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Reframing the narrative of productivity Follow-up: From static control to regenerative learning

Amar Taja[1*], Dimosthenis Kifokeris[1] and Daniella Troje[1]

[1] Department of Architecture and Civil Engineering, Chalmers University of Technology, Gothenburg, Sweden
[*]E-mail: amar.taja@chalmers.se

Abstract. Productivity follow-up in Swedish construction remains fragmented and audit-driven, which restricts cross-project learning and perpetuates static control. This study reconceptualizes follow-up as a regenerative learning system, wherein interpreted feedback leads to changes in routines and decision-making. Through a conceptual synthesis of prior research, complemented by a Swedish case investigation on productivity follow-up, sustainability transitions theory is integrated with regenerative principles to develop the Regenerative Productivity Framework. This framework consists of three interrelated pillars: (1) timely and interpretable feedback signals, (2) digital connectivity that enables signals and knowledge to circulate across projects and stakeholders, and (3) cultural sensemaking and adaptive capacity that convert signals into routine change. The analysis indicates that "digital stagnation" results from weak organizational integration under regime lock-in rather than a technology deficit. It also shows how existing waste and rework data can be used as signals for renewal. The main contribution is a testable model that guides pilot experiments, shifting follow-up from a record-keeping function to becoming a diagnostic and navigational tool for long-term regenerative production in the sector.

1. Introduction

Productivity follow-up within the Swedish construction sector is used inconsistently across managerial levels, ranging from retrospective auditing and cost control to input–output efficiency [1–3]. The strategic use of follow-up continues to be fragmented and predominantly tied to individual projects, limiting knowledge transfer and thus weakening cumulative learning across projects [4,5]. In this paper, productivity follow-up refers to the organizational routines and information practices by which productivity signals (e.g., time, cost, flow, and deviations) are systematically collected, interpreted, and subsequently transformed into decisions. The follow-up, when limited to deviation reporting, results in a passive productivity audit [3,6]; this logic is primarily focused on retrospective compliance, which results in learning being only weakly institutionalized. In contrast, regenerative perspectives emphasize renewal and adaptive capacity, suggesting that follow-up practices should intervene directly in established routines and governance conditions and not be limiting to performance documentation [7–9]. Therefore, incorporating such perspectives has the potential to amend the aforementioned shortcomings.

Against this background, our research question is: How can we improve productivity-follow up in the Swedish construction sector by integrating regenerative principles? To answer this question, his paper develops the Regenerative Productivity Framework (RPF): a theoretically grounded model that aims to reframe productivity follow-up from static control to regenerative learning (i.e., interpreted feedback that leads to altered routines and decisions, rather than merely accumulating more data [11,12]). We do not touch upon the measurement of productivity itself; rather, we focus on why such measurement seldom

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transforms into cross-project learning that alters routines and decisions, even as digitalization efforts have become widespread [4,5,10]. The framework, developed through comparative mapping and synthesis (Section 3.4) and detailed in Section 4, consists of three components: (1) timely and interpretable feedback signals, (2) digital connectivity that enables signals and knowledge to circulate among projects and stakeholders, and (3) cultural sensemaking capacity that converts interpreted signals into revised routines and decision-making practices [11–13]. Our contribution is not simply an additional performance-measurement technique; rather, it is a set of mechanisms that reorganize data use and digitalization into feedback, connectivity, and sensemaking.

2. Background: Two discourses

2.1 Productivity Follow-Up

Fragmented productivity practices and isolated project environments reflect weakly institutionalized follow-up routines in construction [1,5]. In Sweden, site-level metrics are mainly collected for local reporting, limiting their use in organizational learning. This restricts knowledge transfer between projects, reinforcing isolated silos of practice. [1–3]. Such fragmentation is causing ongoing disruptions, more waste, and rework, because lessons learned from recurring phases are not consistently shared across similar production sequences [5,14,15]. The main issue, therefore, is not the measurement itself but the connection between measurement and its use, where the degree to which monitoring relates to interpretation, decision-making, and changes in upstream planning impacting, requires investigation [3,5,6].With the lack of standardized indicators and compatible documentation formats, it is hard to detect hidden waste mechanisms and transfer learning across different stages and projects [5].

Improvement depends on comparable, usable follow-ups, resulting in actionable routines across roles and organizational boundaries [5]. Empirical findings have indicated the necessity for establishing consistent metrics, implementing clear decoding practices for both site staff and planners, and following up interactively rather than retrospectively auditing [3,5,6] Evidence from Swedish follow-up practice indicates that anchoring productivity within stable and comparable units (e.g., structured cost breakdowns tied to construction parts rather than ad hoc estimates) can reduce reactive decision-making and enhance learning continuity [5]. For such routines to operate beyond isolated projects, they must be supported contractually and digitally, because responsibilities and incentives remain fragmented under price competition, resulting in dispersed accountability within construction governance [16–18].

