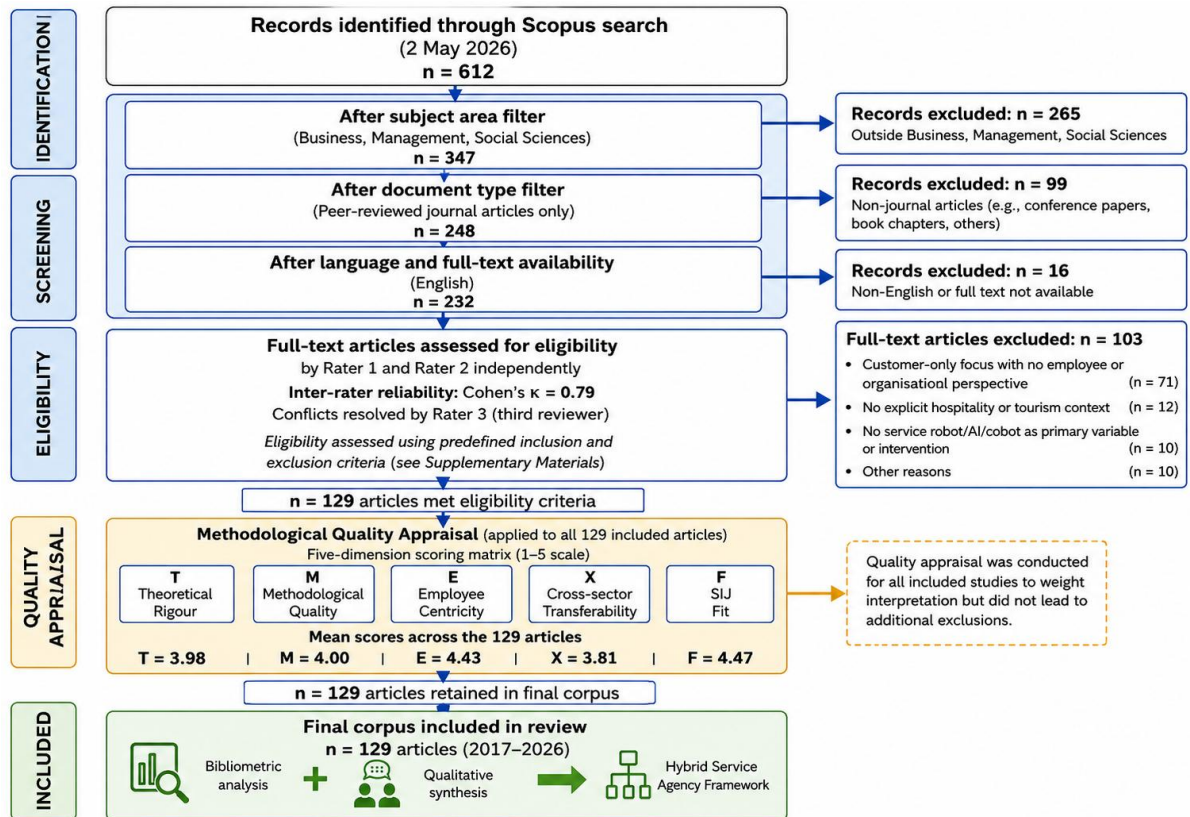


Figure 1. PRISMA 2020-informed flow diagram for systematic article selection and methodological quality appraisal (Figure created with support from GPT-5.5; conceptual content developed by the authors).

2.1 Data Analyses Overview

To capture both the descriptive landscape and the deeper intellectual structure of the field, five complementary analyses were conducted. Descriptive statistics documented publication trends, citation impact, authorship patterns, journal distribution, and the methodological and geographic profile of the corpus, providing context for the field's evolution and informing subsequent interpretive claims. Keyword co-occurrence analysis using VOSviewer identified thematic clusters and their temporal evolution (van Eck and Waltman, 2010). Bibliographic coupling was then employed to map intellectual relationships among articles based on shared references and to detect research communities via the Louvain algorithm (Kessler, 1963; Zupic and Čater, 2015). Qualitative thematic synthesis was used to interpret each community and develop the multi-level workforce-transformation framework. Together, these methods provide a robust and multi-layered basis for understanding how hospitality robotics research is organised, where quality concentrations lie, and where critical gaps remain.

3. Findings

3.1 Analysis 1: Descriptive Analysis

The corpus comprises 129 peer-reviewed articles published between 2017 and 2026 and exhibits steep, non-linear growth: approximately 70% (n=90) appeared between 2024 and 2026, following a formative phase (2020–2021) and a consolidation phase (2022–2023). This trajectory confirms that service-robot workforce research has moved from crisis-response inquiry into a self-sustaining, theory-driven programme, with the most recent wave concentrated on employee-centric and dark-side outcomes rather than the adoption questions of earlier work. Because the distribution is strongly recency-weighted, citation counts are an unreliable proxy for intellectual contribution, and the analysis therefore privileges structural and thematic evidence over citation weighting. Full publication, citation, authorship, and journal-distribution statistics are reported in Supplementary Material B (Figures S1-S2).

The corpus is workforce-centric in its primary focus: 62% of articles centre on employee-related outcomes, against 22% on organisational adoption and 16% on mixed outcomes. Physical service robots are the dominant technology studied (67%), with chatbots and cobots forming smaller but growing sub-streams, and the corpus is methodologically diverse, spanning survey, mixed-methods, qualitative, and experimental designs. Geographically, it is concentrated in Chinese institutional affiliations (29%), a limitation examined in Section 4.3. Together, the post-2024 surge, the methodological diversity of recent work, and the decisive shift toward employee-centric outcomes establish that the field has reached a maturity that both justifies and requires integrative theoretical synthesis.

3.2 Analysis 2: Keyword Co-occurrence and Temporal Evolution

Keyword co-occurrence analysis (VOSviewer) maps the field's thematic structure. The network is anchored by "service robots," whose strongest links to hospitality, artificial intelligence, and human–robot collaboration, radiate into three zones: technology-and-context anchors, a workforce-and-employee core carrying the network's most recent temporal signatures, and adoption-and-service-quality streams that are themselves reorienting toward workforce experience. The keyword-standardisation procedure and the full cluster structure are reported in Supplementary Material C (Figure S3).

Three intellectual phases are legible in the cluster mean publication years (Figure S4). In the foundational phase (up to 2022), research asked whether robots belonged in hospitality, in a deployment-facing vocabulary of technology acceptance and service encounters. In the consolidation phase (2023), the centre of gravity shifted toward employee experience alongside technology diversification, as generative AI and robot anthropomorphism arrived simultaneously with job crafting and service-robot risk

awareness, the field's first systematic attention to employee risk and relational dynamics. In the workforce-consequence phase (2024 onwards), the frontier concentrates dark-side outcome constructs: cognitive appraisal, turnover intention, career sustainability, and the field's newest keyword, scale development (mean year 2026.0). This progression, from whether to deploy robots to how integration reshapes employee psychological states, relational dynamics, and career trajectories, supplies the keyword-level warrant for the workforce-transformation framing and prepares the ground for the community analysis, which maps the same progression onto six intellectual communities.

