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DUAL TAKT AREA DESIGN: EFFECTS ON PRODUCTION FLOW

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ABSTRACT

Takt planning is used in lean construction to stabilize production flow by structuring work sequencing across locations. This approach centers on designing takt areas that coordinate and supervise work. Although literature often assumes a uniform design, empirical insights into different zoning strategies and their effects on supervision and coordination are limited. This study draws on nine semi-structured interviews with site management and subcontractors, combined with on-site observations from a case study of a complex construction project where two distinct takt area design approaches are applied in parallel within the same organization. Laboratory zones follow a subcontractor-oriented logic that emphasizes continuity of responsibility, whereas office zones follow an area-based logic centered on spatial ownership and coordination across multiple trades. The findings show that differentiated takt area design supports production flow through mechanisms aligned with functional context, but also introduces additional coordination demands at organizational interfaces. Rather than being mutually exclusive, these supervisory logics represent different combinations of trade-oriented and area-oriented control. The study contributes empirical insight into takt area design and supervisory practices as interrelated, context-dependent decisions, and highlights the need for further research on adaptive takt planning in complex construction projects.

KEYWORDS

Takt planning, Takt area design, production flow, site management.

INTRODUCTION

Takt planning is increasingly used in lean construction to ensure stable flow by organizing work sequences based on a fixed takt. It aims to reduce variability, improve trade coordination, and increase predictability by synchronizing activities spatially and temporally (Tommelein & Emdanat, 2022). A key part is designing takt areas, which define work distribution and activity coordination across the project (Tommelein, 2022).

Previous studies have shown that takt area design is vital for balancing workload, minimizing production variability, and ensuring continuous flow, especially in projects with non-repetitive tasks and varying work densities (Jabbari et al., 2020; Tommelein, 2022). However, construction projects often feature areas with diverse functional and technical features-like highly specialized spaces next to more standardized and repetitive zones. These differences challenge the idea that a common takt area design can be applied uniformly across all projects.

Designing takt areas links closely to site management, affecting duties for coordination and monitoring. Research shows takt planning isn't uniform but tailored to organizational and

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project contexts, shaping responsibility and coordination (Gardarsson et al., 2019; Tommelein & Lerche, 2023). While location-based planning emphasizes spatial control, takt approaches add temporal structure, both relying on active supervisory coordination (Lehtovaara et al., 2021; Frandson et al., 2015). Most studies focus on planning techniques, with limited empirical research on how takt area design influences site management roles during execution.

Consequently, empirical understanding remains limited regarding how various approaches to takt area design generate distinct forms of supervisory follow-up and coordination within a single project organization, and how these differences influence production flow.

THEORETICAL BACKGROUND

TAKT PLANNING AS A PRODUCTION CONTROL SYSTEM

Within lean construction, takt planning is commonly understood not only as a scheduling method but as a production control system aimed at stabilizing flow during execution. Rather than improving individual activities, takt planning structures production around a fixed rhythm that governs sequencing, handovers, and coordination between trades (Tommelein & Emdanat, 2022). From a production theory perspective, flow stability is intricately linked to reducing variability and managing interdependencies between tasks and actors (Ballard & Howell, 1998).

Takt planning implements these principles by breaking work into repeatable units synchronized to a shared takt time, enabling systematic oversight and management of production progress. However, its success relies not just on the takt plan but also on how production is organized spatially and managed during execution (Tommelein, 2022). Failures in takt-based systems often arise from issues in production control and coordination, especially in tracking interdependent activities (Lehtovaara et al., 2022). Recent studies highlight that effective production control and daily management are essential for sustaining flow in takt-based systems, particularly in complex project settings (Lehtovaara et al., 2021; Tommelein & Lerche, 2023).

TAKT AREA DESIGN AS A MANAGERIAL AND ORGANIZATIONAL DECISION

Takt area design determines how a project is spatially divided to support the takt and is a critical factor in balancing workload and maintaining continuous flow. Research on workload-based zoning and work density has shown that differences in work content between areas can significantly affect the feasibility of maintaining a stable takt time, particularly in non-repetitive construction contexts (Jabbari et al., 2020; Tommelein, 2022). From this perspective, takt area design is not merely a geometric exercise, but a managerial decision that directly affects production control.