2.2 Regeneration paradigm: reframing the narrative

As stated, the current implementation of productivity follow-up acts as a persistent constraint within the current regime that affects knowledge flow. The built environment's regenerative views shift the focus from incremental auditing to system-level renewal, emphasizing adaptive capacity and reciprocity, thus creating net-positive value in design and governance [7,8,19,20]. From this perspective, follow-up matters because it shapes what the system can "see," treats as value, and change over time.

The empirical evidence within sustainability transitions scholarship shows that digital transformation and learning often remain stagnant, even when the necessary tools are present. This stagnation is frequently attributed to regime lock-in; established routines, governance structures, and procurement logics have stabilized the incumbent practices, resulting in limited progress [4,9,10,21]. Regenerative production requires more than technological change; it involves reconfiguring norms and institutions to transform feedback interpretation and response in projects and organizations [7,12,19]. The framing of this phenomenon highlights dynamic learning capacity as the primary performative requirement. This capacity is characterized by the updating of routines, the sustaining of interactive feedback loops, and the creation of organizational coherence across fragmented production settings [4,5,11,13]. Consequently, section 4 denotes three leverage points, namely, signals, connectivity, and sensemaking, which enable

follow-up to shift from reporting to regenerative learning.

3. Methodology

3.1 Research design

We adopt a conceptual synthesis approach to develop an integration model for the follow-up of regenerative productivity in Swedish construction, drawing on existing empirical knowledge and relevant theoretical frameworks. This provides a system-oriented perspective on how follow-up works in practice in order to present a theoretically grounded model that can support future experimentation and inform strategic decisions in the field [4,9]. In this context, learning is understood as a change in decision-making practices and organizational routines, prompted by meaningful feedback rather than by simply accumulating more data. This interpretation aligns with valuing experimentation and reflective adjustment in transition governance [11,13].

3.2 Analytical material and scope

The analysis is grounded in well-documented challenges in productivity follow-up, including fragmented measurement practices, weak learning loops, and the organizational and contractual constraints outlined in Section 2.1. Alongside academic and grey literature, we incorporate empirical insights from a recent study on productivity follow-up in Swedish construction [5], highlighting indicator fragmentation, inconsistent reporting, misaligned digital systems and organizational structures, and limited follow-up integration into project-level decision-making. These insights serve as contextual evidence of how productivity follow-up currently functions within the production regime, without introducing new empirical data in this paper.

To ensure transparency in defining the scope of the theoretical synthesis, a structured literature search was conducted across Scopus and Web of Science, with Google Scholar used for forward and backward snowballing from key seed papers. The time frame was set to 2000-2025 to encompass both the origins of transition governance scholarship and the evolution of research on construction digitalization and regenerative built environments [12,20,21]. The search was organized around three thematic queries: (1) productivity follow-up and performance measurement in construction, particularly as related to feedback and learning, e.g., [1,3,6]; (2) digital transformation and data-enabled work practices in construction, focusing on adoption, implementation, and routine integration [4,10,22–24]; and (3) sustainability transitions alongside regenerative concepts in the built environment [7–9,11,19]. For the digitalization literature, the research was further refined to include only studies from Nordic countries and the UK and within construction-relevant subject categories. The combined search yielded approximately 14,429 records (Scopus: n=4,772; Web of Science: n=9,657). Standard screening was followed, initially parsing by title and abstract followed by full-paper review, while excluding duplicates, irrelevant domains, and purely technical papers lacking implications for organization, learning, or governance. After five iterations and progressively targeting sources that directly support model development, the synthesis was distilled into a corpus suitable for a conceptual conference paper, supplemented by targeted contextual literature (e.g., waste, rework, and contractual conditions) strengthening the problem framing [14–18]. We, subsequently, ended up with 27 references.

3.3 Theoretical positioning

This methodology conceptualizes productivity follow-up as a sociotechnical practice, shaped by the interplay of data infrastructures, tools, routines, roles, and institutional logics. Sustainability transitions scholarship explains the persistence of current follow-up practices as a form of regime stabilization and lock-in, where cost-driven norms, fragmented governance structures, and project-based routines perpetuate established behaviors over time [9,21]. In contrast, regenerative built environment frameworks introduce principles such as reciprocity, net-positive contribution, adaptive capacity, and iterative renewal, clarifying the direction and quality of

learning that a "regenerative" follow-up system should foster [7,8,19,20]. Research on digital transformation and human–data interaction further highlights that successful embedding requires not only technical solutions but also supportive organizational routines, interpretive capacity, and legitimacy in data use [4,10,24,25].