3.3 Analysis 3: Bibliographic Coupling and Research Communities

Bibliographic coupling maps intellectual relationships among articles based on shared references, making it particularly suited to emerging fields where citation patterns are still forming (Kessler, 1963; Zupic and Čater, 2015). A coupling network was constructed for all 129 articles using the Louvain algorithm with a minimum threshold of 12 shared references; 60 articles met this threshold, producing six communities (see Figure 2). The threshold of 12 shared references was set so that detected communities reflect substantive intellectual proximity rather than incidental citation overlap. The fact that 60 of the 129 articles met this threshold is partly explained by the characteristics of bibliographic coupling in a young and rapidly expanding field. Coupling strength depends on accumulated shared references, and the field's most recent work, 70% of which was published between 2024 and 2026, has had limited time to develop the dense reference-sharing that coupling detects (Zupic and Čater, 2015). Crucially, the 69 articles below the threshold were not discarded. They inform the descriptive analysis and the keyword co-occurrence and temporal analyses, all of which were conducted across the full corpus of 129 articles (see Sections 3.1 and 3.2). The framework accordingly rests on triangulation across three analyses operating at different resolutions: the descriptive and keyword analyses establish field-level structure and its evolution across the full corpus, while bibliographic coupling identifies finer community structure within the subset of articles meeting the coupling threshold. The communities provide finer-grained evidence about the mechanisms and conditions represented in the literature, while the full corpus establishes whether the patterns identified within the communities are consistent with the field's overall trajectory. The recency of the community papers similarly reflects the actual distribution of the literature rather than a sampling choice, since the workforce-focused turn theorised by the framework is itself a recent development (Section 3.2.3).

The communities span multiple levels of analysis, from the service encounter (Community 1) through individual enabling and relational dynamics (Communities 2, 3 and 4), breakdown pathways (Community 5), and organisational governance (Community 6). Each community maps onto one or more of the four propositions developed in Section 3.4 (see Supplementary Materials for the papers included in each community). Each community captures a partial facet of human–robot collaboration,

including the triad, collaboration antecedents, individual adaptation, identity, threat, and governance, but none integrates these facets into a team-level account of when collaboration becomes generative. The HSA framework is therefore the synthesis across communities, not a structure contained within any single one. This distinction is central to the construct's contribution: HSA integrates complementary streams of evidence at the team level rather than restating the findings of any individual community.

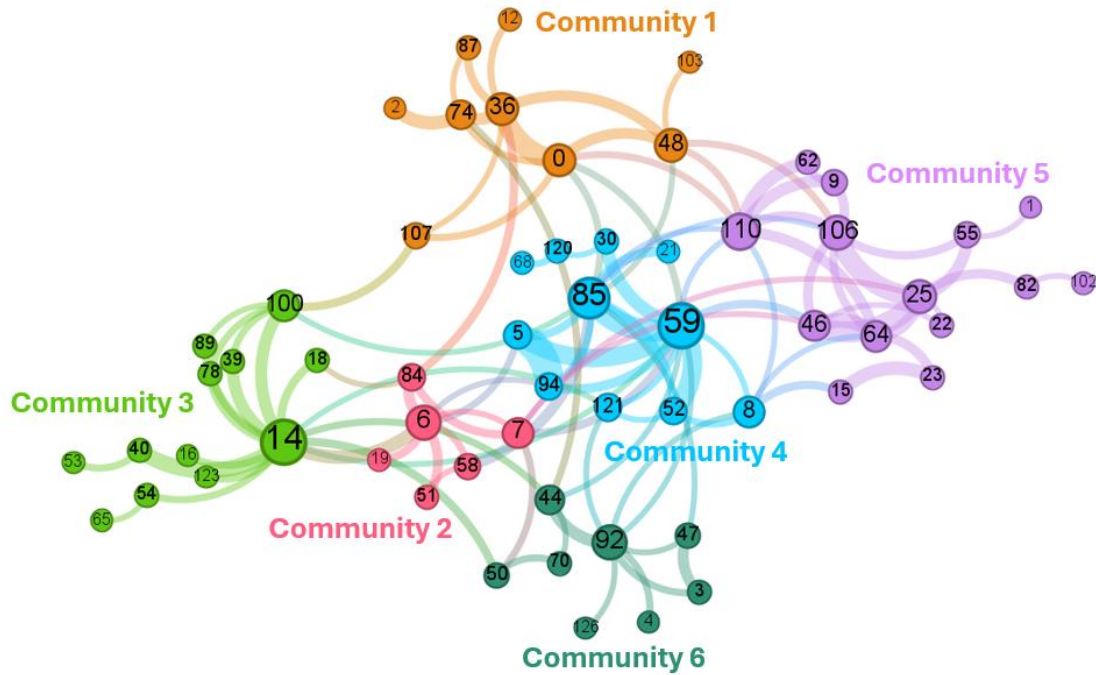


Figure 2. Bibliographical Coupling Results (Developed by authors using Gephi)

3.3.1 Community 1 ($n = 9$): *The Service Triad as the Unit of Analysis*

Community 1 establishes that the robot-employee-customer triad, not the dyadic encounter, is the appropriate unit of analysis for service robot research. Its central finding is that human-robot complementarity is consequential: when robots underperform, employees providing high interaction quality preserve customer repatronage outcomes that neither actor alone could guarantee (Odekerken-Schröder et al., 2022), and field experimental evidence confirms that robotic service agents achieve guest satisfaction equivalent to human staff, demonstrating viable complementarity without service quality loss (Schmidt et al., 2025). Robot deployment transforms rather than eliminates human roles, with employees transitioning into enabling and coordination functions that derive their purpose from the robot's presence (Tuomi et al., 2021). Customers endorse the team positively while employees frequently resist it, a paradox of team endorsement alongside employee ambivalence (Moliner-Tena et al., 2024). Perceived implementation fairness does not resolve this tension automatically: when employee expectations are unmet,

overconfidence and complacency can paradoxically intensify dysfunctional behaviour (Gong, 2025a). Robot anthropomorphism adds a design-level mechanism, building employee psychological ownership and warmth that condition team readiness (Sehgal et al., 2025). *This community anchors Proposition 2 (Triadic Role Design).*

3.3.2 Community 2 (n = 6): Designing Productive Collaboration: Structural Antecedents of Human–Robot Co-Work

Community 2 is the most temporally concentrated in the corpus, with four of its six papers published in 2025–2026. As the smallest community, its conclusions are correspondingly more provisional than those drawn from the larger communities, and we treat its central pattern as proposition-generating rather than as an established generalisation: the evidence suggests that productive collaboration is shaped substantially by organisational design rather than by employee disposition alone. Role ambiguity under high human-robot task interdependence suppresses collaboration willingness even among employees with neutral attitudes toward robots (Wang et al., 2024). Trust in robots involves a multidimensional architecture spanning technology performance, interpersonal rapport, and organisational context, yet organisational investment alone proved insufficient to drive trust directly, confirming that active governance communication rather than deployment decisions per se shapes employee orientations toward robot co-work (Park et al., 2025). Compounding this, high perceived organisational investment in robots combined with visible customer satisfaction can increase employee risk awareness when the combination is read as substitutive rather than augmentative (Pan et al., 2025). The community introduces the first validated Employee-Robot Co-work Experience scale capturing cognitive, sensory, and emotional dimensions predictive of both performance and turnover (Tu et al., 2026), and confirms that collaboration willingness is driven by perceived reliability and job crafting opportunity while undermined by perceived inefficiency and social loafing risk (Wu et al., 2025). *This community anchors Proposition 3 (Organisational Governance), in conjunction with Community 6.*

