

TACTICAL OBEYAS FOR PRODUCTION CONTROL: VISUAL MANAGEMENT WITH KAIZEN, TAKT & LPS

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ABSTRACT

Offshore wind turbine pre-assembly is a high-stakes construction environment characterised by extreme logistical complexity, crane-dependent operations, and tight vessel/weather constraints where time is the primary currency. Despite the increasing adoption of Lean Construction approaches such as the Last Planner System (LPS) and Obeya rooms, current implementations often lack the operational distinction among management levels needed for tactical production control at the site level. This paper employs a Design Science Research (DSR) approach to develop and evaluate a multi-layered Visual Management (VM) artefact. This Tactical Obeya system integrates (1) a takt production line, (2) LPS make ready, (3) an integrated deviation management layer linking safety, quality, and technical constraints to quantified flow interruptions, and (4) Kaizen layer introducing continuous improvements. The artefact shifts management emphasis from reactive output reporting toward proactive input verification and commitment-based coordination (“Reliable Promising”), enabling collective blocker removal and escalation to strategic kaizen improvement events. The theoretical analysis explains how the system reduces flow variability and enhances value delivery to the installation vessel. Initial evaluation indicates improved predictability and stability sufficient to support a reduction trajectory from a volatile 28-day average loadout cycle toward a consistent 20-day target, enabled by continuous feedback loops and structured deviation learning.

KEYWORDS

Constraint analysis, Kaizen, Last Planner System, Takt Planning, visual management.

INTRODUCTION

The offshore wind industry is frequently described as “modular construction” operating under conditions of high capital intensity, tight weather windows, and zero tolerance for waste (J Lerche, S Lindhard, et al., 2022; J. Lerche et al., 2022). Vessel day rates can exceed tens of thousands of dollars per hour, making even short production interruptions consequential. Within this ecosystem, the pre-assembly site is a critical interface between land-based supply chains and offshore installation vessels. It is where tower sections, nacelles, and blades are staged, integrated, and prepared for loadout and offshore installation. At this junction, time is the primary currency and flow variability is a primary driver of cost and risk. While traditional planning tools are useful for planning intent (Koskela et al., 2014), they often fail to make real-time execution status visible and actionable to frontline teams (Daniel et al., 2015). As a result, deviations: equipment issues, missing parts, safety and quality disruptions, and coordination

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failures, are frequently detected late and resolved through reactive firefighting rather than proactive control. Kaizen events (Stevens et al., 2023) at a pre-assembly site identified that loadout cycles averaged approximately 28 days with high variability.

In such environments, the cost of late problem detection is amplified by strong interdependencies between logistics, heavy lifting operations, specialised trades, and vessel-facing schedules. This means that production control systems must do more than represent planning intent; they must enable fast recognition of emerging flow disturbances and coordinated response across effectively supports functions before disruptions propagate into the next takt window or loadout sequence. Accordingly, the challenge is not only to plan work, but to create a tactical control environment in which readiness, execution status, and deviation signals are continuously aligned.

This instability was driven by fragmented communication, procurement delays that were “invisible” to site execution teams, and insufficient synchronisation across multiple actors engaged in continuous operations. In response, this paper develops and evaluates a Tactical Obeya (Salvatierra & Fuentes, 2020): a physical and procedural production control environment integrating takt (Lehtovaara et al., 2021; J Lerche, Peter Enevoldsen, et al., 2022) and last planner planning (Ballard, 2000; Jon Lerche et al., 2020; Schöttle & Böker, 2023) principles with multi-layered visual management to establish a predictable execution “heartbeat”. This study aims to design and evaluate a tactical visual management system to support modular construction project control, moulded at an offshore wind pre-assembly site. Two research questions guide the study: RQ1: How can a Tactical Obeya be designed to support modular construction project control? RQ2: How can such an artefact influence flow variability, coordination, and improvement through the lenses of Lean Construction theory? This paper contributes to Lean Construction and production control literature in three ways. First, it conceptualises Tactical Obeya as an execution-focused socio-technical control system that extends beyond conventional planning visibility by integrating takt-based production control, make-ready protection, deviation escalation, and systemic learning within one tactical environment. Second, it proposes a layered artefact design that links short-interval production status with cross-functional readiness verification and structured improvement loops, thereby offering a design-oriented contribution grounded in Design Science Research. Third, it provides a practice-oriented control logic for high-variability modular construction settings, showing how flow interruptions can be made visible, quantified, and escalated in ways that support more reliable commitments and earlier corrective action.