Given the above, and to avoid theory layering, the following frameworks are applied systematically within RPF: transitions scholarship provides the multi-level change frame [9,21] allowing transition management to inform experimentation and learning cycles as governance processes [11–13], while regenerative scholarship provides the normative direction for "what the system should become" [7,8], as it is embedded in the socio-technical mechanisms expounded by digitalization research [4,10]. When technological innovation systems (TIS) are invoked, they are used as a supporting process view of system building and functional weaknesses/strengths, grounded in functional dynamics rather than introduced as a competing theory [26].

3.4 Analytical procedure: comparative framework analysis

The analysis unfolds in three phases. In Phase 1, the research problem is structured by identifying core dimensions of productivity follow-up, such as indicator design, the presence and quality of feedback loops, digital infrastructure configurations, and organizational and contractual conditions [1,3,16–18]. Phase 2 involves theoretical mapping, systematically linking the problem dimensions from Phase 1 to concepts and principles from regenerative frameworks and sustainability transitions literature (including net-positive contribution, long-term socio-ecological learning, and interdependence [7,8,19]), as well as to transition categories like regime rules, experimentation dynamics, and contextual pressures shaping change [9,11,12]. Attention was paid to the role of indicator systems and digitalization metrics in facilitating knowledge development, legitimation, and resource mobilization, as described in the TIS literature, without treating TIS as a competing explanatory framework [26]. Phase 3 focuses on model synthesis (see Section 4), where insights from the mapping are integrated to reveal where existing follow-up practices reinforce regime logics, where regenerative potential exists, and how reconfigurations could reposition follow-up as an active regenerative feedback mechanism [9,11,12].

3.5 Strategic niche interpretation

Because regenerative production is still emerging and not yet fully institutionalized in construction, including in Sweden, the model is viewed through a niche-focused experimental approach aligned with sustainability transition theories and transition management [27]. Regenerative productivity follow-up is conceptualized as an intervention that can be trialed in pilot projects, alliances, and other bounded settings where, redesigned follow-up routines, indicators, and digital feedback mechanisms can be tested and refined through iterative learning cycles [11–13]. This interpretation does not introduce an additional theoretical layer, but specifies how experimentation and learning can be organized so that validated practices can diffuse beyond isolated projects and contribute to broader shifts in routines and governance expectations [9].

3.6 Methodological validity and transparency

This study's validity depends on its transparent analytical process and its basis in established research fields. The problem area is defined through well-documented challenges in productivity tracking; the theoretical sampling is intentional and tailored to the systemic nature of the issue; and the comparative approach is clear and reproducible. Transparency is further enhanced by explicitly reporting the database sources, the time frame from 2000 to 2025, the initial search results of 14,429 items, and the five-phase screening process. The resulting model is not intended as a final causal theory but as a structured conceptual proposal designed to guide further empirical research, refinement, and application within regenerative production [3,4].

4. Findings: The Regenerative Productivity Framework (RPF)

The ongoing challenges in productivity follow-up within Swedish construction, which have traditionally been seen as operational nuisances, take on a new meaning when viewed through a regenerative lens. Instead of being just an administrative task, follow-up starts to look like a system-level learning process that can redirect focus, influence behavior, and create new pathways for transformation. By connecting the problem areas identified in Section 2.1 with regenerative principles and mechanisms of sustainability transition, a three-pillar framework is formed. The aforementioned pillars were not established in advance; rather, they emerged during Phase 3 (Section 3.4) as three significant leverage points within the comparative mapping. These include: (i) the quality and timeliness of feedback signals, (ii) the connectivity among projects and actors, and (iii) the organizational sensemaking capacity, which is responsible for transforming signals into altered routines and decision practices. Therefore, the pillars highlight the areas in which productivity follow-up may become a regenerative lever rather than merely stabilizing the current regime. In this context, "regenerative learning" refers to feedback that has been interpreted and leads to changes in routines and decisions. This process is not simply the accumulation of more data, but rather involves organizational sensemaking that alters actions.

4.1 Pillar 1: Data-driven follow-up as regenerative feedback and renewal

Swedish construction sits on lots of data that rarely becomes knowledge. Despite decades of warnings about waste, inefficiency, and rework saturating project delivery [3,6,14,15], follow-up practices still rely heavily on manually assembled spreadsheets, improvised reporting chains, and fragmented indicator sets [5]. Even where more advanced tools exist (e.g., BIM-linked dashboards or EVM), they are commonly applied in inconsistent, diluted or improvised forms that undermine learning [1,5,10]. Labor hour deviations remain unexamined, bottlenecks become normalized, and discrepancies turn into routine rather than signals.