3.3.3 Community 3 (n = 12): Proactive Adaptation in the Hybrid Workplace: Job Crafting, Affordances, and the Limits of Acceptance

Community 3 challenges technology acceptance as the primary frame for employee responses, arguing that proactive reconfiguration of job demands and resources, not adoption attitude, determines individual-level outcomes. Its theoretical backbone is Job Demands-Resources (Bakker and Demerouti, 2007), extended on the resource side through affordance theory, which reveals that employees differentiate physical from cognitive robot affordances and show stronger preference for the former (Leung et al., 2023), and on the demand side through job crafting research, which shows that performance expectancy drives active task boundary reshaping in robot-augmented work (Song et al., 2022). Employee self-efficacy compounds this: when robots are responsive

and interactive, self-efficacy combines with these design qualities to generate cognitive trust and improved service performance (Chung et al., 2025). A zero-sum framing of work moderates whether the crafting pathway opens: employees perceiving fixed-pie competition resist robots, but this appraisal responds to participatory design and advocacy communication (Jin et al., 2025). A systematic review of 34 employee-perspective studies confirms the centrality of cognitive appraisal in shaping employee responses to robot co-work (Xu et al., 2023). Subsequent empirical work surfaces a critical paradox: when robot co-work is perceived as evidence that the organisation values efficiency over human contribution, surface performance rises while work passion declines significantly (Xu et al., 2025). *This community anchors Proposition 1 (Psychological Empowerment).*

3.3.4 Community 4 (n = 11): Identity Reconstruction and Relational Consequences of Sustained Co-Work

Community 4 asks what happens after acceptance: the medium- to longer-run consequences of ongoing robot co-work for employee identities and relational lives. Nine of eleven papers were published in 2025-2026, making this the field's most recent frontier. When conditions are supportive, co-work generates a positive cluster: robot social presence reduces workplace loneliness (Liu et al., 2025a); developmental HR practices amplify psychological empowerment and reduce depersonalisation (Liu et al., 2025c); robot compatibility stimulates both explorative and exploitative learning (Guan et al., 2025b); and rapport leadership sustains the positive trajectory (Leung et al., 2025). When conditions are unsupportive, the same exposure generates the reverse: anthropomorphic robots intensify colleague objectification (Li et al., 2026); robot social competence has a curvilinear relationship with job insecurity (Wu et al., 2026); and only employees who integrate robot co-work into their occupational self-concept achieve adaptive service improvisation rather than identity displacement (Horng et al., 2025). This bright/dark bifurcation, determined by HR practices, leadership, and organisational communication, provides *both the sustaining-condition evidence for Proposition 1 and the temporal specification for Proposition 4.*

3.3.5 Community 5 (n = 14): Threat Appraisal and Workforce Attrition

Community 5 is the largest in the corpus and the most theoretically unified around a single replicated chain: robot exposure triggers threat perception, job insecurity, and robot-phobia, which drives behavioural withdrawal in the form of turnover intention, reduced organisational citizenship, and robot-directed abuse. Robot-phobia functions as a distinct job stressor, separate from general technology anxiety, amplified by high interaction frequency (Chen and Cai, 2025). Generation Z employees show accepting attitudes in principle but heightened sensitivity to perceived risk and robot awareness, with insecurity mediating turnover (Horpynich et al., 2025). Transformational leadership, perceived organisational support, and tech-savviness consistently buffer the threat chain

and redirect it toward constructive adaptation (Yu et al., 2022; Shum et al., 2024; Mistry and Horpynich, 2026). The community's core claim, that it is the appraisal rather than robot capability or deployment intent that determines outcomes, follows from this consistent moderation pattern. Several non-linearities qualify the general picture: robot autonomy that generates role conflict undercuts performance benefits (Gong, 2025b); robot service failures trigger both resistance and adaptive coping, with employee autonomy determining which predominates (Gong, 2026); and when collaboration effectiveness, working conditions, and autonomy are aligned, career sustainability improves, confirming a positive counterpart to the attrition pathway (Poulose et al., 2026). *This community anchors Proposition 4 (Threat Appraisal and HSA Breakdown).*

3.3.6 Community 6 ($n = 8$): Organisational Adoption, Stakeholder Divergence, and Governance of Hybrid Service Systems

Community 6 asks why three principal stakeholder groups systematically evaluate robot deployments from positions that are structurally divergent. Customers foreground functional and emotional benefits; managers foreground financial investment and technical reliability; and employees recognise operational potential while anticipating role disruption (Zhong et al., 2022). Ivanov et al. (2020) document that managers frame robot adoption in augmentation terms while employees interpret the same deployment through the lens of job displacement; this perceptual divergence, when left unaddressed by explicit governance communication, generates the information asymmetry that employees fill with displacement rather than augmentation reasoning. Seyitoğlu et al. (2021) document what this produces in practice: both employees and managers exhibit job-insecurity-driven resistance even when both nominally prefer a mixed model, marking precisely the governance vacuum deliberate architecture must fill. Cultural and generational context modulate the structure of this divergence without eliminating its logic: UTAUT pathways vary with uncertainty avoidance and power distance (Abdelhakim et al., 2023); Generation Z collaboration intentions are sensitive to job insecurity across national contexts (Ali et al., 2023); and strong role-identity investment in front-of-housework generates sector-specific resistance that aggregate adoption frameworks do not capture (Konak and Çiçek, 2025). *This community anchors Proposition 3 (Organisational Governance), in conjunction with Community 2.*

Table S7 in the Supplementary Materials provides a structured comparison of the six communities across unit of analysis, dominant theoretical frameworks, primary outcome variables, and their respective contribution to the Hybrid Service Agency framework.

3.4 Toward a Theory of Hybrid Service Agency: A Multi-Level Enabling Framework

3.4.1 Framework Architecture

The six research communities reveal a common concern at the heart of human-robot collaboration in services: under what conditions can humans and robots achieve outcomes together that neither could achieve independently? Addressing this question requires a cross-level perspective that connects organisational governance, role design within the service encounter, and individual psychological experiences with the performance of the wider service team. We refer to this collective capacity as HSA. The concept is introduced here as a working characterisation and is formally defined at the end of Section 3.4.2, once its key propositions and underlying conditions have been established. Importantly, HSA shifts the focus beyond whether employees accept or adopt robotic technologies. Instead, it seeks to explain how effective human-robot collaboration develops, how it can be sustained over time, and why it may weaken or break down.

The central argument of the framework is that HSA does not reside at any single level of analysis. Instead, it emerges through the convergence of three enabling conditions operating across different levels. Organisational governance (P3) provides the macro-level foundation, triadic role design (P2) shapes how human, robot, and customer roles come together within the service encounter, and psychological empowerment (P1) enables frontline employees to work proactively and constructively with robotic systems. These conditions are interconnected, but they should not be understood as simply nested within one another. Governance creates broader conditions that support effective role design and employee empowerment, while these lower-level processes contribute more directly to the emergence of HSA. In this sense, governance influences HSA through the conditions it creates rather than through a direct effect on team performance.