Beyond workload considerations, takt area design also influences organizational structures and coordination mechanisms on site. By defining how work is grouped spatially, takt areas shape the allocation of responsibilities for coordination, monitoring, and follow-up among site management roles. In addition, research on location-based management highlights that spatial structuring should reflect technical system boundaries and work dependencies to support effective production control (Kenley & Seppänen, 2010). Recent research by Riekki et al. (2024) indicates that takt practices, including zoning strategies and associated managerial roles, continue to evolve as organizations gain experience with takt-based production, particularly in complex projects. Despite this, existing literature has mainly focused on analytical support for zoning decisions, while giving limited attention to the organizational implications of different zoning strategies.

LOCATION-BASED MANAGEMENT

Takt planning shares conceptual similarities with location-based management (LBM), as both approaches organize production by locations and aim to support continuous flow (Kenley & Seppänen, 2010). While LBM primarily organizes production through spatial sequencing of locations, takt planning introduces a fixed temporal rhythm that governs progression across locations (Frandson et al., 2013; Seppänen, 2014).

Comparative studies indicate that both approaches rely on active production control and coordination in practice, and that the distinction between the approaches is primarily related to how work is structured and visualized rather than fundamentally different control principles (Frandson et al., 2015; Seppänen, 2025). Recent contributions further emphasize that both approaches integrate spatial and temporal dimensions of production control, and are often applied in combination in practice, rather than as mutually exclusive planning methods (Seppänen, 2025). Differences between the approaches are therefore often related to how spatial and temporal control are emphasized and implemented, rather than to distinct underlying principles.

These differences have implications for site management practices. Location-based approaches often emphasize area ownership and spatial responsibility, while takt-based approaches introduce a stronger temporal structure and shared production rhythm. Nonetheless, both approaches require active coordination between trades and continuous follow-up to maintain flow, particularly in complex projects.

SUPERVISORY ROLES AND COORDINATION MECHANISMS

Effective production control in construction depends on how planning systems are enacted through site management practices. Supervisors play a significant role in coordinating subcontractors, monitoring progress, and addressing deviations from the plan. Ballard and Howell (1998) emphasize the importance of shielding production from variability through proactive coordination and control, highlighting the role of site management in maintaining a reliable workflow.

In takt-based production systems, supervisory practices depend on how takt areas are defined and how work is organized within them. The design of these areas influences whether supervisory focus is on locations, trades, or work sequences, resulting in different coordination and follow-up routines. Although previous studies highlight the roles of site management and production control in takt planning (Lehtovaara et al., 2021; Andreassen & Drevland, 2023), there is still limited empirical evidence on how various takt area designs create distinct supervisory logics within the same project setup.

In addition, Andreassen and Drevland (2023) highlight that even in takt-based systems, production flow may be challenged by coordination interfaces and handoff-related issues, underscoring the importance of supervisory practices in maintaining flow during execution.

RESEARCH GAP

Taken together, the existing literature establishes takt planning as a production control system in which spatial structuring, temporal coordination, and managerial roles are closely intertwined. Research has provided analytical tools for takt area design and highlighted similarities between takt planning and location-based approaches.

However, little attention has been paid to how takt area design influences supervisory practices and coordination mechanisms during execution, especially in projects with multiple strategies active. Although recent research has begun to explore production control and management in takt planning, there remains limited empirical insight into how different zoning strategies affect supervisory practices within the same project organization, which will be further addressed in this study by examining a project with two distinct supervisory practices.

METHODOLOGY

This study uses a qualitative case study to examine how takt area design and supervisory practices influence production flow in a complex project setting. The approach enables analysis of intertwined planning, management, and production processes in real-life contexts (Yin, 2018).

RESEARCH DESIGN AND METHODS

The study is based on a combination of a literature review, semi-structured interviews, and on-site observations conducted within a single construction project. The literature review provides the theoretical foundation for understanding takt planning, takt area design, and site management roles, while the empirical data enable an in-depth examination of how these concepts are enacted in practice. The case study design enables detailed exploration of supervisory practices and coordination mechanisms that are difficult to capture quantitatively.

CASE DESCRIPTION

The empirical case is an interior works contract within the Life Science Building at the University of Oslo, one of the largest and most complex public construction projects in Norway. Developed by Statsbygg, the project comprises advanced laboratory facilities alongside office and support areas and is organized into multiple parallel main contracts, including several interior works contracts (Statsbygg, n.d.).