Empirical evidence reinforces that follow-up is often decoupled from production, surfacing too late to support course correction and rarely travelling beyond the boundaries of a single project [5]. This aligns with long-standing research showing that Swedish construction struggles to translate measurement into organizational learning because each project is insulated from cumulative experience [1,2,5]. Such fragmentation is not accidental; it is structurally stabilized. Sustainability Transitions Theory describes this as a regime locked into cost-centric norms, role fragmentation, and risk-dispersing contractual structures that collectively suppress systemic learning [9,21]. The dispersal of follow-up responsibilities among planners, controllers, and site managers dilutes the interpretive authority needed for metrics to gain meaning [5].

Regenerative thinking reverses this logic by considering follow-up not as a bureaucratic step, but the circulatory system through which renewal and adaptation occur [7,8,20]. It treats indicators as early signals of system behavior rather than as historical records, where rework spikes, labor drift, CRM fault patterns, and the 27,000-case reclamation dataset analyzed in recent empirical work are not just isolated anomalies [5,14].

Transition theory sharpens this opportunity through the lens of niche learning. The sector already runs small-scale experiments: selective earned value management (EVM) trials, pilot dashboards, digital tracking prototypes, and lean-inspired coordination routines [5]. Empirical evidence shows EVM is not a niche, but a long-standing practice with uneven adoption. 'Pilot', however, refers to specific trials intended for learning in protected settings [4,10]. Yet, these tools often remain superficial add-ons, lack organizational embedding, and are abandoned once they confront entrenched behaviors [4,10]. Without institutional scaffolding, niche learning evaporates before it can unsettle established routines. The study repeatedly confirms this: lessons generated in pilots do not travel, tools are introduced faster than routines can absorb them, and digitalization creates data-rich but insight-poor environments [5].

Repositioning data-driven follow-up as regenerative feedback demands more than collecting more data. It requires metabolizing it. Repositioning data-driven follow-up as regenerative

feedback involves more than collecting data; it requires metabolizing it. 'Metabolizing' indicates organizational sensemaking, leading to changed routines and decisions, not just data accumulation [11,13]. As a result, follow-up becomes a continuous sensing function that identifies tensions, supports adjustments, and enables learning over time and across projects. Rather than reinforcing the current regime, data-driven follow-up helps the system recognize itself, challenge inertia, and renew patterns of practice.

In this reframed perspective, Pillar 1 is not simply about improving measurement. It is about restoring the system's capacity to learn; a capacity that has been eroded by fragmentation, superficial digitalization, and regime-stabilizing routines. Positioned as regenerative feedback, data-driven follow-up becomes the engine that transforms information into system intelligence.

4.2 Pillar 2: Digital integration as systemic connectivity

Digitalization in Swedish construction advances but rarely coheres. Tools arrive faster than organizations can absorb them, producing a landscape of dashboards, planning software, and mobile apps that operate in parallel rather than in concert [4,10]. The empirical evidence demonstrates that this pattern aligns with previous research on construction digitalization, where the diffusion and embedding of such practices are largely contingent upon established organizational routines and the legitimacy they confer, rather than the mere availability of tools [4,10,22]. Empirical investigations show that project teams often rely on incompatible templates, manually stitched data sources, and selectively used systems that reflect local intuition more than organizational intent [5], showing that connections exist, but the pathways between them do not.

Regenerative thinking interprets this fragmentation not simply as a technological lag, but as a structural disconnect. Digital infrastructure in a regenerative system should thus act as the channel through which information, relationships, and material cycles reinforce one another [7,19]. Regeneration depends on interdependence, where data should not be locked in silos, its insights trapped within tools, and its decision-making isolated across organizational boundaries.

Empirical evidence supports this interpretation. Through projects, digital tools are introduced as local optimization rather than as components of an integrated system. Interfaces among planning, cost control, and site operations remain weak or ad hoc. Data travels upwards for reporting but rarely sideways for coordination, which means digitalization strengthens surveillance more readily than collaboration [5]. Upward reporting, combined with weak lateral coordination, has been observed to correspond with empirical findings on ICT uptake. In such cases, the prevalence of local workarounds and the persistence of 'it's fine as it is' routines have significantly constrained the potential for deeper organizational integration [10].

Sustainability Transitions Theory provides the vocabulary to explain this. Digitalization, when enacted piecemeal, functions as an incremental add-on that leaves the regime architecture intact. A TIS, by contrast, becomes transformative when it establishes shared standards, learning channels, and legitimacy structures that allow new practices to grow into system-level norms [4,9]. To prevent theory layering, the use of TIS here is strictly as a meso-level lens for system-building functions like knowledge development, legitimation, and resource mobilization. This aligns with the functional dynamics scheme in [26], where without systemic integration, digital tools can create local efficiencies, but not the connective capacity needed for regeneration.