At the individual level, job crafting provides an important mechanism through which psychological empowerment is translated into team-level agency. Empowered employees can actively reshape their tasks and relationships to work with the robot in complementary rather than competing ways (Song et al., 2022; Xu et al., 2023). It is through this active adjustment of work, rather than empowerment alone, that individual psychological states contribute to collective performance. HSA therefore emerges at the team level from the interaction of organisational support, well-designed roles, and employees' active efforts to adapt their work around robotic capabilities. No single condition produces HSA on its own; it is their alignment across levels that allows effective human-robot collaboration to emerge and be sustained.

The framework is dynamic rather than static. At a given point in time, it follows a directional pathway in which organisational governance supports effective role design, role design creates the conditions for psychological empowerment, and empowerment, through job crafting, contributes to the emergence of HSA. Over time, however, these

relationships develop through feedback. The outcomes generated by HSA can strengthen or weaken the very conditions that initially supported its development.

Three feedback mechanisms, discussed further in Section 3.4.3, capture this dynamic process. First, a reinforcing loop occurs when successful HSA provides organisations with visible evidence that human-robot collaboration is working, encouraging further investment in the governance conditions that produced it. Second, a corrective loop occurs when HSA begins to break down. When the source of this deterioration is correctly recognised, organisations can respond by adjusting roles, leadership practices, communication, or other supporting conditions. Third, a temporal loop captures the more gradual consequences of sustained unsupportive human-robot collaboration. Over time, such experiences can weaken employee empowerment, often before their effects become visible in conventional performance measures. The framework is therefore directional at a particular point in time but becomes dynamic through these feedback processes as experiences and outcomes reshape the conditions that produced them.

The same architecture also explains how HSA can deteriorate. When the enabling conditions are weak or absent, sustained threat appraisal (P4) can gradually undermine the human contribution to the team, encouraging withdrawal and, ultimately, exit. Threat appraisal is therefore not treated as a separate process but as the breakdown pathway within the same framework. The corrective and temporal feedback loops become particularly important at this stage because they determine whether deterioration is recognised and addressed or allowed to continue. Figure 3 brings these relationships together by showing the three enabling conditions across levels, job crafting as the mechanism connecting individual empowerment with team-level HSA, the three feedback loops, and the breakdown pathway that organisations need to recognise and address.

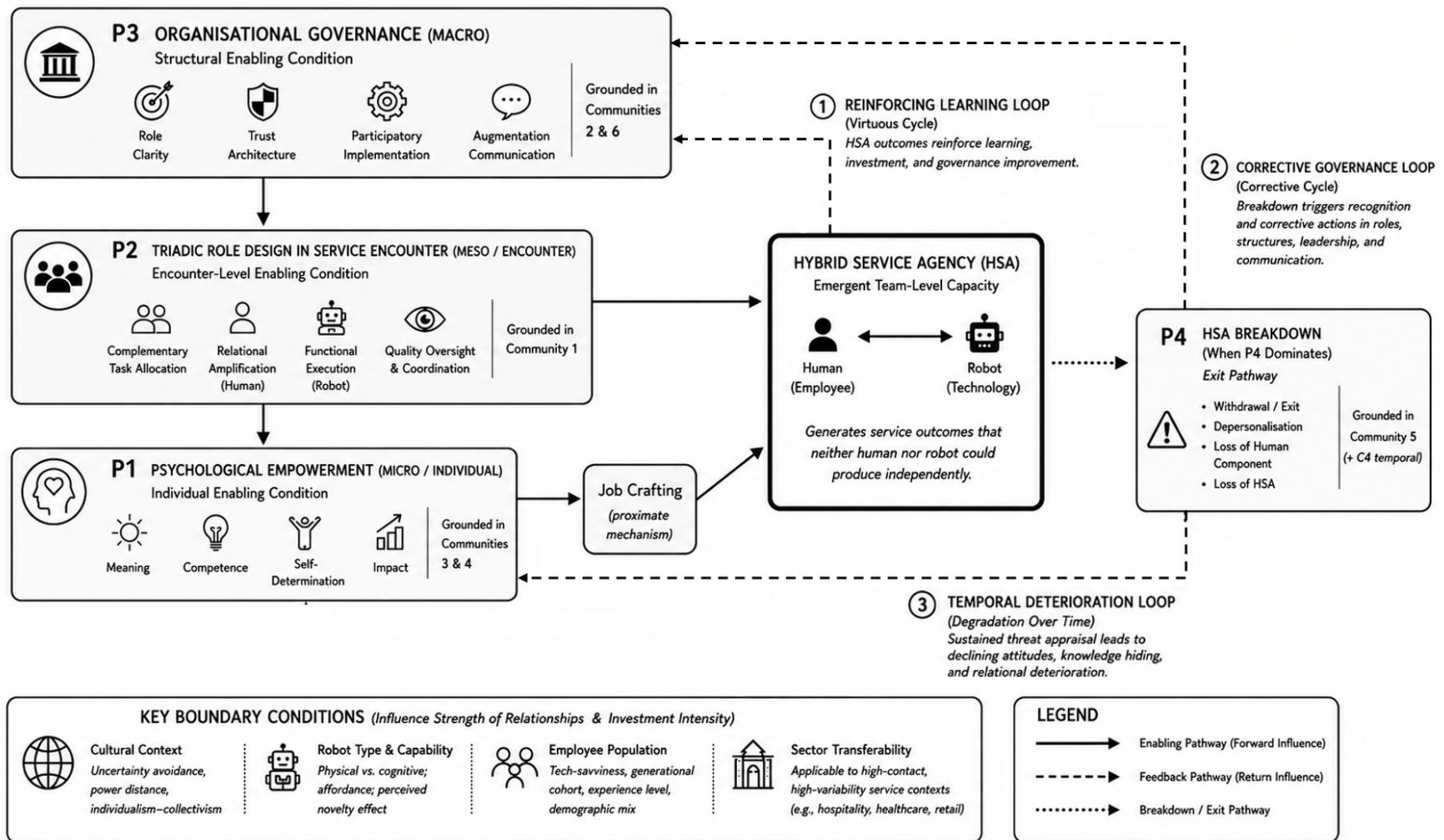


Figure 3. Hybrid Service Agency (HSA): A Multi-Level Enabling Framework. (Figure created with support from GPT-5.5; conceptual content developed by the authors)

3.4.2 Inductive Derivation: From Six Communities to Four Theoretical Propositions

The HSA construct from Community 1. The construct itself is grounded in Community 1's central finding: employee complementarity of an underperforming robot preserves customer repatronage outcomes that neither actor alone could guarantee (Odekerken-Schröder et al., 2022), and human-robot teams achieve equivalent guest satisfaction when robots are deployed at functionally bounded touchpoints (Schmidt et al., 2025). The paradox Community 1 identifies, that customers endorse the human-robot team while employees frequently resist it (Moliner-Tena et al., 2024), is the first tension the framework must resolve. It establishes that team-level performance requires individual enabling conditions that are not automatically present, making the team the appropriate unit of analysis and the enabling conditions the primary theoretical question.

