

Transformative phygital service research (TPSR): an agenda for future research

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Abstract

Purpose – This paper aims to develop a transformative phygital service research (TPSR) framework to explain how hybrid physical-digital service systems shape consumer well-being, autonomy, dignity and inclusion. While prior phygital service research (PSR) advances understanding of hybrid experiences and human-centred ecosystems, key ambiguities persist around agency, governance and interpretive labour in algorithmically mediated interactions. Existing frameworks address value co-creation but lack clarity on how digitally enforced rules and redistributed labour drive transformation. TPSR addresses this gap by theorising contradiction-driven processes through which human–AI arrangements and socio-technical dynamics produce both empowering and erosive outcomes in phygital service environments.

Design/methodology/approach – Using a theory synthesis approach (Jaakkola, 2020), this conceptual paper integrates literature from phygital services, PSR, transformative service research (TSR), service-dominant logic (SDL), socio-technical systems and activity theory (AT). AT is used as the explanatory foundation to conceptualise how mediated action, contradictions, algorithmic governance and expansive learning influence transformation in phygital ecosystems. The paper develops a conceptual architecture distinguishing antecedent system configurations, mediating mechanisms, transformative outcomes and failure conditions and advances theoretically grounded propositions to support future empirical investigation.

Findings – The TPSR framework shows that transformative outcomes in phygital environments arise from interactions among artefacts, governance rules, communities and labour divisions within hybrid activity systems. It identifies three discontinuities: algorithmic mediation of agency, digitally enforced rules and non-human interpretive labour. Transparent algorithms enhance autonomy and trust, while opacity reduces control. Adaptive governance fosters inclusion; rigid rules intensify exclusion. Immersive mediation can boost engagement or cause overload. Redistributed human–AI labour reshapes trust and well-being. Contradictions within these systems trigger learning processes that yield empowering or erosive outcomes, depending on governance quality, participation and context, extending TSR, SDL and PSR.

Originality/value – This paper advances the first contradiction-driven conceptual framework of TPSR. Rather than positioning phygitality solely as an experiential or operational phenomenon, TPSR conceptualises phygital services as evolving socio-technical activity systems that condition human capability, inclusion and dignity through mediated interactions. By specifying theoretical mechanisms, boundary conditions and potential reversal pathways, the framework extends PSR and transformative service scholarship and provides a robust conceptual foundation for future empirical research and the design of equitable, human-centred phygital service ecosystems.

Keywords Transformative phygital service research, Phygital service research, Activity theory, Consumer well-being, Transformative service research, Service ecosystems, Consumer dignity

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1. Introduction

Hybrid physical-digital (“phygital”) service ecosystems are rapidly reshaping how individuals interact with markets, institutions and socio-technical infrastructures. Across sectors such as healthcare, retail, education and public services, algorithmically mediated interfaces, immersive environments and intelligent artefacts increasingly structure service encounters (Batat, 2024a; Mele et al., 2021; Shankar et al., 2022). These developments signal more than technological augmentation; they represent a socio-technical transformation in how agency, participation and value creation are organised (Kaptelinin and Nardi, 2018; Roten and Vanheems, 2024). Phygital systems redistribute decision authority, embed governance within code and intertwine human and non-human actors in ways that directly affect autonomy, dignity and well-being (Kabadayi et al., 2023a, 2023b; Pasquale, 2015). As such, phygital services must be understood not only as innovations in customer experience but as infrastructures that actively shape human capability and social outcomes (Anderson and Ostrom, 2015; Batat, 2025).

Responding to this transformation, Batat (2025) proposed phygital service research (PSR) as a third wave of service research that extends both foundational service research (FSR) and transformative service research (TSR) to address hybrid physical-digital service ecosystems. PSR argues that existing paradigms struggle to capture the complexity of technology-mediated human experiences that unfold fluidly across physical and digital realms, particularly when sensory immersion, algorithmic mediation and socio-cultural meaning-making converge (Batat, 2024b; Batat and Hammedi, 2023).

Existing PSR has generated rich insights into experiential design, customer journeys and operational performance. Most scholarship conceptualise phygitality through immersive experiences, seamless channel integration and engagement optimisation (Bolton et al., 2018; Klaus, 2024; Lemon and Verhoef, 2016). While this body of work clarifies how hybrid environments influence satisfaction, loyalty and affective responses, it remains largely focused on descriptive and experiential dimensions (Banik and Gao, 2023; Mele and Russo-Spena, 2025). The dominant emphasis on efficiency and experience design leaves underexplored the deeper socio-technical mechanisms through which phygital systems transform agency, inclusion and equity. Consequently, the field lacks an explanatory framework capable of accounting for the broader human consequences of algorithmically mediated service environments (Batat, 2025; Shankar et al., 2022).

TSR provides a normative orientation towards well-being, empowerment and vulnerability in service systems (Anderson et al., 2013; Anderson and Ostrom, 2015). Together with service-dominant logic (SDL) and service ecosystem perspectives, TSR highlights multi-actor value co-creation and institutional coordination (Vargo and Lusch, 2016; Chandler and Vargo, 2011). However, these frameworks implicitly assume that agency, governance and interpretive work remain primarily human and socially negotiated. Technology is typically theorised as an enabling resource rather than as an autonomous actor capable of enforcing rules, reallocating authority or performing interpretive labour (Grewal et al., 2020; Huang and Rust, 2018). As Batat (2025) argues, while TSR advances ethics and well-being, it continues to operate largely within segmented physical/

digital frames and lacks analytical tools for theorising hybrid (e.g. phygital) ecosystems where technology actively participates in meaning-making and governance.

Phygital environments introduce three structural discontinuities that expose limits in current service theory. *Firstly*, algorithmic mediation of agency means that recommendation systems, predictive analytics and adaptive interfaces actively shape consumer choices rather than merely supporting them (Shankar et al., 2022; Yeung, 2018). *Secondly*, digitally enforced rule structures embed governance within code, producing non-negotiable and often opaque constraints that differ fundamentally from socially negotiated institutional norms (Pasquale, 2015; Kabadayi et al., 2023a, 2023b). *Thirdly*, non-human interpretive labour emerges as artificial intelligence performs diagnostic, classificatory and decision-making functions previously reserved for human actors (Rust and Huang, 2021; Roten and Vanheems, 2023). Together, these discontinuities reconfigure how agency, authority and meaning are produced within service systems, generating tensions between efficiency and dignity, personalisation and equity, automation and human judgement that cannot be adequately modelled by frameworks grounded in human-centric assumptions. Importantly, these limitations do not suggest that TSR, SDL or PSR do not fully specify the phygital phenomena; rather, they indicate that these frameworks do not explicitly model how algorithmic mediation, digitally enforced rules and non-human interpretive labour operate as causal mechanisms within hybrid service systems.

To address these discontinuities, this paper introduces transformative phygital service research (TPSR), a framework that conceptualises phygital services as socio-technical activity systems in which transformation emerges through mediated interactions among subjects, artefacts, rules, communities and divisions of labour (Engeström, 2001; Kaptelinin and Nardi, 2009). TPSR does not extend existing theories by merely adding digital context; rather, it resolves boundary failures that arise when agency and governance are distributed across hybrid human-algorithmic systems. The proposed framework positions phygital services simultaneously as encounter-level interactions, designed configurations and ecosystem infrastructures, thereby clarifying their ontological status across analytical levels. By integrating Activity Theory’s (AT) contradiction-driven change logic with the normative aims of transformative service scholarship, TPSR provides an explanatory lens for understanding how hybrid systems generate both empowering and detrimental outcomes (Batat, 2025; Engeström and Sannino, 2010). TPSR therefore extends rather than replaces existing service theories by specifying the causal processes through which these hybrid socio-technical conditions reshape agency, governance and value co-creation.

TPSR advances an explicit causal architecture that distinguishes antecedent system configurations, mediating mechanisms and transformative outcomes, while also specifying conditions under which transformation may fail or reverse. Antecedents include the configuration of artefacts, governance rules, communities and labour distributions. Mediating mechanisms involve agency reconfiguration, algorithmic governance, collective learning and adaptive role negotiation (Engeström, 2001; Gallan et al., 2019). These mechanisms generate outcomes such as empowerment, inclusion, equity and dignity or, under certain conditions,

capability erosion and exclusion (Anderson and Ostrom, 2015; Roten and Vanheems, 2024). This architecture shifts phygital research from descriptive mapping towards mechanism-based explanation, directly addressing calls for greater theoretical precision in PSR and TSR (Batat, 2025).