This is why digital systems, when becoming interoperable, transparent, and mutually reinforcing, can support regenerative information and value flows. They allow indicators from Pillar 1 to move fluidly across sites, disciplines, and decisions, planning routines to respond to real-time signals rather than retrospective reports, and fragmented practices to become collective intelligence. Empirical evidence underscores that when data is consolidated, even temporarily, coordination improves, deviations surface earlier, and decisions become more anticipatory [5].

Under this reframing, digital integration can enable a regenerative production system to exist by binding dispersed activities into a coherent sociotechnical whole, allowing learning, feedback,

and adaptation to propagate across the system rather than remaining confined to individual projects. In this sense, Pillar 2 is the skeleton of the regenerative model. Without systemic connectivity, renewal cycles cannot travel, signals cannot accumulate, and regenerative behaviors cannot take hold. Digital integration becomes the architectural backbone through which the construction regime can reorganize itself toward regenerative practice.

4.3 Pillar 3: Organizational culture as adaptive capacity

Digital integration may bind the technical system together, but it cannot regenerate the system on its own. Connectivity creates pathways for information to move, yet it does not ensure that organizations will listen, interpret and/or act on it. Thus, organizational culture becomes decisive; however, in Swedish construction, it remains anchored in cost minimization, risk insulation, and the choreography of linear project delivery [1,16,18]. These priorities compress time horizons and narrow the space for reflection, cross-actor sensemaking, and experimentation. When culture is organized around predictability and avoidance, learning becomes peripheral. Follow-up practices risk becoming routines of compliance and complacency rather than engines of foresight.

Empirical evidence reinforces this structure, describing a production environment where planning is frequently overridden by urgency, deviations are absorbed locally rather than analyzed collectively, and accountability is dispersed to the point that no single actor feels mandated to translate insight into change [5]. This dispersal reflects a shared expectation that follow-up is something to be "done" rather than a learning opportunity.

Regenerative frameworks then counter-position culture as adaptive capacity. Culture is where signals are interpreted, new forms of value are recognized, and practices either reinforce the status quo or open space for alternative trajectories [19]. The empirical evidence aligns with regenerative built-environment scholarship, which regards adaptive capacity and the redefinition of value as structural conditions for renewal, rather than merely soft factors. This positioning has been observed as a significant shift in the understanding of renewal processes [7,8,20]. In regenerative terms, culture is the medium through which systems metabolize change; if it cannot absorb new information, it cannot regenerate either. When culture is rigid, teams often recognize inefficiencies but normalize them. Digital tools are introduced but quickly reinterpreted through familiar routines. As a result, lessons from one project are praised in principle, yet not implemented in practice. These patterns reveal not a lack of capability but a lack of cultural infrastructure to sustain adaptive behaviors [5]. Without this infrastructure, well-designed feedback mechanisms and digital systems cannot function effectively.

Sustainability transitions scholarship frames this as a regime-level phenomenon. Regimes shift only when organizations realign their internal logic with emerging landscape pressures, environmental requirements, policy directions, and social expectations. In construction, the pressures mentioned earlier increasingly demand circularity and regenerative performance, driving a shift that has attracted the attention of practitioners and scholars and challenging traditional practices [9,19,21]. Still, in the current regime, cultural alignment cannot be a short-term feature of transition, but a precondition where procurement stabilizes short-term compliance and disperses learning responsibility, resulting weak systematic learning capacity.

Thus, regenerative follow-up can redirect managerial attention from narrow project-efficiency metrics to broader system behavior patterns. It highlights where coordination is failing, learning is stalling, and adaptive capacity is emerging. In doing so, it can cultivate the habit of seeing each project as part of a longer arc of systemic performance. Under this reframing, culture is a latent resource. The sector's strong operational discipline, emphasis on reliability, and pride in craftsmanship have adaptive potential if redirected toward regenerative outcomes. Pillar 3 identifies this potential and positions organizational culture as the medium through which regenerative practices can accumulate, circulate, and eventually stabilize.

4.4 Interpreting the RPF

RPF is not a static classification list, but a system of three interlocking pillars connecting standard productivity domains to regenerative principles using mechanisms derived from sustainability transitions theory [22]. As shown in Table 1, the value does not come from the individual parts but from their collective operation. Each row represents a pathway where a familiar industry practice is repurposed into a lever for regeneration.

Consider the first pathway. It reengineers performance indicators, moving them from passive reporting to active regenerative learning. Data-driven follow-up becomes a live feedback system, allowing organizations to adjust operations when environment shifts. This aligns with transition governance, emphasizing reflexive monitoring, iterative adjustment, and learning cycles over just retrospective auditing [11,13]. Therefore, this approach develops institutional knowledge that preserves the project's memory for future projects. Analytically, through the lens of sustainability transitions, this creates the necessary space for niche learning and experimentation that accumulates beyond a single project, rather than being lost at handover [5,9].