This study focuses on one interior works contract covering carpentry, system interiors, flooring, painting, and related finishing work across both laboratory and office areas. The work is executed using takt planning as the primary production control approach, providing insight into takt-based execution within a shared organizational and contractual framework.

The project includes areas with fundamentally different functional and technical requirements. Laboratory areas involve specialized installations, strict quality requirements, and low tolerance for deviations, while office areas are more standardized and repetitive. These differences form the basis for examining how takt area design and site management practices are adapted within the same project organization. Further details are presented in the findings.

LITERATURE REVIEW

The literature review was conducted through targeted searches in Scopus and relevant conference proceedings published by the International Group for Lean Construction (IGLC). The purpose of the review was to identify foundational and recent contributions related to takt planning, takt area design, production flow, and site management practices.

The review was not conducted as a formal systematic literature review but as a structured, iterative process to establish the theoretical background and position the study within existing research. Emphasis was placed on recent studies addressing production control and management aspects of takt planning.

INTERVIEWS

The empirical data includes nine semi-structured interviews with site management personnel directly involved in takt planning and execution. The interviewees represent strategic, tactical, and operational roles, providing perspectives across multiple organizational levels.

The interviews focused on supervisory roles, follow-up methods, coordination practices, and the perceived effects of takt area design on production flow. The expansion from three to nine interviews strengthens the study's empirical basis and enables the identification of recurring patterns and differences between laboratory and office areas.

An overview of the interviewees is provided in Table 1.

Table 1: Overview of interviewees

Role (Number of interviews)	Organizational level	Area of responsibility	Contribution to the study
Project Leader (1)	Strategic	Overall responsibility for the contract and coordination with client/other general contractors	Strategic assessment of the project delivery model and organizational structure
Site Manager (3)	Tactical	Responsibility for production management and coordination of disciplines and progress within defined building sections	Tactical experience with collaboration, coordination, and governance during execution
Supervisor (3)	Operational	Daily follow-up of subcontractors, quality, HSE, and progress in production	Operational experience with collaboration and the on-site application of the project delivery mode
Sub-contractor (2)	Operational	Execution of trade-specific work within defined takt areas. Coordination with the supervisor and adherence to takt sequences	Perspective on how takt area design and supervision affect coordination/production flow from a subcontractor viewpoint

OBSERVATIONS

In addition to interviews, the study draws on extensive on-site observations. Observations were conducted through active participation in daily site coordination activities. This included daily morning coordination meetings during a two-month summer internship period, as well as evening and weekend coordination meetings during six months of part-time employment.

Empirical data access was facilitated by the first author's role within the project, enabling detailed insight into coordination practices and production processes. This proximity also introduces a potential risk of bias.

Respondents were informed of the researcher's dual role during data collection. To mitigate potential bias, observational insights were primarily used to contextualize interview findings rather than serve as standalone evidence. Furthermore, the interpretation of empirical data was continuously discussed with co-authors throughout the analysis.

DATA ANALYSIS

Interview transcripts and observational notes were analyzed using qualitative thematic analysis. Data were coded and grouped into themes related to takt area design, supervisory practices, production flow, and coordination challenges.

The thematic structure was developed iteratively, combining theoretical concepts with patterns emerging from the empirical data, consistent with established qualitative analysis principles (Jacobsen, 2022).

The findings are structured into five themes reflecting the empirical material: (1) takt area design configuration, (2) supervisory roles and follow-up practices, (3) effects on production flow, (4) coordination challenges, and (5) perceived advantages and limitations.

The analysis is based on an interior works contract and may not fully capture the complexity of projects with more extensive technical system integration.

FINDINGS

TAKT AREA DESIGN CONFIGURATION

The interior works contract applies takt planning across both laboratory and office areas. The building is divided into eight longitudinal zones, each containing laboratory and office sections.

As shown in Figure 1, each zone is subdivided into two laboratory areas (Lab 1 and Lab 2) and two office areas, with a largely consistent layout across floors. Exceptions include Levels 1 and 5, which contain a higher proportion of off-takt areas and shared functions.

Takt area design is not primarily driven by geometry, but by technical system requirements and functional dependencies. Interviewees report that the location breakdown aligns with system boundaries, such as ventilation zones and electrical circuits, enabling testing, commissioning, and isolation within defined areas. Takt areas are thus structured to support both production flow and technical completion.