This paper makes three precise contributions. Firstly, it identifies the theoretical discontinuities introduced by phygitality and demonstrates that existing service frameworks do not explicitly model hybrid socio-technical transformation. Secondly, it develops a research framework that articulates how mediated interactions generate conditional transformative outcomes. Thirdly, it advances generative propositions specifying mechanisms, boundary conditions and potential reversals, enabling empirical testing. By reframing phygital services as engines of socio-technical transformation, TPSR provides a coherent foundation for analysing and designing human-centred hybrid service ecosystems. Throughout the paper, we maintain a clear distinction between explanatory mechanisms and normative implications. TPSR is developed primarily as a framework explaining how hybrid socio-technical configurations generate conditional transformations in human well-being, while ethical and human-centred implications are derived from rather than substituted for this explanatory logic.

2. Literature review

Most marketing literature has studied phygital services as mere integration of physical and digital services while defining the contours of this emerging phenomenon. Specifically, literature on Phygital services dominates the foundational discourse of the phygital phenomenon. For instance, Batat and Hammedi (2023) introduce the extended reality technology (ERT) framework, highlighting the role of immersive technologies in transforming customer experiences. Similarly, Batat (2024a) proposed the phygital customer experience (PH-CX) framework to outline critical drivers, characteristics and outcomes of phygital customer experiences. Mele et al. (2024) extended this line of thought with a conceptual model that outlines the dynamic interplay between physical and digital elements in service ecosystems. In addition, Bolton et al. (2018) proposed eight “dualities” to understand customer experience while integrating digital, physical and social realms, while Jacob et al. (2023) highlighted emerging customer journey metaphors in the digital-physical convergence. Alexander and Varley (2025) introduced the experiential retail territories framework, reframing retail environments as immersive, interactive spaces that blend physical presence with digital augmentation. Klaus (2024), through a viewpoint perspective, articulated three propositions that define phygital service experiences, emphasising value co-creation and the centrality of customer perception.

Complementing these theoretical discourses, several qualitative studies offer insights into the experiences of consumers and organisations navigating phygital services. Del Vecchio et al. (2023) identified thematic clusters to map the structure and dynamics of the phygital transformation process, while Mele et al. (2021) offered insights into the phygital customer journey through the lens of a fuzzy process. These authors referred to journey as the circular path of moments, which are seen as phenomenological microworlds of events, interactions, relationships and emotions. Through

mixed-method qualitative research, Batat (2024b) underscored the importance of sensory modalities, particularly sight and touch, in fostering immersive phygital experiences. Pangarkar et al. (2022) provided strategic insights, suggesting actionable, growth-oriented strategies for phygital retailers. Bonfanti et al. (2023) investigated the interplay between technological integration and customer-centric strategies in shaping phygital experiences. Findings reveal that emotional engagement, experiential design and contextual relevance are critical in delivering value to phygital consumers. Roten and Vanheems (2024) investigated the evolving concept of consumer autonomy in phygital environments, where integrating digital technologies into physical retail spaces redefines the boundaries of control, agency and freedom. Mele et al. (2024) offered a perspective on the phygital customer journey by underscoring the significance of designing for flexibility and adaptability, underscoring that phygital experiences are lived and constructed in real time by users, not merely delivered by brands.

Several quantitative studies add empirical robustness, validating key relationships between phygital constructs and consumer behaviour. Kumar et al. (2025) examined how different generations perceive and engage with phygital services within the retail banking sector, providing timely insights into consumers' shifting expectations in a digitally transforming industry. Banik (2021) demonstrated that customer involvement and innovativeness significantly predict satisfaction and loyalty within the phygital retail experience. Banik and Gao (2023) emphasised that hedonic drivers (i.e. mental imagery, entertainment and aesthetics) affect customer experiences in phygital retailing. Hyun et al. (2024) examined how luxury brands strategically harness phygital experiences to strengthen customer-based brand equity. Findings reveal that immersive, personalised phygital experiences can deepen emotional engagement and enhance brand associations, ultimately contributing to greater brand loyalty and perceived value. Mishra et al. (2023) suggested that retailers aiming for long-term customer relationships should design phygital experiences that prioritise empowerment and emotional gratification alongside convenience. Lawry (2022) delved into the psychological and behavioural dynamics influencing consumer acceptance of phygital shopping experiences in luxury retail. Findings suggest that when consumers perceive phygital environments as enabling meaningful and emotionally gratifying self-gifting experiences, their acceptance of these hybrid formats increases significantly. Pantano and Gandini (2017) unravelled how social interactions are reconfigured within phygital retail environments, where the boundaries between physical and digital spaces are increasingly blurred. Table 1 shows a select set of studies showing the focal dimensions of phygital services.

Thus, research on phygital services has advanced substantially, with research primarily focusing on the phygital customer experience (e.g. Dahish et al., 2025; Batat, 2024c) and the phygital customer journey (Mele and Russo-Spena, 2022; Mele et al., 2021). Table 2 provides an overview of existing research on several focal dimensions of phygital services. These contributions have deepened our understanding of how physical and digital dimensions converge to shape consumer experiences and service interactions. Complementary work has extended this inquiry into consumers' behavioural outcomes, such as satisfaction, loyalty

Table 1 Overview of existing research on focal dimensions of phygital services

Author(s)	Focal dimensions of phygital services	Method	Key contribution/result
Batat (2025)	Phygital service research (PSR): human-first ecosystem logic	Conceptual	Develops the PSR framework, positioning phygital services as human-first hybrid ecosystems and advancing FSR/TSR towards positive impact and experience design. Establishes the normative and experiential foundations upon which further explanatory frameworks can build
Lee et al. (2024)	Transformative capabilities	Conceptual	Emphasises affective, cognitive, sensory and social experiences in phygital contexts; proposes well-being-oriented metrics
Batat (2022)	Transformative luxury	Conceptual	Extends transformative logic into luxury phygital contexts, linking hybrid experiences to wellbeing and self-development
Saragih (2025)	Transformative capabilities	Conceptual	Bridges phygital design with TSR; proposes competence frameworks for inclusive, transformative phygital services
Batat (2024a)	Transformative capabilities	Conceptual	Connects phygital experiential constructs to wellbeing outcomes and proposes methodological approaches
Batat and Hammedi (2023)	Phygital experience	Conceptual	Conceptualises the extended reality technology (ERT) framework for phygital experiences
Banik (2021)	Phygital experience	Quantitative	Shows customer involvement and innovativeness influence patronage intentions in phygital retail
Bolton et al. (2018)	Dualities in hybrid CX	Conceptual	Introduces Eight "dualities" shaping superior customer experiences in hybrid B2B and B2C markets
Banik and Gao (2023)	Phygital experience	Quantitative	Demonstrates hedonic drivers (imagery, entertainment, aesthetics) influence phygital experiences, with gender differences
Klaus (2024)	Phygitality as CX form	Conceptual	Proposes phygitality as a distinct evolution of customer experience
Batat (2024b)	Sensory dimensions	Conceptual	Identifies sensory dimensions (sight, touch, sound, scent, taste) influencing phygital customer experiences
Alexander and Varley (2025)	Experiential retail territories	Conceptual	Introduces experiential retail territories (ERT) as a future-oriented phygital retail framework
Pangarkar et al. (2022)	Rapport and engagement	Qualitative	Shows phygital functionality enhances trust, commitment and seamless customer experience
Hyun et al. (2024)	Luxury website phygitality	Quantitative	Identifies website attributes building brand equity and repurchase intention via phygital experience
Mishra et al. (2023)	Channel integration	Quantitative	Explores how channel integration influences phygital customer experience
Dahish et al. (2025)	Social listening in phygital	Qualitative	Develops social listening framework to improve phygital experience
Bonfanti et al. (2023)	Phygital shopping experience	Qualitative	Identifies utilitarian, hedonic, social and playful drivers of improved phygital shopping
Mele et al. (2021)	Phygital customer journey	Qualitative	Reframes the customer journey as a fuzzy, looping phygital process
Del Vecchio et al. (2023)	Phygital environments	Qualitative	Identifies Five key themes related to phygital technologies and environments
Kumar et al. (2025)	Phygital banking behaviour	Quantitative	Examines value, trust, risk, engagement and loyalty in phygital banking contexts
Henkin et al. (2025)	NFTs and digital twins	Quantitative	Examines NFT-linked digital twins and consumer responses to physical luxury products
Roten and Vanheems (2024)	Phygital autonomy	Qualitative	Identifies visual, verbal and kinetic autonomy dimensions influencing perceived autonomy
This study	Phygital service activity systems for transformative outcomes (TPSR)	Conceptual	Advances PSR by introducing a causal, contradiction-driven activity-system framework explaining how artefacts, rules, communities and division of labour condition transformative well-being outcomes in hybrid service ecosystems

and engagement (Kumar et al., 2024; Kumar et al., 2025), thereby establishing a growing body of knowledge on the operational and experiential dimensions of phygitality.