Digital integration, the second pathway, builds systemic connectivity by reframing digitalization as the infrastructure for regeneration instead of just a collection of tools [5]. The Swedish sector has historically struggled with "pilot fatigue," where digital efforts remain stuck in a well-documented pattern of diffusion and lack of implementation deriving from a lack of common standards or documented trials for changed routines [4,10,22]. The second pathway counters that. It establishes the connectivity needed for interdependence across socio-ecological systems [19,24]. Integrated digital practices become the efferent connections. This pathway coordinates the shared learning between actors, directly supporting the functional conditions imperative for system-level reconfiguration. In this paper, TIS is not treated as a parallel explanatory theory; instead, the function is anchored in TIS's functional dynamics [26].

Finally, the third pathway integrates organizational culture with adaptive capacity. Culture is positioned as the key to how organizations manage pressure, and a shift is proposed from the dominant emphasis on cost control and risk aversion (often limiting the sector's willingness to adapt or learn) to recognizing experimentation and long-term value creation as legitimate business priorities. In transition terms, follow-up signals can influence norm change only when they are interpreted and acted upon through internal routines that continue beyond project completion [5,9,12,21]. As a result, when follow-up measures resilience or circularity, it sets the tone for value change. Over time, this surplus of value change will signal shifting norms, helping institutions internalize broader environmental demands.

4.5 Multi-level Alignment of the Framework

RPF only shows its full potential when placed within the layered dynamics of socio-technical transitions. At the landscape level, Swedish construction faces mounting environmental and

Table 1. The three pathways of the Regenerative Productivity Framework

Productivity domain (example from practice)	Regenerative principle (proposed lever)	Transition-relevant mechanism
Data-driven follow-up (e.g., deviation logs, EVM dashboards)	Feedback and renewal (signal-to-decision loops)	Learning-by-doing and iterative experimentation
Digital integration (e.g., interoperable datasets across planning, cost, and site)	Systemic connectivity (infrastructural scaffolding)	Regime reconfiguration via TIS functional dynamics[26]
Organizational culture (e.g., compliance-to-sensemaking routines)	Adaptive capacity (shared interpretation > routine change)	Institutional alignment with landscape pressures[9,21]

policy demands, making incremental improvements less effective. This view aligns with research on sustainability transitions, emphasizing external pressures and the limitations of small-scale changes within established regimes [9,21]. However, at the regime level, the sector is still governed by deeply rooted norms, including prioritizing cost, adversarial contracting, and linear delivery models that foster fragmentation and block reflexive learning [5]. These patterns align with Nordic views on contracting and governance, shaping routines and collaboration [16–18]. This structural inertia can explain why productivity follow-up remains weakly institutionalized; the practice is not lacking in technical adequacy; it is culturally and systematically contained.

Within this tension, the meso-level mechanisms of TIS provide connective architecture through which transformative practices might gain traction. However, it is worth noting that in this paper, all references to TIS are limited to its role in functional dynamics, how knowledge, legitimacy, and resources align to stabilize new practices. It is not an additional layer of theory [26]. Without these functions, digital tools reinforce fragmentation rather than enabling coordination [4,5]. The second pillar, digital integration, serves as the hinge of the transition, turning isolated experiments into infrastructure for regenerative learning across organizations.

At the micro level, Strategic Niche Management (SNM) reveals where regeneration must begin as a protected experimentation. Instead of framing SNM as a standalone theory, we adopt a niche-oriented experimentation approach aligned with the principles of transition management. Pilots are seen as intentional learning environments needing refinement, institutionalization, and diffusion to extend their impact beyond isolated projects [11–13], thus addressing empirical insights that pilots tend to dissipate before any meaningful interaction with the system structure [5]. Transforming pilots into strategic learning spaces shifts their role from peripheral experiments to incubators of alternative routines that may challenge the regime's stability.