The takt areas are relatively small, typically ranging from 400 to 700 m², with an average of about 500 m². This is described as a deliberate strategy to enable closer follow-up and a more balanced workload across takt periods.

Two distinct takt trains are implemented in parallel:

- **Laboratory areas** consist of approximately 30+ takt wagons, reflecting high technical complexity and interdependence. Work sequences are not strictly linear, and trades frequently return to previously completed areas due to sequence constraints and specialized installations.
- **Office areas** consist of approximately 25–28 takt wagons and are characterized by a higher degree of standardization and repetition, enabling more predictable sequencing and clearer spatial structuring.

To illustrate the two takt area configurations, Figure 1 presents a simplified spatial representation.

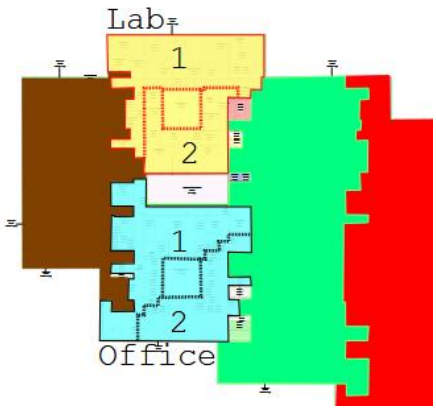

Figure 1: Takt area layout, floor

In addition, several areas fall outside the takt system ("off-takt"), including shafts, staircases, and technical rooms. These are less structured and frequently disrupt production flow.

SUPERVISORY ROLES AND FOLLOW-UP PRACTICES

The differentiated takt area design is associated with two distinct supervisory logics.

In laboratory areas, supervisors follow subcontractors across multiple takt areas. This trade-oriented approach supports continuity in supervision, detailed follow-up of execution, and improved communication through accumulated trade-specific knowledge.

However, it reduces spatial overview and increases reliance on coordination with other supervisors.

In office areas, supervisors are responsible for fixed geographical areas. This area-based approach emphasizes spatial ownership, coordination of multiple subcontractors, and management of handovers and area readiness.

While this provides strong local control, subcontractors working across areas must relate to multiple supervisors, increasing administrative workload and fragmenting.

EFFECTS ON PRODUCTION FLOW AND COORDINATION

Both supervisory approaches support production flow through different mechanisms.

In laboratory areas, production flow is supported by continuity of supervision and the accumulation of trade-specific knowledge. Supervisors following subcontractors across areas can identify recurring issues, ensure consistent execution, and maintain adherence to takt despite high technical complexity and non-linear work sequences. This continuity is described as particularly important in managing specialized environments where deviations may have cascading effects across subsequent activities.

In office areas, production flow is primarily supported through predictable spatial handovers and structured area readiness. The area-based supervisory approach enables systematic verification of completed work before subsequent trades enter the area, reducing downstream disruptions. The high level of repetition further contributes to stability, as similar work sequences are repeated across multiple areas.

However, takt control also produces unintended effects. Subcontractors adjust operations to avoid becoming the "missing wagon," for example by increasing storage or altering delivery schedules. While improving system-level flow, this may create inefficiencies in logistics and material handling.

COORDINATION CHALLENGES AND INTERFACE MANAGEMENT

Despite the benefits observed within each area, the coexistence of two supervisory logics introduces coordination challenges at organizational interfaces.

Subcontractors operating across both laboratory and office areas must adapt to different supervisory structures, reporting routines, and coordination practices depending on location. Interviewees describe this as a source of confusion and increased coordination effort, particularly when transitioning between areas governed by different supervisory logics.

Unclear responsibility at spatial interfaces is a recurring issue. Boundaries between takt areas, between laboratory and office zones, and between takt and off-takt areas are not always clearly defined, leading to ambiguity in task ownership-particularly in shared or transitional areas.

Off-takt areas, including shafts, staircases, and technical rooms, are consistently described as the least structured parts of the project. These areas are characterized by weaker planning, limited resource allocation, and less formalized coordination practices, making them frequent sources of disruption to the main takt sequences.

Furthermore, digital coordination systems are described as both enabling and constraining coordination. While they support documentation and tracking, they may also reduce direct communication among actors, slowing the resolution of issues that could otherwise be addressed through informal interaction.