2.1 Current phygital service research: structural antecedents of hybrid systems

PSR has rapidly evolved to document how hybrid physical-digital ecosystems reshape service encounters across retail,

healthcare, hospitality and public services. Recent scholarship conceptualises phygitality not merely as channel integration but as the blending of embodied and digital affordances that structure perception, participation and value creation (Batat, 2024a; Batat, 2025; Mele et al., 2024). Rather than treating phygital services as isolated touchpoints, emerging work frames them as socio-technical environments composed of interdependent structural elements. Four streams of

Table 2 What existing frameworks explain, what they cannot explain and how TPSR resolves the gap

Issue/phenomenon	What existing theories explain (TSR/SDL/PSR)	What they cannot explain	How TPSR resolves the gap
1. Agency in hybrid physical–digital environments	TSR addresses empowerment and vulnerability as human-centred outcomes (Anderson and Ostrom, 2015; Anderson et al., 2013). SDL explains agency through resource integration and value co-creation (Vargo and Lusch, 2014). PSR conceptualises human-first experience design and recognises technology as shaping agency in hybrid ecosystems (Batat, 2025)	While PSR acknowledges technological shaping of experience, existing frameworks do not explain how algorithmic systems autonomously redirect, constrain or reconfigure agency through decision automation and behavioural nudging (Grewal et al., 2020; Shankar et al., 2022)	Building on PSR's human-first orientation, TPSR conceptualises algorithmic artefacts as mediating actors within activity systems, explaining how phygital agency becomes conditionally empowering or erosive depending on transparency, oversight and community mediation (Engeström, 1987; Batat, 2025)
2. Redistribution of labour between humans and intelligent artefacts	Service ecosystem theory explains role reconfiguration and coordination (Chandler and Vargo, 2011; Akaka et al., 2015). PSR recognises hybrid human–technology collaboration in service delivery (Batat, 2025)	Existing theories do not theorise non-human interpretive labour, where AI systems diagnose, classify, recommend or triage autonomously, thereby reshaping responsibility, accountability and emotional labour (Huang and Rust, 2018; Rust and Huang, 2021)	TPSR extends PSR by explicitly modelling division of labour as a socio-technical redistribution, linking shifts in interpretive labour to dignity, trust, relational warmth and emotional well-being in phygital contexts (Engeström, 2015; Roten and Vanheems, 2023)
3. Rules and institutional logics	Ecosystem theory explains institutions, norms and shared meanings (Chandler and Vargo, 2011). PSR highlights governance and ethical design principles in phygital ecosystems (Batat, 2025)	These perspectives cannot explain algorithmic governance, where rules are embedded in code, enforced automatically and often non-negotiable or opaque (Pasquale, 2015; Yeung, 2018)	TPSR integrates PSR's ethical concerns with AT's treatment of rules as material–historical mediators, explaining how algorithmic rule enforcement reshapes access, equity and fairness in phygital services (Engeström and Sannino, 2010; Kabadayi et al., 2023)
4. Contradictions in socio-technical systems	TSR acknowledges tensions between well-being goals and market structures (Anderson et al., 2013). SDL and ecosystems treat conflicts as coordination challenges (Vargo and Lusch, 2016). PSR identifies tensions between technology-driven efficiency and human-first experience design (Batat, 2025)	Existing theories lack a formal mechanism to explain how contradictions (e.g. personalisation vs privacy; automation vs dignity) generate systemic transformation rather than incremental adjustment (Lemon and Verhoef, 2016)	TPSR adopts Activity Theory's concept of contradictions as engines of change, extending PSR by explaining how phygital tensions trigger expansive learning and transformative redesign (Engeström, 2001; Blocker et al., 2022)
5. Transformation pathways in hybrid services	TSR theorises well-being outcomes but not systemic evolution (Anderson and Ostrom, 2015). PSR frames phygital transformation around human-first experience principles (Batat, 2025)	No existing framework explains how hybrid systems evolve through cycles of disruption, resistance, negotiation and redesign driven by algorithmic mediation (Akaka and Chandler, 2011)	TPSR extends PSR by integrating expansive learning cycles to explain how phygital systems evolve towards (or away from) well-being-enhancing practices over time (Engeström, 2001; Finsterwalder et al., 2017)
6. Multi-layered mediation of service activity	SDL identifies resource integration; ecosystems describe layered systems (Vargo and Lusch, 2014; Chandler and Vargo, 2011). PSR acknowledges multisensory and multi-touchpoint mediation (Batat, 2025)	These perspectives do not structurally model simultaneous mediation by artefacts, rules, communities and labour within a single explanatory system (Mele et al., 2021)	TPSR operationalises PSR's insights through AT's activity system model, explaining how layered mediation jointly produces transformative or erosive outcomes (Engeström, 2015)
7. Nature of the service object (phygital service as activity)	Existing theories conceptualise service objects as value propositions or experiences (Grönroos, 2011; Vargo and Lusch, 2016). PSR reframes phygital services as hybrid ecosystems designed around human-first experience (Batat, 2025)	They do not conceptualise the service object as an evolving socio-material activity shaped by contradictions and mediated action (Mele and Russo-Spena, 2022)	TPSR builds directly on PSR by reconceptualising phygital services as dynamic objects of activity, whose purpose and outcomes evolve through digital–physical mediation towards (or away from) transformative well-being (Leont'ev, 1978; Engeström, 2015)

research are particularly relevant: artefacts, rules, communities and divisions of labour.

Artefactual infrastructures: A substantial body of work examines how immersive interfaces, adaptive platforms and intelligent artefacts mediate sensory engagement and behavioural possibilities. Extended reality environments and

AI-driven systems actively shape perception and redistribute cognitive effort rather than functioning as neutral tools (Batat and Hammedi, 2023; Mele et al., 2021; Mele et al., 2024). In the similar vein, Batat (2025) argues that these artefacts form the experiential backbone of PSR, enabling human-first experience design that moves fluidly between physical and

digital realms. Socio-technical perspectives similarly emphasise that tools structure action by expanding or constraining agency (Kaptelinin and Nardi, 2018). Together, this work establishes artefacts as active mediators of human capability. However, while this stream demonstrates how artefacts reshape interactional affordances, it stops short of explaining how such configurations translate into conditional transformations in capability or well-being.

Rule structures and algorithmic governance: Phygital research increasingly recognises that governance is embedded within digital infrastructures. Algorithmic decision systems regulate participation through coded protocols that differ fundamentally from socially negotiated institutional norms (Kabadayi et al., 2023a, 2023b). Batat (2025) highlighted the ethical implications of digitally enforced rules and calls for human-centred governance in hybrid ecosystems. Service ecosystem theory acknowledges institutional arrangements as coordinating mechanisms (Chandler and Vargo, 2011), yet phygital environments extend governance into automated infrastructures that reshape access, accountability and fairness. Existing work therefore identifies algorithmic governance structures but does not specify the mechanisms through which digitally enforced rules produce divergent trajectories of empowerment or erosion.

Hybrid communities: Value creation in phygital ecosystems emerges through coordination among human and technological actors. Service ecosystem research conceptualises value as co-created within actor networks (Frow et al., 2014; Vargo and Lusch, 2016). PSR advances this view by emphasising relational assemblages in which intelligent artefacts participate in interpretive and decision processes (Batat, 2025). Hybrid communities therefore function as dynamic collectives where humans and algorithmic actors jointly influence experience and outcomes. Yet the literature remains largely descriptive in showing who participates in phygital ecosystems rather than explaining how hybrid actor constellations generate transformative outcomes.

Division of labour: Automation redistributes cognitive, emotional and interpretive tasks between humans and machines. AI systems increasingly perform diagnostic and classificatory functions previously associated with professional expertise (Huang and Rust, 2018; Roten and Vanheems, 2023). This redistribution reshapes responsibility structures and relational expectations within service encounters. Phygital research documents both efficiency gains and tensions arising from hybrid labour arrangements, particularly in emotionally sensitive contexts. As a result, although redistribution of labour is well documented, its causal implications for agency, dignity and inclusion remain theoretically underdeveloped.

Taken together, these streams describe the structural architecture of phygital systems. However, existing scholarship primarily maps experiential and operational dimensions rather than explaining how these structural elements interact to generate transformation in well-being.

While TSR, SDL and PSR collectively recognise multi-actor value co-creation, institutional arrangements and human–technology interaction, they do not explicitly model how algorithmically mediated decision-making, non-negotiable digital rules and machine-performed interpretation jointly reconfigure service outcomes. TPSR builds on these foundations by introducing a mechanism-based explanation of

how these elements interact to produce both empowering and erosive transformations.