5. Discussion

The empirical evidence indicates that productivity follow-up within Swedish construction is inconsistently defined and applied across various managerial levels. As a result, follow-up routines are weakly institutionalized and display uneven connections to decision-making processes. The prevailing methods are primarily based on retrospective documentation intended for cost management, thereby restricting follow-up to after-the-fact reporting rather than enabling timely adjustments or course corrections. The sector, while containing data, lacks interpretive capacity and processing utility. Waste reports and deviation logs are consistently produced; however, they are seldom translated into learning or inputs for collective action, as they are regarded primarily as administrative outputs. Therefore, the potential for systematic improvement remains largely untapped [5]. RPF interprets this dynamic through recurring patterns of project-focused reporting, minimal transfer between projects, and limited decision-making integration [5], highlighting the necessary changes to make follow-up a true learning mechanism. In this context, regenerative learning is defined as feedback interpreted and subsequently leading to altered routines and decisions; this process is characterized by organizational sensemaking that transforms action, rather than merely accumulating further data [9,11–13]. As described in Sections 3 and 4, the limited impact of previous digital initiatives can be attributed to weak coupling among Pillars 1 (signals), 2 (connectivity), and 3 (sensemaking). This outcome is not solely due to the availability of tools [4,10]. Empirical evidence suggests that digital tools, when introduced without legitimacy, clear roles, and established routines for responding to signals, are often regarded as mere add-ons. As a result, they seldom diffuse beyond organizational boundaries and are unable to challenge the existing operational standards [4,22].

The practical implications indicate that procurement and contracts can either enable or constrain regenerative learning, due to their significant influence on the incentives for knowledge sharing, continuity, and accountability among various actors. When governance logics are

directed towards short-term cost compliance, follow-up tends to remain as retrospective auditing, rather than shifting towards anticipatory learning. As a result, the responsibilities for translating insight into action are often dispersed and fragmented across different actors [16–18]. RPF indicates a shift away from traditional auditing, resulting in a focus on anticipatory monitoring and error-to-learning routines. Therefore, irregularities are now regarded as signals for coordinated interpretation and the redesign of routines [5]. RPF, as a conceptual contribution, refrains from asserting causal validation. Instead, it proposes locations in which routine change may occur, as well as the necessary enabling conditions. RPF thus provides a basis for further empirical investigation. Therefore, subsequent research should evaluate RPF in both pilot projects and established organizational contexts, using transition governance perspectives on experimentation and diffusion [9,11,12]. It is also necessary to assess whether redesigned feedback signals, interoperable data flows, and sensemaking routines produce measurable changes in decision timing, cross-project learning, and routine adoption.

6. Conclusions

This paper argues that the persistent productivity challenge in Swedish construction is not solely a measurement issue, but fundamentally a learning problem. The pursuit of efficiency, when based primarily on input/output indicators and retrospective cost control, has led to follow-up processes that appear reassuring but fail to reliably improve decision quality, cross-project learning, or adaptive capacity. Therefore, the introduction of improved measurement tools is unlikely to transform system performance if follow-up is still regarded merely as documentation rather than as a mechanism for timely interpretation and action. The main contribution of this paper is reframing productivity follow-up as a diagnostic and navigational capability for organizational health. This can be significant in enabling actors to interpret signals, coordinate responses, and alter routines, rather than serving as a mandatory administrative procedure.

This reframing is achieved via proposing the Regenerative Productivity Framework (RPF), outlining three interdependent conditions necessary for transforming follow-up into regenerative learning. Those include timely, interpretable feedback signals, digital connectivity that enable signals and knowledge to traverse organizational boundaries, and a culture of sensemaking that translates interpreted feedback into modified routines and decisions. In this context, regenerative learning is defined as feedback that, when interpreted, leads to altering routines and decisions rather than merely accumulating additional data. Therefore, RPF suggests that transformative improvements are more likely to arise from reconfiguring follow-up use rather than increasing the reporting volume. This requires moving from documenting past deviations toward anticipatory monitoring and establishing error-to-learning routines, supported by interoperable data flows integrating planning, production, logistics, cost, and incentives to act on signals.

Finally, the framework is presented as a conceptual proposition, rather than as definitive causal proof. The value of the framework lies in its provision of a structured model to guide targeted experimentation and systematic evaluation. Therefore, future research should examine the framework within both pilot projects and established organizational contexts, observing whether redesigned feedback signals, interoperable data flows, and structured sensemaking routines result in measurable changes in decision timing, cross-project learning, and the adoption of new routines over time. This reframing repositions productivity follow-up from static control, retrospective compliance, and cost auditing to regenerative learning, where feedback signals are interpreted and acted upon to continually renew routines and decision-making.