BACKGROUND

LEAN CONSTRUCTION: TAKT PLANNING, AND VISUAL MANAGEMENT

Lean Construction aims to maximise value creation while minimising waste through improved workflow stability, pull-based coordination, and reliable commitments (Koskela et al., 2018). A central method within this paradigm is Takt Planning (Binniger et al., 2018; Lehtovaara et al., 2021; J Lerche, Peter Enevoldsen, et al., 2022), which establishes a steady production rhythm by structuring work into uniform time intervals. This temporal structuring enables predictable handovers, balanced resource allocation, and enhanced flow reliability. Visual Management (VM) plays a critical enabling role by making system conditions transparent, supporting shared situational awareness, and facilitating timely responses when execution diverges from plan (Grönvall et al., 2021; Verbano et al., 2017).

In highly complex and continuous production settings, such as offshore wind pre-assembly, VM is often applied primarily as a retrospective reporting mechanism, for example, through boards that document completed activities. Such implementations provide limited support for

operational control. To effectively support takt-based production, VM must extend beyond information display and function as an active control system.

Despite the growing literature on Takt Planning, Last Planner System, Visual Management, and Obeya, prior studies tend to emphasise either planning reliability, retrospective performance follow-up, or room-based coordination at managerial level. Fewer studies explain how these elements can be integrated into a tactical, execution-oriented control system that makes hourly or half-shift production status, input readiness, and cross-domain deviations visible within one shared environment. In particular, the literature offers limited guidance on how safety, quality, and technical disruptions can be treated as flow disturbances rather than parallel reporting streams, and how these signals can be escalated into structured learning loops. This paper addresses that gap by proposing Tactical Obeya as an integrated artefact for execution-level control in a high-variability modular construction setting

PRODUCTION CONTROL AND CONTINUOUS IMPROVEMENTS

Effective production control (Liker, 2004) in Lean Construction is closely linked to Kaizen (Stevens et al., 2023; Vieira et al., 2022), understood as the continuous, systematic improvement of processes through learning from daily operations. In takt-based environments, deviations from the planned rhythm are not merely failures but sources of learning. VM systems that support real-time detection of disturbances enable teams to reflect on causes, test countermeasures, and incrementally stabilise flow (Ikuma et al., 2011; Tezel et al., 2018). In this way, Kaizen is operationalised through short feedback loops where production control and continuous improvement are tightly coupled. Its here seen as the learning part of the organisation.

BIG ROOMS: FROM TACTICAL COORDINATION TO EXECUTION

The Obeya, commonly known as a “Big Room,” originated at Toyota as a cross-functional space for coordinating complex product development efforts (Salvatierra & Fuentes, 2020). In construction, Obeya-inspired practices are widely used to improve cross-functional alignment, reduce fragmentation, and support coordination around milestones, design or phase readiness, and weekly work plans (Szyperski et al., 2023), also in connection with VM (Tezel et al., 2016). However, these applications typically operate at operational or tactical planning levels and offer limited support for real-time execution at the workforce.

Offshore wind pre-assembly presents conditions that demand a different configuration. Tight sequencing constraints, crane-dependent operations, and vessel-driven deadlines require rapid coordination and immediate response to variability. This context motivates the concept of a tactical Obeya, oriented around inputs, deviations, and execution. Such a setting relies on an execution-focused VM to enable hour-by-hour production control and real-time flow stabilisation at the frontline.