2.2 Limits of TSR, SDL and PSR in explaining hybrid transformation

TSR provides a normative framework centred on well-being, dignity and vulnerability (Anderson et al., 2013; Anderson and Ostrom, 2015). SDL and service ecosystem perspectives conceptualise value creation as multi-actor coordination within institutional arrangements (Vargo and Lusch, 2016; Chandler and Vargo, 2011). More recently, PSR extends these traditions by foregrounding human-first experience design in hybrid environments (Batat, 2025). While PSR advances TSR by foregrounding phygital experience, our TPSR framework complements this by providing a systemic analytical architecture for understanding how hybrid service ecosystems generate contradictions, power asymmetries and transformation pathways.

Despite their contributions, these frameworks share two limitations when applied to deeply hybrid systems. Firstly, they rely on human-centric assumptions about agency and governance. TSR and SDL largely treat technology as an enabling resource rather than as a semi-autonomous actor capable of enforcing rules or performing interpretive labour. PSR acknowledges technological mediation but emphasises experiential design over causal explanation. When algorithmic systems actively shape decision rights and redistribute authority, frameworks grounded in human negotiation struggle to model these dynamics. Secondly, existing theories lack explicit modelling of algorithmic mediation. Digitally enforced rule structures, opaque recommendation systems and AI-performed interpretation introduce contradictions between efficiency, autonomy and equity. While PSR highlights ethical and experiential implications (Batat, 2025), it does not provide a systemic causal architecture explaining how such contradictions propagate through service ecosystems. These limitations suggest the need for an explanatory framework capable of modelling mediated activity, contradiction and transformation within hybrid socio-technical systems (see Table 2).

2.3 Theoretical gap: explaining transformation in hybrid phygital systems

The preceding review reveals an important theoretical gap at the intersection of PSR and TSR. Current phygital scholarship has made significant progress in mapping the structural elements of hybrid ecosystems including artefactual infrastructures, algorithmic rule structures, hybrid communities and redistributed divisions of labour (Batat, 2024a; Batat, 2025; Mele et al., 2024). At the same time, TSR and service ecosystem perspectives provide robust normative frameworks for evaluating well-being, dignity and inclusion (Anderson et al., 2013; Anderson and Ostrom, 2015; Vargo and Lusch, 2016). However, these streams remain only partially integrated (see Table 3).

Specifically, existing frameworks do not yet offer a causal explanation of how hybrid socio-technical configurations translate into transformative outcomes. TSR foregrounds well-being but assumes primarily human-negotiated institutional arrangements, leaving underdeveloped the role of algorithmic governance and intelligent artefacts as active mediators of agency. Service ecosystem perspectives describe multi-actor

Table 3 Comparative positioning of service frameworks

Dimensions	Transformative service research (TSR)	SDL/service ecosystems	Phygital service research (PSR)	Transformative phygital service research (TPSR)
Core focus	Well-being and vulnerability	Value co-creation in actor networks	Human-first phygital experience	Causal transformation in hybrid systems
View of technology	Enabling resource	Operand/operant resource	Experiential mediator	Semi-autonomous mediator of agency
Governance model	Socially negotiated institutions	Institutional coordination	Ethical design emphasis	Algorithmic + institutional mediation
Analytical level	Normative system outcomes	Actor networks and resources	Experience ecosystems	Activity systems and causal mechanisms
Treatment of contradictions	Implicit	Limited	Experiential tensions	Explicit contradiction-driven learning
Explanatory ambition	Normative orientation	Descriptive coordination	Human-centred design	Generative causal architecture

coordination but lack explicit modelling of how contradictions between artefacts, rules and labour structures generate divergent trajectories of empowerment or erosion. PSR advances a human-first orientation and highlights experiential and ethical dimensions of hybrid ecosystems (Batat, 2025), yet it stops short of specifying the generative mechanisms through which these structural elements interact to produce conditional transformations.

The central theoretical gap, therefore, concerns the absence of an explanatory framework capable of linking phygital system configuration to transformation through identifiable mediating processes. In deeply hybrid environments, algorithmic mediation of decision rights, digitally enforced rule structures and non-human interpretive labour introduce tensions that cannot be fully captured by theories grounded in human-centric assumptions. Without a mechanism-level model of how these contradictions are enacted and resolved, existing approaches risk remaining descriptive rather than predictive.

Addressing this gap requires a framework that treats phygital services as evolving socio-technical activity systems in which artefacts, rules, communities and divisions of labour interact dynamically to shape well-being. The next section introduces TPSR as such a framework, building on the human-first principles articulated in PSR (Batat, 2025) while extending them into a causal architecture capable of explaining both empowerment and vulnerability in hybrid service ecosystems.

3. The transformative phygital service research framework

3.1 Defining TPSR: ontological structure of the framework

TPSR conceptualises phygital services as multi-level socio-technical activity systems in which transformative outcomes arise from the structured interaction between system configurations, interactional mechanisms and well-being outcomes. This ontological distinction is essential to avoid conflating the phygital service environment with the transformations it produces.

At the first level, system configuration refers to the structural arrangement of the phygital service ecosystem. This configuration comprises four interdependent components:

- 1 artefacts, including adaptive digital-physical technologies that mediate perception and action;
- 2 rules, encompassing both institutional norms and algorithmically enforced protocols;

- 3 communities, consisting of hybrid collectives of human and technological actors; and
- 4 divisions of labour, which specify how cognitive, emotional and technical tasks are distributed between humans and intelligent systems.

Together, these elements define the structural conditions under which phygital activity unfolds. At the second level, interaction mechanisms describe how these structural elements operate dynamically in practice. TPSR identifies mechanisms such as agency reconfiguration through artefact mediation, algorithmic governance of participation, collective co-learning within hybrid communities and redistribution of interpretive labour. These mechanisms translate system configuration into lived experience by shaping how actors interpret, negotiate and enact service interactions. At the third level, transformative outcomes capture the normative consequences of phygital activity. Outcomes manifest across multiple scales, including individual empowerment and autonomy, community inclusion and shared value creation and systemic equity and dignity. Importantly, TPSR treats these outcomes not as guaranteed effects but as contingent results of how system configurations and interaction mechanisms resolve or amplify internal tensions. This three-level ontology clarifies that TPSR is neither an encounter-level description nor merely a design framework. Instead, it provides an explanatory model linking structural antecedents to mediated processes and normative consequences within hybrid service ecosystems.

3.2 An activity theory perspective on contradictions beyond TSR

TPSR draws on AT because AT offers a uniquely powerful lens for explaining how contradictions within socio-technical systems generate transformation (Engeström, 1999). While TSR foregrounds well-being and multi-actor coordination, it largely assumes that institutional arrangements remain negotiable and that agency resides primarily in human actors. Phygital environments challenge these assumptions by embedding decision authority within algorithmic systems and digitally enforced protocols.

AT contributes explanatory leverage by modelling service systems as historically evolving activity structures in which contradictions between elements, such as tensions between artefacts and rules or between divisions of labour and community expectations serve as engines of change. In phygital contexts, these contradictions frequently emerge as conflicts

between automation efficiency and embodied dignity, or between algorithmic personalisation and collective equity. AT explains how such tensions trigger cycles of reflection, negotiation and redesign that reshape both system configurations and actor capabilities. Crucially, TPSR does not simply relabel TSR constructs using AT terminology. Rather, AT enables TPSR to theorise how transformation occurs under conditions where agency is distributed across human and non-human actors and where rules are embedded in code rather than negotiated through social consensus. By tracing how contradictions propagate through mediated activity and produce divergent outcomes depending on contextual conditions, TPSR extends the explanatory scope of service theory into domains characterised by algorithmic governance and hybrid labour arrangements (Engeström and Sannino, 2021). Figure 1 presents proposed TPSR framework.

In this sense, AT functions as the analytical engine of TPSR: it provides the conceptual tools to model contradiction, mediation and expansive learning within phygital systems, thereby explaining why similar technological configurations may yield empowerment in one context and vulnerability in another. This contradiction-centred logic distinguishes TPSR from existing service frameworks and grounds the causal architecture developed in the following section. This ontological structure provides the scaffolding for the causal architecture developed in the next section, where system configuration, interaction mechanisms and transformation outcomes are linked through explicit explanatory logic.