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References

[1] Landin A and Oberg M 2014 Productivity and Efficiency in the Development of the Swedish Construction Sector *American Journal of Industrial and Business Management* **4** 307–18
[2] Koch C, Shayboun M, Manès A and Nordlund T 2020 *Produktivitetsläget i svenskt byggande 2018: Lokaler, flerbostadshus, grupphus och anläggning* (Stockholm, Sweden)
[3] Lee T Y, Ahmad F and Sarijari M A 2023 Current Status and Future Research Trends of Construction Labor Productivity Monitoring: A Bibliometric Review *Buildings 2023, Vol. 13, Page 1479* **13** 1479
[4] Samuelson O and Stehn L 2023 DIGITAL TRANSFORMATION IN CONSTRUCTION – A REVIEW *Journal of Information Technology in Construction* **28** 385–404
[5] Taja A and Hama Amin R 2025 Productivity follow up in the Swedish construction industry; an investigation of implementation and influencing factors
[6] Shehata M E and El-Gohary K M 2011 Towards improving construction labor productivity and projects' performance *Alexandria Engineering Journal* **50** 321–30
[7] Du Plessis C 2012 Towards a regenerative paradigm for the built environment *Building Research and Information* **40** 7–22
[8] Cole R J, Busby P, Guenther R, Briney L, Blaviesciunaite A and Alencar T 2012 A regenerative design framework: Setting new aspirations and initiating new discussions *Building Research and Information* **40** 95–111
[9] Köhler J, Geels F W, Kern F, Markard J, Onsongo E, Wieczorek A, Alkemade F, Avelino F, Bergek A, Boons F, Fünfschilling L, Hess D, Holtz G, Hyysalo S, Jenkins K, Kivimaa P, Martiskainen M, McMeekin A, Mühlemeier M S, Nykvist B, Pel B, Raven R, Rohracher H, Sandén B, Schot J, Sovacool B, Turnheim B, Welch D and Wells P 2019 An agenda for sustainability transitions research: State of the art and future directions *Environ. Innov. Soc. Transit.* **31** 1–32
[10] Jacobsson M and Linderoth H C J 2012 User perceptions of ICT impacts in Swedish construction companies: "it's fine, just as it is" *Construction Management and Economics* **30** 339–57
[11] Kemp R, Loorbach D and Rotmans J 2007 Transition Management as a Model for Managing Processes of Co-Evolution towards Sustainable Development *International Journal of Sustainable Development and World Ecology - INT J SUSTAIN DEV WORLD ECOL* **14** 78–91
[12] Loorbach D 2010 Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework *Governance* **23** 161–83
[13] Loorbach D, Wittmayer J, Avelino F, von Wirth T and Frantzeskaki N 2020 Transformative innovation and translocal diffusion *Environ. Innov. Soc. Transit.* **35** 251–60
[14] Josephson P-E and Saukkoriipi L 2007 *Waste in construction projects: Call for a new approach* (Gothenburg, Sweden)
[15] Asadi R, Rotimi J O B and Wilkinson S 2023 Rework causes classification model with liable parties of the contract in construction projects *Front. Built Environ.* **9** 1143829
[16] Eriksson P E and Westerberg M 2011 Effects of cooperative procurement procedures on construction project performance: A conceptual framework *International Journal of Project Management* **29** 197–208
[17] Lahdenperä P 2012 Making sense of the multi-party contractual arrangements of project partnering, project alliancing and integrated project delivery *Construction Management and Economics* **30** 57–79
[18] Kadefors A, Aaltonen K, Gottlieb S C, Klakegg O J, Lahdenperä P, Olsson N O E, Rosander L and Thuesen C 2024 Relational contracting in Nordic construction – a comparative longitudinal account of institutional field developments *International Journal of Managing Projects in Business* **17** 22–4
[19] De Wolf C and Bocken N 2024 Digital Transformation of the Built Environment Towards a Regenerative Future *A Circular Built Environment in the Digital Age* ed Catherine De Wolf, Sultan Çetin and Nancy M. P. Bocken (Springer) pp 259–75
[20] Plaves Y, Jacobs P, Uylaki T and Jonescu E E 2024 Regenerative design: Research, practice, and implementation in the built environment *Proc. Inst. Civ. Eng. Urban Des. Plan.* **177** 96–108
[21] Rotmans J, Kemp R and Van Asselt M 2001 More evolution than revolution: Transition management in public policy *Foresight* **3** 15–31
[22] Shibeika A and Harty C 2015 Diffusion of digital innovation in construction: a case study of a UK engineering firm *Construction Management and Economics* **33** 453–66

[23] El Masry A 2025 Factors Influencing Big Data Adoption for Sustainability in the Swedish Construction Industry: Technical, Economic, and Organizational Perspectives *Buildings* **15** 1671
[24] Kifokeris D K 2025 Initiating the Conceptualisation of Human-Data Interactions in Regenerative Building Production *Proceedings of the 2025 European Conference on Computing in Construction* **6**
[25] Hummel P, Braun M, Tretter M and Dabrock P 2021 Data sovereignty: A review *Big Data Soc.* **8**
[26] Bergek A, Jacobsson S, Carlsson B, Lindmark S and Rickne A 2008 Analyzing the functional dynamics of technological innovation systems: A scheme of analysis *Res. Policy* **37** 407–29
[27] Cole R J 2023 Transition to a regenerative future: a question of time *Buildings and Cities* **4** 457–74