Proposition 1 (Psychological Empowerment) is derived from the intersection of Communities 3 and 4. Community 3 establishes psychological empowerment as the individual-level mediator of positive co-work outcomes, with active job crafting as the proximate mechanism (Song et al., 2022; Xu et al., 2023). Community 4 contributes the bifurcation evidence that elevates this from a finding to a proposition-generating mechanism: the empowerment pathway diverges sharply depending on whether HR practices are developmental, leadership is rapport-oriented, and the organisation sustains the salience of human contribution alongside the robot's expanding functional role (Liu et al., 2025b; Leung et al., 2025). The same co-work exposure generates opposite outcome trajectories under these contrasting conditions (Xu et al., 2025; Horng et al., 2025). It is this cross-community convergence, the same moderating structure producing opposite outcomes in two independent bodies of work, that makes empowerment a proposition-generating mechanism rather than a single finding.

Proposition 1: The greater a frontline employee's robot co-work-induced psychological empowerment, encompassing perceived meaning, competence, self-determination, and impact, the more reliably the human-robot team will express HSA in the service encounter. This relationship is mediated by active job crafting: empowered employees proactively reconfigure task and relational boundaries to complement rather than compete with the robot, which is the proximate mechanism through which individual psychological states translate into team-level HSA expression. The pathway is enabled by developmental HR practices and rapport leadership, and is systematically undermined by organisational dehumanisation, identity displacement, and unmanaged threat appraisal (Liu et al., 2025b; Song et al., 2022; Guan et al., 2025a; Xu et al., 2025).

Proposition 2 (Triadic Role Design) is derived from Community 1's collective argument that team-level performance depends on how roles within the triad are designed and communicated, not only on which technologies are deployed. If HSA is a team-level property, role designs positioning human and robot as competitors suppress it while those

specifying complementarity activate it. The key evidential move is Gong's (2025a) finding that perceived implementation fairness can paradoxically intensify employee dysfunction when role expectations are unmet, establishing that role clarity cannot be assumed even under good-faith governance. Role design is therefore an active architectural task, not a residual of deployment.

Proposition 2: HSA is maximised when role design allocates explicitly complementary rather than redundant or competitive functions to human and robot actors within the service triad, with employees occupying the roles of relational amplifier, quality overseer, and coordination hub for the robot's functional capabilities. Role designs that leave task boundaries ambiguous, position the robot as a plausible substitute for the employee's core relational functions, or fail to communicate the division of labour to customers suppress HSA even when P1 and P3 conditions are otherwise met (Odekerken-Schröder et al., 2022; Moliner-Tena et al., 2024; Tuomi et al., 2021; Gong, 2025a).

Proposition 3 (Organisational Governance) is derived from the intersection of Communities 2 and 6. Community 2 establishes that collaboration is an organisational design outcome: role ambiguity, absent institutional trust, and substitutive deployment signals suppress collaboration willingness regardless of employee attitude (Wang et al., 2024; Park et al., 2025; Pan et al., 2025). Community 6 identifies the specific mechanism through which governance failure is structurally produced: managers hold an implicit augmentation logic that employees cannot access, and the resulting information asymmetry fills with displacement reasoning rather than augmentation reasoning (Ivanov et al., 2020; Zhong et al., 2022). Together, the two communities establish governance as HSA's structural precondition. The necessary-condition logic is asymmetric: enabling conditions do not produce HSA automatically, but their absence prevents it absolutely.

Proposition 3: Deliberate organisational governance, encompassing role clarity, trust architecture between employees and both robots and the organisation, participatory implementation processes, stakeholder-aligned communication of the augmentation rationale, and culturally attuned deployment strategies, functions as a necessary antecedent of HSA. The necessary-condition logic implies an asymmetry: high governance investment does not guarantee HSA, but low governance investment guarantees its absence. Governance failures, including ambiguous role boundaries, absent augmentation communication, and unmanaged stakeholder divergence, are the primary proximate causes of the threat appraisal documented in Community 5 (Wang et al., 2024; Pan et al., 2025; Zhong et al., 2022; Abdelhakim et al., 2023).

Proposition 4 (Threat Appraisal and HSA Breakdown) is derived from Community 5, with temporal specification from Community 4. Community 5 replicates a mediation chain across fourteen studies in which robot exposure triggers threat appraisal, insecurity, and behavioural withdrawal, with consistent moderators distinguishing

adaptation from attrition (Yu et al., 2022; Chen and Cai, 2025). Community 4 adds a temporal dimension that the appraisal chain alone cannot provide: depersonalisation, colleague objectification, and relational deterioration accumulate gradually before exit statistics move, generating a long-run breakdown pathway that is distinct from the short-run threat-to-withdrawal sequence (Li et al., 2026; Wu et al., 2026). The two pathways require different interventions at different implementation stages, and their temporal separation is the framework's most practically consequential structural feature.

Proposition 4: When governance conditions are insufficient, including absent or ambiguous augmentation rationale, weak transformational leadership, low employee autonomy, and robots perceived as plausible relational substitutes, sustained cognitive threat appraisal dissolves the human component of the team through withdrawal and exit, making HSA impossible regardless of robot capability or role design intent. The breakdown mechanism operates through two temporally distinct pathways: a short-run pathway linking threat appraisal directly to turnover intention, and a longer-run pathway in which sustained unsupportive co-work produces depersonalisation, knowledge hiding, and relational deterioration before exit occurs (Chen and Cai, 2025; Horpynich et al., 2025; Yu et al., 2022; Li et al., 2026; Wu et al., 2026).

Defining the HSA construct. Having developed the four propositions from the six research communities, we can now formally conceptualise the construct that brings these insights together. Hybrid Service Agency (HSA) is defined as the emergent capacity of a human-robot team, situated within a human-robot-customer sociotechnical system, to generate workforce and service outcomes that neither the human nor the robot could achieve independently. This capacity develops when supportive organisational governance (P3), effective triadic role design (P2), and psychological empowerment through job crafting (P1) work together, while sustained threat appraisal (P4) can weaken or ultimately undermine it.

Importantly, HSA is a property of the team rather than an attribute of an individual employee or a capability embedded within the robot. It emerges through the way humans, robots, and customers interact within a particular service setting and depends on the conditions that support this interaction over time. Positioning the formal definition after the propositions is therefore deliberate. It reflects the inductive logic of the framework, with HSA emerging from the evidence and theoretical insights synthesised across the six research communities rather than being introduced in advance as an assumption that guides their interpretation. With the construct now fully specified, Table 1 sets out how HSA differs from the adjacent constructs against which it is positioned, namely human-robot collaboration, human-AI teaming, sociotechnical systems, complementarity, and the hybrid service agent of Gnewuch et al. (2024), across unit of analysis, core mechanism, the role of the customer, and the distinctive value it adds.