4. Causal architecture of transformative phygital service research

4.1 Antecedents: system configuration of phygital activity

Building on the human-first orientation of PSR (Batat, 2025), TPSR advances the analysis from experiential design towards

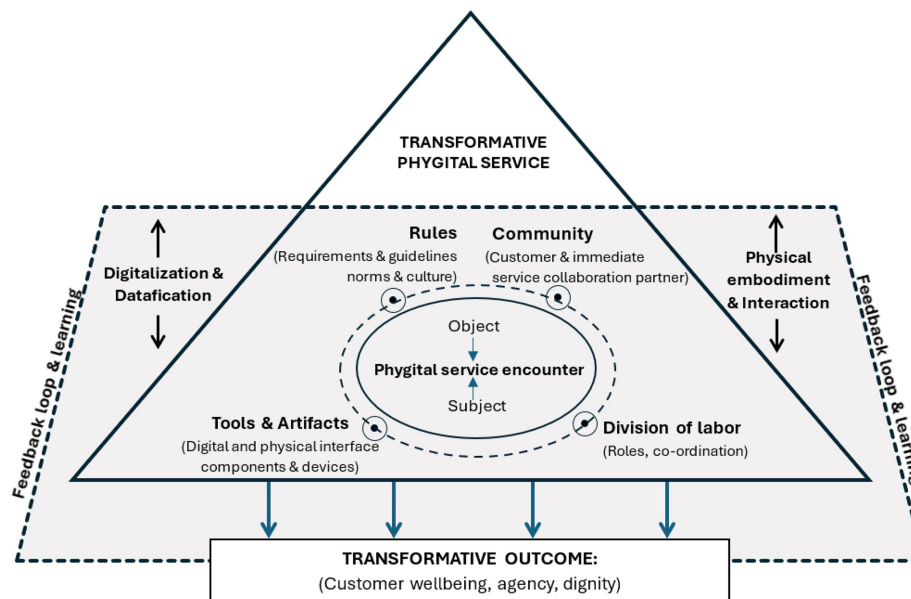
an explicit causal architecture explaining how hybrid socio-technical systems generate transformation. TPSR conceptualises phygital services as structured activity systems whose transformative potential emerges from the configuration of four interdependent antecedent dimensions: artefactual infrastructure, rule structures, community composition and division of labour. These dimensions form the structural conditions that shape how agency, authority and value creation unfold in practice.

Firstly, artefactual infrastructure comprises the digital and physical technologies that mediate hybrid interaction, including immersive interfaces, smart environments and AI-driven adaptive systems. PSR demonstrates that such artefacts extend sensory engagement and support human-centred experience design (Batat, 2025), while research in socio-technical mediation shows that they actively structure perception and redistribute cognitive effort (Kaptelinin and Nardi, 2009; Kaptelinin and Nardi, 2018; Mele et al., 2024). Artefacts therefore function not as passive tools but as mediating structures that condition the scope of human action.

Secondly, rule structures refer to the institutional and algorithmic protocols governing participation in phygital systems. Increasingly, governance is embedded in code and executed automatically, transforming negotiated social norms into digitally enforced procedures (Kabadayi et al., 2023a, 2023b). While PSR emphasises ethical and human-centric governance (Batat, 2025), algorithmic rule systems reallocate decision authority in ways that reshape access, fairness and accountability (Chandler and Vargo, 2011).

Third, community composition captures the constellation of human and non-human actors engaged in the service ecosystem. Service ecosystem theory recognises that value emerges through multi-actor coordination (Frow et al., 2014; Vargo and Lusch, 2016) and PSR extends this view by highlighting collaborative human-technology assemblages oriented towards well-being (Batat, 2025). In phygital

Figure 1 Transformative phygital service research framework



environments, intelligent artefacts increasingly participate in interpretive and decision processes, altering relational dynamics.

Fourth, division of labour specifies how cognitive, emotional and interpretive tasks are distributed between humans and machines. AI systems now perform diagnostic and classificatory functions traditionally associated with human expertise, reshaping responsibility and relational expectations (Huang and Rust, 2018; Roten and Vanheems, 2023).

Together, these dimensions form a generative structural environment. TPSR treats system configuration as a field of possibilities within which transformation becomes feasible but remains contingent on how structural tensions are enacted in interaction.

4.2 Mediating mechanisms: agency, governance and learning

While PSR foregrounds human-first experience design (Batat, 2025), TPSR specifies the mechanisms through which system configuration translates into lived transformation. Drawing on AT's model of mediated action and expansive learning (Engeström, 1987; Engeström, 2001; Engeström and Sannino, 2010), TPSR identifies three interrelated mediating processes: agency mediation, algorithmic governance and collective learning.

The first mechanism, agency mediation, concerns how digital artefacts translate human intention into algorithmically processed action. Adaptive interfaces can expand perceived autonomy when they remain intelligible and controllable (Batat, 2024a; Mele et al., 2021), but opaque systems may compress agency and generate alienation (Kaptelinin and Nardi, 2018). At the micro-process level, agency reconfiguration involves shifts in perceived control, decision autonomy and cognitive load. For instance, when algorithmic recommendations become default options, users may experience reduced perceived autonomy but increased decision efficiency, leading to compliance rather than active choice-making.

The second mechanism, algorithmic governance, arises from rule mediation. Digitally enforced protocols regulate participation and redistribute decision rights. Research shows that perceptions of fairness and trust depend on the transparency and responsiveness of such governance structures (Kabadiyi et al., 2023a, 2023b). Tensions frequently emerge between automated enforcement and embodied judgement, creating contradictions that invite reinterpretation and redesign (Engeström and Sannino, 2010). Algorithmic governance operates through perceptual and behavioural mechanisms, including perceived fairness, transparency and trust. Opaque rule enforcement may reduce trust and trigger resistance, whereas explainable systems may increase perceived legitimacy and voluntary compliance.

The third mechanism, collective learning, occurs within hybrid communities. Human and technological actors adapt through recursive feedback loops, enabling co-learning and practice revision. These learning processes determine whether contradictions generate empowerment or systemic friction (Engeström, 2001; Gallan et al., 2019). TPSR thus explains transformation as a dynamic process emerging from mediated interaction rather than as a direct effect of technology adoption.

Collective learning unfolds through iterative feedback loops, where actors adapt their behaviour in response to system outputs. This includes behavioural adjustment (e.g. adapting to platform rules), cognitive reframing (e.g. redefining expectations) and social validation processes within hybrid communities. Together, these mechanisms translate structural configurations into observable behavioural and perceptual changes that ultimately shape well-being outcomes.

4.3 Conditional transformation: multi-level outcomes

Consistent with the normative orientation of TSR (Anderson et al., 2013; Anderson and Ostrom, 2015) and the human-first emphasis of PSR (Batat, 2025), TPSR conceptualises transformation as conditional and multi-level. Outcomes emerge only when mediating mechanisms resolve structural tensions in ways that enhance human capability.

At the individual level, successful mediation produces empowerment, autonomy and psychological well-being. Consumers experience expanded capability when artefacts and governance systems support meaningful participation (Lee et al., 2024). At the community level, transformation manifests as inclusion and shared value creation, strengthening collective resilience (Gallan et al., 2019). At the systemic level, outcomes include institutional equity and dignity, reflected in sustainable and fair service arrangements. TPSR emphasises that these outcomes are contingent. Similar technological configurations may yield divergent effects depending on how agency mediation, governance structures and learning processes interact under specific contextual conditions.

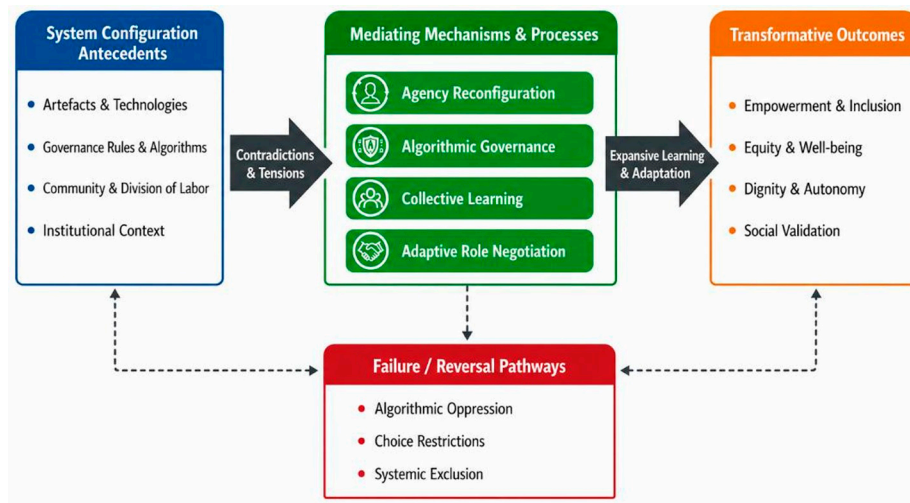
4.4 Failure and reversal conditions

A distinctive feature of TPSR is its explicit modelling of failure and reversal conditions, extending PSR's human-centric concern with ethical impact (Batat, 2025) into a predictive explanatory framework. Transformation is not inherently positive; phygital systems may generate erosion as well as empowerment. When algorithmic rules override embodied judgement without compensatory human mediation, dignity may decline and perceptions of injustice may intensify (Roten and Vanheems, 2023). Excessive automation can weaken relational warmth and trust, echoing concerns about depersonalisation in digital service environments (Alkire et al., 2020). Conversely, insufficient integration may produce inefficiency and exclusion, limiting access to benefits.