THE LAST PLANNER SYSTEM

The Last Planner System (LPS) is a foundational Lean Construction planning and control approach structured around the progression from “Should” to “Can,” “Will,” and ultimately “Did” (Ballard, 2000). Its primary objective is to improve plan reliability through systematic constraint removal, increased task readiness, and strengthened commitment management (Ballard & Tommelein, 2016; Daniel et al., 2015; Ebbs & Pasquire, 2018; Ebbs et al., 2018; Jon Lerche et al., 2020). In offshore wind pre-assembly, execution is characterised by continuous 24/7 operations, rapid task turnover, and strong interdependencies among specialised crews. Under these conditions, weekly commitments alone are insufficient to guide action. Instead, commitments must be decomposed into more granular operational signals that support decision-making at hourly intervals (J Lerche, S Lindhard, et al., 2022; J. Lerche et al., 2022; J Lerche et al., 2020). When integrated with takt-based logic, LPS commitments can be

translated into short-cycle execution rhythms with immediate feedback. This integration enables early detection of slippage and supports Kaizen-driven adjustments before local disturbances escalate into system-wide flow disruptions.

METHODOLOGY

DESIGN SCIENCE RESEARCH WITH EMBEDDED CASE EVALUATION

This study uses a Design Science Research (DSR) (Hevner et al., 2004; Järvinen, 2007) approach because the central objective is to design and evaluate a practical artefact that addresses a real production-control problem. DSR is appropriate in construction engineering and Lean research when contributions take the form of engineered systems, methods, or frameworks designed for practice (Skaar et al., 2020).

DSR CYCLES AND RESEARCH DESIGN

The research follows a structured DSR process: 1) Problem Identification: High cycle-time variability and poor tactical visibility. 2) Objective Definition: Create an artefact enabling coordination and deviation control with forward-looking capabilities. 3) Design and Development: Build a multi-layered tactical VM artefact, including takt timeline, role alignment, and deviation minutes. (Formalise and explain the artefact using Kaizen, Takt, LPS, and VM literature). 4) Demonstration: Deploy the artefact in a live pre-assembly environment during production cycles. 5) Evaluation: Compare “as-is” firefighting with the potential to “to-be” stabilised workflow using deviation records and theoretical evaluation.

DATA SOURCES

Evidence is drawn from: direct analysis of the tactical Obeya board artefacts (weekly plan board, deviation tracking layers). Kaizen follow-up documentation, progress reports, and improvement logs; observation of meetings (daily huddles, weekly review cadence); minutes of deviation records and their linkage to work orders; early-cycle-time trend indicators (planned vs. actual gap narrowing).

EVALUATION LOGIC AND METRICS

The evaluation in this paper focuses on tactical control efficacy, assessed through theoretical positions from similar implementations and data-based assumptions regarding improvement potential. Existence and use of structured escalation to strategic improvement; early-cycle-time stability signals (variance reduction); qualitative evidence of increased motivation, accountability, and shared situational awareness.

The empirical basis for evaluation should be interpreted as an embedded case-based assessment of the artefact rather than a full before-and-after causal study. The evaluation draws on direct site observations, board artefacts, deviation records, Kaizen documentation, meeting routines, and early operational indicators generated during implementation. These sources were used to assess whether the artefact increased visibility of flow disturbances, supported cross-functional coordination, and provided a practicable structure for escalation and learning. As the implementation unfolded in a live project environment, the evidence primarily supports claims regarding design relevance, operational usefulness, and early indications of improvement potential, rather than statistically robust proof of performance impact.