Table 1. Hybrid Service Agency (HSA) and adjacent constructs

Construct	Unit of analysis	Core mechanism	Customer role	Distinctive contribution of HSA
Human–robot collaboration	Human–robot dyad	Task coordination and interaction quality	Usually peripheral	Extends the dyad to a human–robot–customer triad and explains when collaboration generate value.
Human–AI teaming	Human–AI team	Shared cognition and role allocation	Typically absent	Incorporates the customer as a co-producer and focuses on emergent service value rather than internal team performance.
Sociotechnical systems	Social and technical work system	Joint optimization of social and technical subsystems	Not central in traditional formulations	Applies sociotechnical logic to customer-involved encounters and identifies enabling and breakdown conditions.
Complementarity	Tasks and occupations	Substitution versus augmentation in work allocation	Absent	Reframes complementarity as a team-level capacity shaped within the service encounter.
Hybrid service agent (Gnewuch et al., 2024)	Customer-facing chatbot–employee interface	Delegation and disclosure of human involvement	Customer communication changes following disclosure	Distinguishes agency, an emergent team capacity, from an agent, a hybrid interface, while incorporating related customer and employee dynamics.
Hybrid Service Agency (<i>this paper</i>)	Human–robot–customer triad (team level)	Multilevel enabling conditions, including organisational governance, triadic role design and psychological empowerment, activate job crafting and HSA, while threat appraisal drives breakdown (see P1–P4 in Figure 3)	Co-producer of value	Explains how human–robot service teams generate, sustain or lose value that neither actor could produce independently.

3.4.3 Cross-Level Feedback Mechanisms

The four propositions function as nodes in a feedback system whose dynamics determine whether HSA emerges, is sustained, or deteriorates over time. Three cross-level mechanisms connect them.

Reinforcing feedback loop (HSA to P3). When P1 conditions are met, empowered employees engage in active job crafting and deliver superior complementarity within the service triad (P2), generating observable service outcomes that provide organisations with evidence to invest further in the governance conditions (P3) that produced those outcomes. Corpus evidence traces each link. Positive co-work experiences drive knowledge management behaviours mediated by learning tensions (Guan et al., 2025a). Developmental HR practices produce a stable positive co-work equilibrium: employee-robot engagement reduces depersonalisation rather than generating it when such practices are in place (Liu et al., 2025c). Self-identity alignment with robot technology produces service improvisation that exceeds initial deployment expectations (Horng et al., 2025). At the encounter level, employees providing high interaction quality preserve customer repatronage (Odekerken-Schröder et al., 2022), creating an observable team-performance signal that distinguishes HSA-generating deployments from robot-only delivery. Organisations that attribute this signal correctly reinvest in the conditions producing it, closing the reinforcing loop.

Corrective feedback loop (P4 to P3). When P4 activates, threat appraisal generates withdrawal and exit, degrading the human component of the team. Governance correction depends on the correct attribution of that degradation. Attribution is not automatic: robot service failures trigger both resistance and adaptive coping simultaneously, with employee autonomy in response protocols determining which predominates (Gong, 2026), meaning that deterioration signals can be misread as employee resistance rather than as governance failure. The structural source of misattribution is documented in Community 6: multi-stakeholder appraisal divergence creates strong incentives to attribute service deterioration to employees rather than to the information asymmetry generating displacement reasoning (Zhong et al., 2022; Ivanov et al., 2020). When correct attribution occurs, the available governance correction is clear: organisational support directly mitigates the perceived risk mediating the threat-to-withdrawal chain (Mistry and Horpynich, 2026).

Temporal feedback loop (sustained P4 to P1 erosion). The relational and identity consequences documented in Community 4 accumulate gradually under sustained unsupportive co-work (P4), feeding back to erode the psychological resources that P1 requires. The early-warning signature is clinically important: robot co-work that induces organisational dehumanisation increases surface service performance as a short-run coping strategy while work passion declines substantially beneath it (Xu et al., 2025),

meaning standard performance metrics will not detect the erosion until it is advanced. Anthropomorphic robots increase colleague objectification over sustained exposure (Li et al., 2026), and moderately socially competent robots sustain the highest insecurity because they remain plausible relational substitutes (Wu et al., 2026). Once depersonalisation sets in, reversing P1 enabling conditions requires active relational rehabilitation rather than governance adjustment alone. This temporal asymmetry, with prevention substantially cheaper than remediation, is derivable directly from the contrast between Community 4's positive trajectory evidence (Leung et al., 2025; Guan et al., 2025a) and its negative trajectory evidence (Li et al., 2026; Wu et al., 2026).

3.4.4 Boundary Conditions

Four boundary conditions specify where the framework's propositions hold with full force, where they hold with modification, and where recalibration is required.

Cultural context. Community 6 establishes that UTAUT adoption pathways vary systematically with uncertainty avoidance and power distance (Abdelhakim et al., 2023), and that Generation Z collaboration intentions are differentially sensitive to job insecurity across national contexts (Ali et al., 2023). The practical implication for P3 is that governance communication strategies are not culturally uniform: the institutional signals that close the information asymmetry in low uncertainty-avoidance contexts require greater formal endorsement and hierarchical legitimation in high uncertainty-avoidance settings. The framework's enabling-condition logic holds across cultural contexts; the specific governance design required to activate it varies.

Robot type and capability level. Physical-affordance robots (handling repetitive, hazardous tasks) generate lower threat appraisal, clearer role complementarity, and more tractable triadic role design than cognitive-affordance robots (handling information processing and social interaction), because cognitive affordances generate the plausible relational substitute perception that activates P4. The non-linear finding that moderately socially competent robots generate the highest sustained insecurity (Wu et al., 2026) implies that cognitive-affordance deployments require substantially higher P3 governance investment than physical-affordance equivalents to achieve the same P1 outcomes.

Employee population characteristics. P4 dynamics are employee-population sensitive. Generation Z employees show more accepting attitudes in principle but greater sensitivity to implementation fairness and autonomy conditions (Horpynich et al., 2025), and tech-savviness consistently buffers the threat chain (Yu et al., 2022). The governance conditions specified in P3 must be calibrated to the population's specific threat appraisal profile rather than deployed uniformly. Organisations with Generation Z-dominant workforces face a specific P3 challenge: governance communication strategies

emphasising procedural fairness and autonomy carry more weight than those emphasising financial security or technology competence.

Sector transferability. The framework's propositions are expected to transfer most directly to high-contact service sectors sharing hospitality's structural characteristics: emotional labour requirements, significant task variability, and customer-facing role ambiguity. Low-contact, highly standardised service contexts fall outside the framework's primary scope because relational complementarity is less central to service value where task routinisation dominates. Healthcare and professional services represent the highest-priority transfer contexts: the mechanisms are structurally identical, but the temporal feedback loop carries greater urgency where occupational identity investment is high and knowledge-hiding has direct quality consequences (Mukherjee et al., 2023).

3.4.5 A Targeted Research Agenda

Proposition 1 (Psychological Empowerment). Longitudinal panel or experience sampling designs tracking employees from pre-deployment through 12 to 24 months, comparing developmental-HR against unsupportive contexts, are the priority. Natural experiments using staggered robot rollout across multi-site organisations offer quasi-experimental variation without the ethics and logistics constraints of random assignment.

Proposition 2 (Triadic Role Design). Encounter-level field experiments randomly varying role communication framing, complementarity versus coverage versus no framing, with matched employee-behaviour and customer-outcome measurement, would provide direct causal evidence. Customer attribution studies correlating role-boundary clarity with service quality attribution patterns would test the claim from the customer side.