Failure occurs when contradictions stabilise in ways that privilege operational efficiency over human capability (Engeström, 2001). By incorporating asymmetrical and negative trajectories, TPSR moves beyond optimistic narratives of digital innovation and offers a balanced causal architecture capable of predicting both empowerment and vulnerability in hybrid service ecosystems. Figure 2 shows the causal architecture of TPSR.

5. Propositions: testable and predictive logic of TPSR

Building on the causal architecture of TPSR and extending the human-first orientation of PSR (Batat, 2025), the following propositions (shown in Table 4) specify how hybrid socio-technical configurations produce transformative or erosive

Figure 2 Causal architecture of transformative phygital service research**Table 4** Summary table – TPSR propositions

Proposition	Core mechanism	Positive pathway	Failure pathway	Example context
P1	Artefact mediation	Transparent adaptive interfaces	Opaque algorithmic control	AI healthcare portals
P2	Community mediation	Human–AI coordination	Fragmented support	Smart retail
P3	Rule mediation	Adaptive governance	Rigid enforcement	Public digital services
P4	Labour division	Hybrid human–AI roles	Total automation	AI triage
P5	Contradiction learning	Reflective redesign	Suppressed tensions	Telemedicine

outcomes. Consistent with Activity Theory’s view of mediated action and contradiction-driven learning (Engeström, 2001; Engeström and Sannino, 2010), TPSR treats transformation as conditional rather than inherent. Each proposition identifies a specific mechanism linking system configuration to well-being outcomes and clarifies the boundary conditions under which empowerment or erosion occurs. To strengthen the explanatory and empirical utility of TPSR, the following propositions are structured as conditional, mechanism-based and falsifiable claims. Each proposition specifies the underlying theoretical mechanism, directional relationships, measurable constructs, boundary conditions, failure or reversal pathways and an empirical testing orientation. Collectively, these propositions move TPSR beyond descriptive categorisation towards a predictive framework capable of explaining when phygital systems enhance or undermine human capability and well-being.

Proposition 1: Artefact-driven agency reconfiguration.

TPSR proposes that phygital artefacts do not merely support decision-making but actively mediate perceptions of autonomy and control. Transformative outcomes in phygital settings are not guaranteed by the mere presence of technology; rather, they are contingent upon how these artefacts mediate the service activity system. Drawing on AT’s notion of mediated action (Engeström, 1987; Engeström, 2001) algorithmic systems reshape agency by influencing how consumers perceive available choices, interpret recommendations and enact decisions. In phygital environments, recommendation engines,

adaptive interfaces and predictive systems may simultaneously reduce cognitive effort while constraining perceived freedom of action.

Negative transformative outcomes emerge when the mediation of an artefact, whether digital or physical, triggers tensions and clashes within the phygital service process. For instance, if a brand introduces a digital application to streamline consumer information and checkout without addressing perceived ease of use or potential privacy concerns, it generates systemic disturbance. This misalignment between the artefact’s embedded design logic and users’ expectations intensifies contradictions between efficiency, autonomy and dignity, potentially leading to diminished well-being or heightened vulnerability (Roten and Vanheems, 2024; Kabadayi et al., 2023a, 2023b).

Conversely, positive transformative outcomes are achieved when artefact mediation successfully eases potential tensions. When participants encounter contradictions, such as a complex or intrusive registration process, their decision not to adopt the artefact surfaces these tensions. This stressing of contradictions can trigger expansive learning and re-modelling of the activity system (Engeström and Sannino, 2010). For example, replacing lengthy registration forms with QR-code access or reduced data disclosure realigns the artefact with user capabilities and concerns, thereby reducing friction and restoring agency.

These dynamics are governed by the zone of proximal development enabled by the mediating tool. Within TPSR,

well-being is realised when artefact mediation positions consumers within a comfortable proximal development zone, where cognitive, practical or socio-hedonic benefits become attainable through phygital guidance (Chaiklin, 2003; Roten and Vanheems, 2023). Such development, however, is not automatic and requires active cooperation among stakeholders to resolve contradictions and sustain human-centred service outcomes:

P1. Transformative outcomes in phygital service systems are determined by the quality of artefact mediation. Specifically:

P1a (Positive condition). When algorithmic decision systems are transparent and allow consumer override, consumers' perceived autonomy and decision confidence increase, leading to higher engagement and well-being.

P1b (Negative condition). When algorithmic systems are opaque and non-negotiable, consumers' perceived autonomy decreases and compliance behaviour increases, leading to reduced psychological well-being.

This relationship is expected to be stronger in high-stakes service contexts such as healthcare, finance and public services, where perceived loss of agency carries greater emotional and social consequences. However, even transparent systems may generate reduced well-being when excessive information complexity produces cognitive overload. Measurable constructs include perceived autonomy, trust in algorithms, perceived behavioural control, compliance behaviour and cognitive load. This proposition can be empirically examined using experimental designs comparing transparent versus opaque algorithmic interfaces across varying levels of decision criticality.

Proposition 2: Community-mediated empowerment.

Transformative outcomes in phygital service systems are shaped by how the community of human and algorithmic stakeholders mediates service activity. From an AT perspective, communities function as collective mediators that coordinate knowledge, responsibility and problem-solving between subjects and the service object (Engeström, 1987; Barab et al., 2004). When community mediation is fragmented or poorly aligned, systemic contradictions are intensified rather than resolved.

Negative transformative outcomes emerge when community mediation, across physical stakeholders (e.g. frontline employees, designers) and algorithmic actors (e.g. AI tools, automated interfaces), triggers unresolved tensions during the phygital service process. For example, AI artefacts designed without input from market research or frontline staff may fail to reflect actual consumer needs, generating frustration and disengagement (Frow et al., 2014; Roten and Vanheems, 2023). Similarly, cooperation failures become salient when technological affordances, such as a "call a store representative" function on a digital kiosk, are not matched by

human responsiveness, thereby heightening user dissatisfaction.

Conversely, positive transformative outcomes arise when coordinated community mediation enables the resolution of such tensions through shared learning and adaptive redesign. Enhanced stakeholder cooperation can surface contradictions and trigger re-modelling of the activity system, expanding the zone of proximal development and supporting higher levels of consumer well-being (Engeström and Sannino, 2010; Chaiklin, 2003):

P2. Transformative outcomes in phygital service systems depend on community mediation.

P2a (Positive condition). When hybrid communities (human + digital actors) provide social validation and shared meaning, consumers' experience increased belonging and social well-being.

P2b (Negative condition). When community feedback is absent, fragmented or algorithmically biased, consumers' experience isolation and reduced trust in the system.

This relationship is expected to be stronger in stronger in platform-based services (e.g. social commerce, digital health communities). Social validation fails when algorithmic filtering distorts visibility or representation.

Proposition 3: Rule-bound equity realignment.

Transformative outcomes in phygital service systems are strongly conditioned by how rules (formal and informal agreements, protocols and information structures) mediate service activity. From an AT perspective, rules function as normative constraints that organise participation and coordinate action between subjects and the service object (Engeström, 2000). When rules fail to evolve in line with the dynamic nature of phygital activity, they can amplify systemic contradictions rather than stabilise the system.

Negative transformative outcomes emerge when rule mediation relies on siloed information, rigid protocols or outdated formal or informal agreements that are misaligned with phygital service practices. As services digitise rapidly, unadapted rules may restrict accessibility, autonomy or dignity, thereby generating tensions and clashes within the activity system. A representative example is the accelerated digitalisation of public services, where digitally enforced protocols have reduced traditional physical access points and eliminated direct contact with civil servants. In such cases, contradictions arise between efficiency-driven digital rules and citizens' diverse capabilities, particularly among populations with limited digital literacy, resulting in frustration and exclusion (Kabadayi et al., 2023a, 2023b; Roten and Vanheems, 2024).