PERCEIVED ADVANTAGES AND LIMITATIONS OF THE DUAL STRUCTURE

Interviewees generally perceive the dual takt area design as a pragmatic and deliberate response to differing functional requirements within the project.

The trade-oriented approach in laboratory areas supports technical control, compliance, and management of complex, interdependent work.

In contrast, area-based approach in office areas enables efficient coordination of standardized processes through clear spatial ownership and predictable handovers.

At the same time, both approaches have limitations. Laboratory supervision reduces spatial overview and increases coordination needs, while office-based supervision may limit familiarity with subcontractors and fragment communication.

Overall, the findings suggest that the choice of supervisory approach is not arbitrary but reflects a trade-off between technical control and spatial coordination. The effectiveness of each

approach depends on its alignment with functional requirements and the project's ability to manage interfaces between different organizational logics.

DISCUSSION

To support the discussion, Table 2 provides a structured summary of the key empirical findings on takt area design and supervisory practices, highlighting differences between laboratory and office areas and their implications for production flow and coordination.

Table 2: Main findings

Dimension	Laboratory Areas	Office Areas
Takt Area Design	Takt areas are defined by technical system boundaries (e.g., ventilation zones and electrical circuits), with strong interdependencies and a need for iterative work sequences across them.	Takt areas are defined as fixed spatial units with a high degree of repetition and standardization, enabling predictable sequencing and clear spatial ownership
Supervisor role	Supervisors follow subcontractors across multiple takt areas, maintaining responsibility for trade execution, sequencing, and quality across locations	Supervisors are responsible for designating a designated area and coordinate multiple subcontractors entering and exiting it according to the takt sequence
Production flow effects	Flow is supported through continuity in supervision and accumulation of trade-specific knowledge, enabling early identification of recurring issues despite high technical complexity	Flow is supported through predictable spatial handovers, systematic area readiness, and repetition of similar work sequences
Perceived advantages	Improved handling of technical complexity, stronger trade-specific insight, and fewer misunderstandings related to specialized work	Efficient coordination of standardized work, strong spatial overview, and effective control of area readiness before handovers
Perceived challenges	Limited spatial overview and increased reliance on coordination with other supervisors to manage interfaces between areas	Limited familiarity with individual subcontractors, fragmented communication for trades working across areas, and increased coordination effort

TAKT AREA DESIGN AS A CONTEXT-DEPENDENT STRUCTURING MECHANISM

The results show that takt area design is not uniformly applied but tailored to meet different functional needs within the same project. This aligns with existing research that highlights the importance of considering work content and technical complexity over mere geometric similarity (Jabbari et al., 2020; Tommelein, 2022). For example, laboratory and office areas are organized differently to suit their specific production requirements. This indicates that takt area design is more of a context-driven managerial choice rather than a fixed planning standard.

Theoretically, this supports viewing takt planning as a production control system where spatial organization plays a key role in managing variability and dependencies (Tommelein & Emdanat, 2022). The research further shows that different takt area design strategies can coexist within one project organization, provided they align with the functional context. This finding complements earlier studies that suggest takt planning is interpreted and implemented differently across projects and organizations, rather than following a single, uniform zoning approach (Gardarsson et al., 2019; Tommelein & Lerche, 2023).

SUPERVISOR ROLES AS AN OUTCOME OF TAKT AREA DESIGN

The findings identify two supervisory logics linked to different takt area configurations. In laboratory zones, supervisors follow subcontractors across areas, while in office zones they oversee fixed areas and coordinate multiple trades. This indicates that supervisory roles are shaped by takt area design, supporting research showing that implementation choices influence site-level supervision (Riekki et al., 2024)

This also supports theoretical perspectives that emphasize the role of site management in enacting production control systems (Ballard & Howell, 1998). From a location-based management perspective, area ownership is a central coordination mechanism, whereas takt-based systems introduce temporal coupling that may favor trade-oriented oversight (Frandson et al., 2013; Frandson et al., 2015).

Rather than being mutually exclusive, trade- and area-oriented controls are complementary. Location-based management already combines both through trade progression across locations (Kenley & Seppänen, 2010; Seppänen, 2014). The observed dual structure reflects different emphases: laboratory areas favor trade continuity, while office areas emphasize spatial control.