Proposition 3 (Governance). The necessary-condition structure calls for Qualitative Comparative Analysis, which identifies configurations of conditions whose absence is sufficient to suppress an outcome regardless of other factors (Fiss, 2011). Multi-site industry partnership data from hospitality chains or healthcare systems with varied governance approaches across robot-equipped properties are the natural data source.

Proposition 4 (Dual-Pathway Breakdown). A multi-wave panel beginning pre-deployment and extending 24 months, measuring both short-run attrition indicators and long-run relational deterioration markers at each wave, would establish whether the temporal dynamics the framework predicts are empirically present and identify early-warning threshold values at which governance intervention remains effective.

Cross-cultural and cross-sector validation. Cross-national designs pairing equivalent robot deployments with matched governance interventions across high and

low uncertainty-avoidance contexts would provide causal evidence for cultural boundary conditions. Replication of the four propositions as hypotheses in healthcare, retail, and professional services is required before structural-analogical generalisability claims acquire empirical warrant.

Agentic AI and the changing integrator role. The next generation of service robots is likely to move beyond performing predefined tasks toward agentic AI systems that can set sub-goals, plan actions, and operate with greater autonomy during the service encounter (Wirtz and Stock-Homburg, 2025). This development raises an important question for the framework's account of value integration (Section 4.1.2). As robots become more capable of coordinating resources and making decisions independently, employees may no longer serve as the sole integrators of robotic capabilities. Triadic role design (P2) must therefore account for a technological actor whose role and functional boundaries can change as its level of autonomy increases.

Agentic AI provides an important setting for testing a key boundary condition of HSA: whether employees remain necessary as integrators when machines become increasingly autonomous. While the enabling conditions and breakdown pathway proposed in the framework remain relevant, the balance of integrative agency between humans and machines may shift. Rather than assuming that integration is primarily a human responsibility, future research should examine how this responsibility is shared across different levels of machine autonomy. Comparative studies of service settings with varying levels of agentic capability could reveal whether greater autonomy strengthens HSA by reducing employees' coordination burden or weakens it by reducing the human-robot complementarity on which HSA depends. Such research could also help identify the point at which human integration remains essential and the conditions under which greater machine autonomy begins to reshape the nature of HSA itself.

4. Discussion

The contribution of this review is not the sum of its three analyses but their synthesis. The keyword temporal analysis documents a field-wide reorientation from consumer acceptance to workforce consequence. The bibliographic coupling analysis demonstrates that the field's intellectual communities have self-organised around mechanisms of enabling and breakdown rather than around journals, national contexts, or prior theoretical templates. The HSA framework gives that self-organised evidence structure a name and a formal architecture. Together, the three analyses establish the empirical warrant for a new theoretical construct, specify the enabling conditions under which it operates, and reveal what six years of rapid publication had assembled without yet being able to integrate. This discussion situates the HSA framework within existing service management, organisational behaviour, and workforce transformation literatures (Section 4.1); translates its four propositions into structural prescriptions for practitioners (Section

4.2); and identifies the methodological constraints and research agenda the framework generates (Section 4.3).

4.1 Theoretical Contributions

4.1.1 What HSA Adds to the Service Management Literature

The central theoretical contribution of this review is a shift in both the unit of analysis and outcome variable. Existing service robot frameworks primarily examine adoption, focusing on whether employees accept robot co-workers (Xu et al., 2023; Bankins et al., 2024). While valuable, this perspective leaves a more important question unresolved: once human-robot teams are deployed, under what conditions do they generate outcomes beyond the capability of either actor alone? Hybrid Service Agency (HSA) addresses this gap by conceptualising collaborative advantage as the key outcome of interest.

First, the framework identifies cross-level enabling conditions that adoption models cannot adequately explain. Psychological empowerment (P1), triadic role design (P2), and organisational governance (P3) jointly determine whether HSA can emerge. Governance is especially critical because it functions as a necessary condition rather than a simple performance enhancer. Weak governance does not merely reduce HSA; it prevents it. This introduces an asymmetric and non-compensatory causal logic absent from conventional adoption models and additive regression approaches.

Second, the framework integrates bright-side and dark-side perspectives into a single contingent system. The same conditions that enable HSA also determine its breakdown pathway (P4). Empowerment without governance can create identity displacement and disillusionment, while governance without effective role design produces coordination failure. Rather than treating positive and negative outcomes as separate phenomena, the framework positions them as opposite outcomes of the same sociotechnical structure.

Third, the framework advances formally testable propositions with identifiable mediating mechanisms (Paul and Criado, 2020). Job crafting links empowerment to HSA expression (P1), role communication connects triadic design to complementarity (P2), governance architecture enables or constrains collaboration conditions (P3), and governance failure triggers withdrawal and long-term relational deterioration (P4). Together, these mechanisms establish a cumulative research agenda for studying human-robot collaboration in service systems.

4.1.2 Situating HSA within Existing Theoretical Streams

AI-at-work literature. Bankins et al.'s (2024) multilevel framework calls for mechanisms linking individual, group, and organisational levels of analysis. Similarly, the most

comprehensive recent meta-analytic work establishes the conditions under which customers regard automated agents as equivalent to human staff, confirming that even state-of-the-art synthesis remains customer-centric and leaves workforce and team-level consequences of deployment entirely unaddressed (Gelbrich et al., 2026). HSA responds to this gap by reframing adoption as a necessary precondition rather than the primary outcome. The unit of analysis shifts from the individual employee to the human-robot-customer triad, while the outcome shifts from acceptance intention to team-level complementarity. As a result, the focus moves from attitude formation to the enabling conditions required for joint performance.

Service-dominant logic and value co-creation. Service-dominant logic holds that value is co-created through the integration of resources, with operant resources, namely skills and knowledge that are characteristically human, acting upon operand resources to produce service outcomes (Vargo and Lusch, 2004). It might be objected that a service robot cannot satisfy SDL's conditions for a co-creating actor, since it possesses neither the intentionality nor the accumulated knowledge the theory attributes to resource-integrating actors. We accept this constraint because it is precisely what makes HSA's contribution to SDL an extension rather than a relabelling. Rather than promoting the robot to a third co-creating actor, HSA specifies it as a resource of ambiguous status: not fully operand because its outputs are consequential and semi-autonomous, yet not operant because it cannot integrate resources on its own account. Its value is realised only when a human operant resource integrates it into the exchange. HSA's theoretical contribution to SDL is therefore to identify the frontline employee as the necessary resource integrator in human–robot service: the actor who converts the robot's semi-operant capabilities into co-created value, and without whom those capabilities remain latent. This recasts co-creation in human–robot encounters as triadic in composition but asymmetric in agency, and it explains why the same robot generates value in one deployment and destroys it in another. The difference lies in whether the human integrator is empowered and role-designed to perform the integration (Čaić et al., 2018; Odekerken-Schröder et al., 2022). This extension is supported by the study's evidence: Community 1 shows that team-level value depends on the employee's integrative contribution rather than the robot's capability in isolation (P2), and Community 3 identifies job crafting as the concrete integrative behaviour through which it occurs (P1).