Conversely, positive transformative outcomes arise when rule mediation supports the resolution of these tensions through expansive learning and adaptive reconfiguration. As contradictions surface, activity systems may re-model their rule structures by introducing hybrid protocols that reintegrate physical touchpoints, assisted services or alternative access pathways. In the public service example, the reopening of

physical counters and guided support mechanisms illustrates how realigning rigid digital rules can reduce equity-based tensions and foster greater inclusion (Engeström and Sannino, 2010).

Rules and their transformative effects are nevertheless bounded by conditions related to the zone of proximal development. When phygital rules provide meaningful guidance that enables task-related, social or empowerment-oriented development, consumer well-being is enhanced (Chaiklin, 2003). Conversely, rules that impose inflexible algorithmic requirements, such as mandatory online registration without alternatives, can block proximal development and exacerbate frustration. The boundary conditions thus lie in the system's capacity to dynamically align digital and physical rules to support adaptive guidance rather than constraint:

P3. Transformative outcomes in phygital service systems depend on rule mediation.

P3a (Positive condition). When adaptive rule mediation resolves tensions and supports equitable re-modelling of the activity system, this enhances consumer well-being and capability.

P3b (Negative condition). When rules are rigid or misaligned that trigger unresolved tensions during the phygital service process.

This relationship is expected to be stronger in highly regulated and high-stakes service environments such as healthcare, finance and public services, where algorithmic decisions directly affect access, opportunity or care outcomes. However, even adaptive rule systems may fail to produce positive transformation when users lack digital literacy, awareness of decision processes or opportunities for meaningful participation and feedback. Relevant measurable constructs include perceived fairness, trust in governance systems, perceived autonomy, inclusion, frustration, psychological well-being, capability enhancement and perceived exclusion. This proposition may be empirically examined using experimental or mixed-method designs comparing adaptive versus rigid algorithmic governance structures across varying service contexts.

Proposition 4: Hybrid division-of-labour efficiency and dignity trade-off.

AT posits that the relationship between the subject and the object of activity is mediated by the division of labour, defined as the distribution and character of tasks among participants (Jonassen and Rohrer-Murphy, 1999). In phygital service systems, this mediation increasingly involves hybrid configurations in which responsibilities are dynamically allocated between human actors and algorithmic artefacts. Consumers may first interact with chatbots or recommender systems before escalating to human agents, illustrating how expertise, authority and responsibility are redistributed. Unlike static role structures in traditional services, phygital divisions of labour are data-driven, adaptive and context-sensitive, potentially reducing inefficiencies and enhancing

responsiveness to diverse consumer needs. However, these configurations also introduce new tensions related to autonomy, control and dignity.

Negative transformative outcomes emerge when the division of labour positions consumers primarily as software operators, thereby diminishing their sense of agency. When algorithmic actors dominate decision-making without offering adaptable levels of user control, AT predicts systemic vulnerability, as unresolved tensions lead to disengagement and avoidance of phygital channels. For example, AI-driven choice architectures that optimise efficiency but constrain user discretion may generate frustration and perceived loss of self-agency, resulting in negative transformative outcomes (Roten and Kovarski, 2025).

Conversely, positive transformative outcomes arise when the division of labour evolves to support flexible participation and personalised control. Well-being is enhanced when AI-mediated systems allow consumers to operate within a comfortable zone of proximal development, enabling them to adjust their level of involvement and influence service outcomes. For instance, AI tools that allow users to refine preference inputs, limit choice sets or balance online and in-store options redistribute labour in ways that restore empowerment. Such adaptive configurations reflect participatory design principles, where consumers actively redefine their problem space, resolving tensions and strengthening agency (Roten and Vanheems, 2023):

P4. Transformative outcomes in phygital service systems depend on how the division of labour between humans and algorithmic actors is configured.

P4a (Positive condition). When AI systems augment rather than replace human roles, consumers experience higher efficiency and perceived competence, improving functional well-being.

P4b (Negative condition). When AI replaces human interaction in emotionally sensitive contexts, consumers experience reduced relational warmth and trust, lowering emotional well-being.

The effect of this relationship depends on task type (utilitarian vs emotional service contexts). At any point of service, hybrid human-AI collaboration may fail when role boundaries are unclear, leading to confusion and reduced satisfaction.

Proposition 5: Systemic contradiction as catalyst for transformation.

Within AT, contradictions function as the primary engine of transformation. In phygital service systems, such contradictions emerge with heightened intensity between algorithmic rules and embodied experience, personalisation and privacy and efficiency and humanity. Rather than representing failures, these tensions constitute productive disturbances that, when surfaced and addressed, trigger cycles of expansive learning. Through these cycles, service structures, artefacts, workflows and institutional norms are reflected upon,

reconfigured and redesigned, producing systemic change that extends beyond individual interactions (Engeström, 2001).

In the TPSR framework, transformative outcomes arise not from the elimination of contradictions but from their collective resolution across the activity system. As subjects interact with adaptive artefacts, negotiate evolving rules, participate in communities and enact hybrid divisions of labour, tensions among these mediated elements catalyse learning-driven re-modelling. These systemic reconfigurations generate durable outcomes such as empowerment, inclusion, equity and enhanced consumer well-being:

- P5.* Transformative outcomes emerge when contradictions among AT elements are surfaced and resolved through expansive learning cycles within phygital service systems. More specifically
- P5a.* When contradictions (e.g. personalisation vs privacy) are recognised and negotiated, they trigger adaptive learning and system redesign, leading to improved long-term well-being.
- P5b.* When contradictions remain unresolved or suppressed, they lead to user frustration, disengagement and capability erosion.

The likelihood of transformation increases when feedback mechanisms work and user participation are present. Users' active participation and learning do not occur when users lack agency or awareness of contradictions.

6. Boundary conditions of transformative phygital service research

These implications follow directly from the causal mechanisms articulated in the TPSR propositions and illustrate how explanatory insights translate into design and governance guidance. Although TPSR offers a generative framework for explaining transformation in hybrid service environments, its explanatory power is not universal. TPSR is specifically designed for contexts where digital and physical infrastructures jointly mediate agency, governance and learning in ways that exceed the assumptions of traditional service theories. Clarifying boundary conditions is therefore essential for theoretical precision and empirical tractability.

Firstly, TPSR is most applicable in settings characterised by algorithmic mediation of decision rights, where digital systems perform interpretive or classificatory labour that shapes access, evaluation or recommendation. In such contexts, AI-assisted health care triage, automated credit assessment or adaptive retail recommendation technology functions as a semi-autonomous actor rather than a passive tool (Batat, 2025; Kabadayi et al., 2023a, 2023b). TPSR outperforms existing frameworks when service outcomes depend on how algorithmic mediation redistributes agency between humans and machines.

Secondly, TPSR is particularly relevant in environments involving digitally enforced rule structures. When governance is embedded in code and executed automatically, negotiation shifts from interpersonal interaction to infrastructural design. These conditions create contradictions between efficiency and dignity that cannot be fully captured by frameworks assuming

socially negotiated institutional norms (Engeström, 2001; Batat, 2025). TPSR is therefore most powerful in contexts where access and participation are shaped by programmable governance.

Thirdly, the framework applies most strongly to services exhibiting hybrid divisions of labour between human and AI actors. When machines perform cognitive or emotional tasks traditionally associated with human expertise, relational dynamics and responsibility structures change in ways that demand explicit modelling of mediation and contradiction (Roten and Vanheems, 2023). TPSR is less necessary in purely human service encounters where labour redistribution is minimal.

Fourthly, TPSR is designed for highly immersive or multisensory phygital environments in which artefacts actively shape perception and embodiment. In such contexts, sensory mediation influences autonomy, overload and inclusion in ways that require analysis of artefact-subject interaction beyond traditional channel integration models (Batat, 2025).

Outside these boundary conditions, such as low-technology service encounters or stable institutional systems governed primarily by human negotiation – existing TSR or service ecosystem frameworks may provide sufficient explanatory power. TPSR therefore functions as a specialised explanatory model for hybrid socio-technical systems where technology operates as an active mediator of agency, governance and learning. These boundary conditions delimit the domain of validity of the TPSR causal architecture and clarify the contexts in which its explanatory power exceeds that of existing service frameworks.

7. Implications

7.1 Theoretical implications

The TPSR framework advances service theory by introducing a causal architecture that connects phygital system configuration to transformative outcomes through identifiable mediating mechanisms. By modelling artefacts, rules, communities and labour as interacting components of an activity system, TPSR extends the human-first orientation of PSR (Batat, 2025) into an explanatory model capable of predicting both empowerment and erosion.

For TSR, TPSR clarifies how well-being emerges from mediated socio-technical interaction rather than solely from institutional arrangements or human collaboration. It demonstrates that dignity and inclusion depend not only on service intentions but on how algorithmic governance, artefact design and hybrid labour structures redistribute agency. This shifts TSR towards a more explicit engagement with infrastructural mediation.