PRODUCTION FLOW MECHANISMS IN DIFFERENT FUNCTIONAL CONTEXTS

The findings indicate that both supervisory approaches support production flow, but through different mechanisms. In laboratory areas, flow stability is achieved through continuity of supervisory oversight, supporting learning effects, and consistent execution across areas. This aligns with flow theory, which emphasizes reducing variability at its source and shielding production from disruptions (Ballard & Howell, 1998; Tommelein, 2022).

In office areas, production flow relies on predictable spatial handovers and thorough verification of area readiness. This aligns with location-based control principles, where flow is sustained by ensuring each area is prepared for the next task (Lehtovaara et al., 2021).

The findings show that flow can be stabilized through different combinations of trade- and area-oriented control, depending on context. However, maintaining flow requires active supervisory practices to manage interfaces and handoffs, rather than occurring automatically (Andreassen & Drevland, 2023).

COORDINATION CHALLENGES AND INTERFACE MANAGEMENT

While differentiated takt design supports flow within areas, it introduces coordination challenges at interfaces. Subcontractors operating across zones must adapt to different supervisory practices, increasing coordination effort

Off-takt areas further illustrate that deviations from structured production control can disrupt flow, reinforcing the need for consistent coordination across the system. This aligns with research showing that local optimization creates new interface challenges (Tommelein, 2022) and that handoffs remain critical risk points in takt systems (Andreassen & Drevland, 2023). Coordination challenges are therefore linked to implementation practices rather than planning logic alone (Lehtovaara et al., 2022

From a production control perspective, the need for active interface management reflects the importance of system-level coordination beyond individual takt areas (Ballard & Howell, 1998). The findings suggest that operating parallel takt area designs increases the burden on site managers to align supervisory practices and maintain overall flow across the project. At the same time, the absence of a fully integrated supervisory model combining trade- and area-based perspectives may reflect practical constraints related to organizational structure, role clarity, and communication pathways, rather than a lack of theoretical feasibility.

ADVANTAGES AND LIMITATIONS OF DIFFERENTIATED SUPERVISORY LOGICS

The findings indicate that no single supervisory configuration is universally superior; effectiveness depends on context. The subcontractor-following approach supports technical control in complex laboratory environments, while the area-based approach enables efficient coordination in standardized office settings.

The laboratory setup also resembles location-based management and flowline principles, where trades move across interdependent locations (Kenley & Seppänen, 2010; Seppänen, 2014). This suggests a hybrid production control approach combining takt scheduling with location-based principles.

This aligns with prior research showing variation in takt implementation across projects (Frandson et al., 2015; Tommelein & Lerche, 2023). The absence of a fully integrated supervisory model combining both trade- and area-oriented perspectives may therefore not reflect a conceptual limitation, but rather practical and organizational constraints in implementing such hybrid configurations.

At the same time, each approach introduces trade-offs: reduced spatial overview in laboratory supervision and reduced trade-specific insight in office supervision. Overall, the findings reinforce that takt planning allows multiple managerial configurations, and that aligning supervisory logic with functional context is critical for effective production control (Riekki et al., 2024; Gardarsson et al., 2019).

CONCLUSION

This study examined how differences in takt area design and supervisory practices influence production flow and coordination within a complex construction project. The findings indicate that differentiated takt area design is associated with distinct supervisory roles, reflecting how site management adapts coordination practices to varying functional and technical conditions, rather than representing a predetermined or universally required configuration.

In technically complex laboratory areas, a subcontractor-following supervisory approach supports flow through continuity of oversight, trade-specific knowledge, and consistent interpretation of requirements. In more standardized office areas, an area-based approach supports flow through spatial ownership, predictable handovers, and coordination within defined areas.

The findings demonstrate that takt area design and supervisory practices are closely interrelated and should be understood as co-dependent decisions within production control. Multiple configurations can support production flow, provided they are aligned with functional requirements and coordination needs. This contributes to takt planning literature by showing how different supervisory logics may coexist within a single project as part of a broader control strategy.

At the same time, the findings suggest that such configurations reflect not only technical necessity, but also practical and organizational considerations related to role clarity, coordination structures, and implementation constraints.

The study is based on a single interior works contract and may not capture the complexity of projects with higher levels of system integration, such as hospitals or highly specialized facilities. This limits transferability and highlights the need for further research across different project types and contractual contexts.

Future research should include additional case studies and broader stakeholder perspectives, including subcontractors, to further examine how different combinations of takt area design and supervisory practices influence production flow and coordination in takt-based construction.

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