Beyond SDL, HSA also connects with the servicescape literature, although this connection is more focused. Servicescape theory explains how the physical and social environment of a service setting shapes the experiences and behaviours of both customers and employees (Bitner, 1992). From this perspective, service robots become an increasingly important part of the servicescape because their presence can change both the physical setting and the social dynamics of the encounter. HSA, however, addresses a different theoretical question. Its role architecture focuses on how responsibilities and

capabilities are organised across the human-robot team, rather than on how the broader service environment is designed. The two perspectives are therefore complementary but conceptually distinct. Servicescape theory helps explain the environment in which human-robot collaboration takes place, while HSA explains how that collaboration is organised and how it can generate collective service outcomes.

Workforce transformation and automation economics. Autor's (2022) task-based account explains why work requiring contextual judgement and social intelligence remains relatively resistant to automation. HSA complements this perspective but shifts the analysis from tasks and occupations to the working team. Rather than asking which tasks remain human, HSA asks how human capabilities combine with robotic capabilities to create value within the service encounter. From this perspective, complementarity may provide a team-level mechanism through which workforce augmentation occurs, as human judgement and adaptability combine with robotic consistency and efficiency. HSA therefore reframes workforce resilience as not only a matter of individual reskilling, but also one of how human-robot teams are designed, supported, and governed. This view is consistent with the sociotechnical principle that performance arises from the effective integration of social and technical elements rather than from either in isolation (Trist and Bamforth, 1951).

Corporate digital responsibility and workforce governance. Corporate digital responsibility (CDR) specifies the norms that should govern an organisation's development and deployment of digital technologies across their lifecycle, oriented toward the fair and transparent treatment of stakeholders (Lobschat et al., 2021; Wirtz et al., 2023). As currently developed, CDR is predominantly customer- and data-facing: its central concerns are privacy, algorithmic fairness, and the ethical handling of the customer-data streams that digital service generates. Extending CDR from customers to employees would be a change of application context rather than a theoretical contribution; HSA's addition is more specific and grounded in the review's own evidence. Community 6 indicates that a central governance failure in robot deployment is informational: managers hold an implicit augmentation rationale to which employees have no access, and the resulting asymmetry is filled by displacement reasoning rather than augmentation reasoning (Ivanov et al., 2020; Zhong et al., 2022). This identifies a responsibility that customer-facing CDR does not theorise, namely the obligation to communicate deployment intent transparently and to govern the interpretive gap that opens when it is withheld. HSA therefore extends CDR by adding a workforce-governance dimension with a distinct mechanism, augmentation communication (P3), and by showing that this responsibility is not merely an ethical commitment but a structural precondition for collaborative performance: left ungoverned, the asymmetry becomes the proximate cause of the threat appraisal that drives HSA breakdown (P4).

From this perspective, responsible digital governance is continuous with the conditions under which human–robot teams generate value, rather than a separate ethical overlay.

4.2 Practical Implications

The HSA framework suggests that effective human-robot collaboration depends not simply on adopting good practices, but on implementing them in the right sequence. Governance (P3) provides the foundation for effective role design (P2), which in turn creates the conditions for employee empowerment (P1). Training employees without first-handed governance and role design may therefore increase, rather than reduce, the risk of HSA breakdown (P4). The managerial implications that follow reflect this sequence, moving from organisational governance to role design and then to individual empowerment. In practice, organisations should approach human-robot collaboration as a staged organisational capability rather than simply a technology adoption exercise.

Step 1. Establish governance (organisational level; P3; Communities 2 and 6). Because governance is the necessary condition, it is the first and foundational investment. Its most specific requirement follows directly from Community 6's central finding: the decisive failure is informational, arising when managers hold an augmentation rationale that employees cannot access and the resulting gap fills with displacement reasoning (Ivanov et al., 2020; Zhong et al., 2022). The corresponding action is not a generic "communicate more" but a targeted one: communicate deployment *intent* explicitly, so that the interpretive gap is closed before it is filled. This must be paired with the trust architecture and participatory implementation that Community 2 identifies as prerequisites for collaboration willingness independent of employee attitude (Wang et al., 2024; Park et al., 2025).

Step 2. Design triadic roles (encounter level; P2; Community 1). With governance in place, service and HR managers should specify how employee roles evolve as task functions shift to the robot, allocating to employees the relational-amplifier, quality-overseer, and coordination-hub functions that Community 1 shows to be the source of team-level value (Odekerken-Schröder et al., 2022; Tuomi et al., 2021). Role clarity must extend to customers, since perceptions of accountability depend on how responsibilities are communicated across the human and robotic actors, and ambiguity here suppresses complementarity even where governance is sound (Moliner-Tena et al., 2024).

Step 3. Build psychological empowerment (individual level; P1; Communities 3 and 4). Only once governance and role design are established does investment in the individual level pay off. The evidence prioritises developmental HR practices, rapport-oriented leadership, and the enabling of job crafting as the proximate route by which empowerment becomes team-level performance (Song et al., 2022; Leung et al., 2025; Guan et al., 2025a). Because the temporal feedback loop makes prevention substantially

cheaper than remediation, this investment must precede, not follow, the appearance of negative outcomes. Managers should accordingly shift their integration metrics from adoption rates to indicators of HSA quality — customer repatronage in human–robot encounters, empowerment across meaning, competence, self-determination, and impact, and knowledge-sharing patterns that distinguish collaborative learning from knowledge hiding (Liu et al., 2025b; Guan et al., 2025a).

Step 4. Monitor breakdown signals (P4; Communities 4 and 5). HSA reframes threat appraisal as a potential sign of governance failure rather than simply employee resistance. Importantly, early deterioration may not appear in conventional performance measures. Employees can maintain short-term performance while work passion, engagement, and knowledge sharing decline (Xu et al., 2025; Yu et al., 2022; Shum et al., 2024). Managers should therefore treat these signals as early warnings and examine underlying governance, communication, and role design before attributing problems to employees. This is particularly important in healthcare and professional services, where occupational identity is strong, and disengagement or knowledge hiding can have significant consequences for service quality (Mukherjee et al., 2023; Zhong et al., 2022).

4.3 Limitations

This review is limited to Scopus-indexed, English-language articles and may therefore exclude relevant research published in other databases, practitioner outlets, or languages. This limitation is particularly important given differences between Scopus and Web of Science in their coverage of social science and non-English research (Mongeon and Paul-Hus, 2016). As a result, studies from regions with advanced service robot deployment, including Japan, South Korea, and the Gulf states, may be under-represented. Future reviews could address this limitation by combining multiple bibliographic databases and incorporating multilingual search strategies.

The corpus also shows strong geographic concentration, with Chinese institutional affiliations representing 29% of included studies ($n = 37$). Consequently, the evidence base reflects hospitality environments where labour markets, automation practices, and cultural attitudes toward robots may differ from Western and Global South contexts. Although the HSA framework is designed at a broader theoretical level, cross-national validation remains necessary before its propositions can be treated as universally applicable. Methodologically, the bibliographic coupling threshold excluded 69 of 129 articles from tightly connected community structures. While these studies informed the keyword analysis, the thematic synthesis and framework development were grounded more heavily in the high-coupling literature. The community structure is also uneven in size: the smaller communities, Community 2 in particular, rest on a limited and recent evidence base, and the conclusions drawn from them should be read as hypotheses for testing rather than settled findings. Finally, community labelling and mechanism

interpretation remain partly interpretive, meaning alternative theoretical readings could produce different narrative structures from the same evidence base.

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