For service ecosystem and SDL perspectives, TPSR adds mechanism-level granularity by explaining how contradictions within hybrid systems generate divergent outcomes. While ecosystem theory describes actor networks and resource integration, TPSR specifies the micro-processes through which artefact mediation and algorithmic rules alter experiential and ethical trajectories.

More broadly, TPSR contributes to emerging scholarship on human–technology interaction by positioning phygital services as transformative infrastructures that shape capability,

autonomy and equity. The framework encourages future research to move beyond descriptive accounts of digital–physical convergence towards causal explanations of socio-technical change.

7.2 Managerial implications

For managers, TPSR provides a diagnostic lens for designing phygital services that balance efficiency with human dignity. The framework suggests that successful transformation depends on managing contradictions rather than eliminating them. *Firstly*, organisations should prioritise transparent artefact design. Adaptive interfaces that allow user adjustment and feedback enhance perceived agency, whereas opaque automation risks alienation. Managers should therefore implement explainable AI practices and participatory design processes. *Secondly*, algorithmic governance must remain contestable. Digitally enforced rules should incorporate escalation pathways and human oversight to prevent rigid exclusion. Hybrid governance models combining automation with human judgement can preserve fairness and trust. *Thirdly*, managers should cultivate hybrid communities of support in which human and digital actors complement rather than replace one another. Training staff to collaborate with intelligent systems enhances collective learning and customer confidence. *Fourthly*, organisations should treat contradictions as signals for continuous redesign. Structured reflection mechanisms – such as feedback loops and iterative experimentation – allow firms to transform tensions between efficiency and empathy into sources of innovation. By embedding these principles into service strategy, firms can develop phygital ecosystems that generate sustainable competitive advantage while advancing consumer well-being.

7.3 Societal and policy implications

TPSR highlights the societal stakes of phygital transformation. As algorithmic systems increasingly mediate access to essential services, policymakers must ensure that digital infrastructures support equity and dignity.

Regulatory frameworks should encourage transparency and accountability in algorithmic governance, particularly in sectors such as healthcare, finance and public services. Policies promoting inclusive access and digital literacy are essential to prevent new forms of vulnerability.

Moreover, TPSR underscores the need for ethical evaluation of hybrid labour systems. Policymakers should consider how automation reshapes employment, responsibility and relational care. Encouraging human-centred design standards can mitigate risks of depersonalisation. By framing phygital services as transformative infrastructures, TPSR informs policy debates about how technology can enhance societal well-being rather than exacerbate inequality.

8. Directions for future research

Each research direction extends specific mechanisms identified in the TPSR propositions and is designed to refine or test the causal architecture proposed in this paper. The TPSR framework positions phygital services as mediated activity systems in which artefacts, rules, communities and divisions of labour interact to generate conditional transformations in well-

being. Because TPSR specifies a causal architecture linking system configuration to transformation outcomes, it opens a focused and mechanism-driven research agenda. Future scholarship should prioritise empirical and conceptual investigations that test, refine and extend these mechanisms under the boundary conditions identified in this paper.

A first priority concerns the empirical validation of TPSR's causal architecture. Research is needed to operationalise antecedent configurations (artefact adaptivity, algorithmic rule rigidity, hybrid community composition and labour redistribution), mediating mechanisms (agency mediation, algorithmic governance and collective learning) and multi-level outcomes. Longitudinal and multilevel designs are particularly suited to examining how these elements interact over time in complex phygital environments. For example, studies could test whether transparency in adaptive interfaces strengthens agency perceptions and downstream well-being, or whether opaque governance structures systematically predict dignity erosion. Such work would establish the incremental explanatory power of TPSR relative to existing frameworks (Batat, 2025; Engeström and Sannino, 2010).

Secondly, future research should investigate contradictions as engines of transformation. TPSR predicts that tensions between efficiency and dignity, automation and empathy or personalisation and equity act as catalysts for expansive learning. Scholars should examine when these contradictions produce empowerment versus when they stabilise into oppressive arrangements. Experimental and field studies could explore how organisations redesign phygital systems in response to such tensions and how users interpret these adaptations. This line of inquiry directly tests TPSR's core claim that transformation emerges from negotiated mediation rather than from technology adoption alone (Engeström, 2001; Batat, 2025).

Thirdly, the growing prominence of immersive and multisensory interfaces calls for research on embodied mediation and psychological thresholds. TPSR suggests that artefacts shape autonomy and well-being through sensory and cognitive channels. Scholars should identify the conditions under which immersion enhances agency versus when it produces overload or exclusion. Experimental studies in retail, healthcare or education could measure how sensory augmentation influences emotional regulation, trust and perceived dignity, thereby clarifying the experiential mechanisms linking artefact design to transformative outcomes.

Fourthly, TPSR invites comparative investigation of algorithmic governance across institutional contexts. Because digitally enforced rules reshape access and participation, cross-cultural and cross-sector research is needed to examine how regulatory regimes and cultural norms mediate fairness and inclusion. Comparative case studies may reveal how different governance models balance automation with human oversight and how these configurations influence trust and equity. Such research would deepen understanding of how phygital infrastructures interact with institutional environments (Batat, 2025; Chandler and Vargo, 2011).

Fifthly, future scholarship should interrogate the ethical consequences of hybrid labour systems. TPSR highlights how redistributing interpretive and emotional labour between

humans and intelligent systems alters responsibility and relational warmth. Research should examine whether algorithmic divisions of labour reproduce inequalities, weaken accountability or reshape professional identities. Mixed-method approaches combining ethnography and quantitative modelling could capture how workers and consumers negotiate these changes and how such negotiations affect systemic well-being (Roten and Vanheems, 2023).

Finally, TPSR provides a foundation for sector-specific transformative programmes. Domains such as healthcare, education, finance and public services offer fertile ground for studying how phygital infrastructures influence capability and vulnerability. Theory-driven programmes in these sectors can inform both academic advancement and evidence-based policy, demonstrating how human-first phygital design contributes to societal value (Batat, 2025).

Taken together, these directions position TPSR as a generative research programme centred on mediated activity, socio-technical contradiction and conditional transformation. By deriving research questions directly from TPSR's internal mechanisms, future inquiry can move beyond descriptive accounts of digital-physical convergence towards causal explanations of how hybrid infrastructures reshape human capability, autonomy and equity. Such work will extend the intellectual agenda of PSR while informing the design of human-centred and socially responsible service ecosystems.

9. Conclusion

This paper advances TPSR as an explanatory framework for understanding how hybrid physical-digital service systems generate conditional transformations in human well-being. Rather than treating phygitality as an extension of channel integration or experiential design, TPSR conceptualises phygital services as socio-technical activity systems in which artefacts, rules, communities and divisions of labour interact through mediating mechanisms to produce multi-level outcomes in autonomy, inclusion and dignity. By specifying a causal architecture linking system configuration, interaction mechanisms and transformation outcomes, the framework moves beyond descriptive accounts of phygital experience towards a generative model capable of explaining both empowerment and erosion.

The central contribution of TPSR lies in resolving theoretical discontinuities that arise uniquely in algorithmically mediated service environments. Existing service frameworks foreground well-being and value co-creation but assume primarily human-negotiated institutional arrangements. TPSR extends this foundation by modelling how digitally enforced rules, intelligent artefacts and hybrid labour systems reshape agency and governance. Drawing on Activity Theory's contradiction-centred logic and building on the human-first orientation of contemporary PSR (Batat, 2025), the framework explains why similar technological configurations may yield divergent outcomes depending on how tensions between efficiency, equity and dignity are mediated.

Importantly, TPSR is not a universal replacement for existing service theories, but a specialised lens designed for contexts characterised by algorithmic decision rights, immersive artefactual mediation and redistributed interpretive

labour. By articulating explicit boundary conditions, propositions and failure scenarios, the framework establishes a platform for cumulative empirical research and practical design guidance. It invites scholars to examine how contradictions within hybrid systems catalyse learning and transformation and it encourages practitioners to design phygital infrastructures that balance technological capability with human flourishing. By doing so, TPSR resolves the theoretical discontinuities introduced at the outset of this paper, namely, the challenges posed by algorithmic mediation of agency, digitally enforced rules and hybrid interpretive labour.

As phygital ecosystems increasingly shape everyday service encounters, understanding their transformative potential becomes a central task for service scholarship. TPSR provides a structured vocabulary and causal logic for analysing this transformation. By situating phygital services within a broader agenda of human-centred and socially responsible innovation, the framework contributes to the evolving intellectual foundations of PSR and offers a roadmap for designing service systems that enhance, rather than diminish, human capability and dignity.

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