CONTEXT: OFFSHORE WIND TURBINE PRE-ASSEMBLY

The case study was a 12-month-long study of a senior site leadership group of different functions (sourcing, delivery, HSE, quality, logistics, and planning), and a group of nineteen last planners, enabling the process. Wind Turbine Generator (WTG) pre-assembly includes

complex operations involving tower stacking, preparation of the nacelle, and of the three blades. Work is plant and equipment-dependent and highly interdependent. Execution is typically continuous (24/7), requiring coordination across specialised crews including lifting teams, mechanical & electrical (M&E) technicians, commissioning personnel, supervisors, and safety/quality stakeholders.

The pre-assembly site is a bottleneck because it is the convergence point between: upstream supply chains (parts, components, tooling, and documentation); three-site assembly crews and day/night lifting teams; vessel schedules and weather windows. Deviations in any upstream element manifest as immediate flow disruptions and downstream schedule impacts. Traditional methods (e.g., Gantt charts) tend to conceal these disruptions until late, limiting corrective action. The project, therefore, requires a system that makes flow interruptions visible and actionable.

ARTEFACT DESIGN: TEIRED TACTICAL OBEYA SYSTEM

The tactical Obeya is conceptualised as a multi-layered Daily Management System (DMS), hierarchically tiered. It is not only a board but a socio-technical control environment that combines visualisation, meeting rhythms, and escalation mechanisms.

OVERVIEW OF ARTEFACT LAYERS

The design comprises four integrated layers as seen in Figure 1:

- i. Layer 1: Takt production line, inspired by J Lerche, Peter Enevoldsen, et al. (2022)
- ii. Layer 2: LPS make-ready as a cross-functional, forward-looking phase plan,
- iii. Layer 3: Integrated deviation management for HSQ + technical disruptions, quantified flow disruptions,
- iv. Layer 4: Kaizen, the continuous improvement and learning in the project.

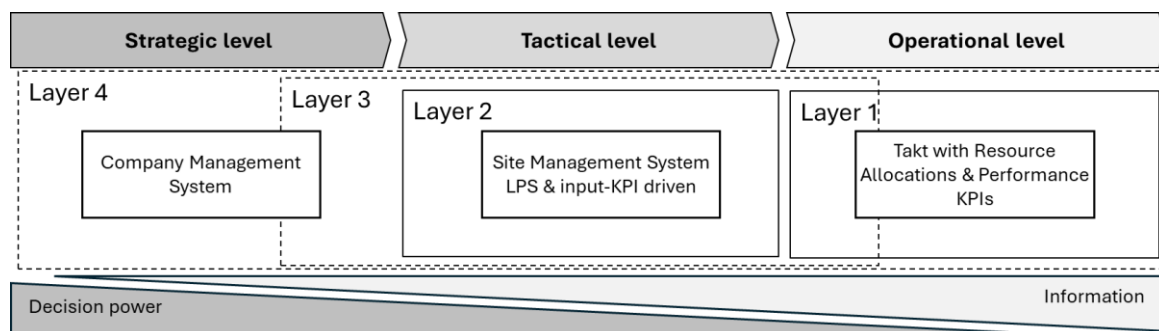


Figure 1: Tactical Obeya multi-layer framework.

LAYER 1: TAKT PRODUCTION LINE (“CONSTRUCTION RHYTHM”)

The first layer is a linear takt-based production line, structured into half-shift takt intervals, with supporting sub-windows spanning hours, also structured into half-shift takt intervals, as needed for key hand-offs. This level of temporal structuring reflects the crane-dependent, tightly sequenced nature of offshore wind pre-assembly tasks (e.g., nacelle and blade preparation, tower stacking, M&E completion, and commissioning), where delays within a crew’s window can quickly propagate into downstream disruption. The production line establishes a shared operational “rhythm” that enables teams to identify emerging slippage early, align priorities across roles, and initiate corrective action before a full shift is lost. The layer is visualised on satellite VM boards at the workplace for the respective teams, focusing on hourly-half shift performance towards the completion of individual components, team organisation, and hour-by-hour deviations. Its form at the tactical level is an integrated part of the Obeya room, with a

focus on overall performance in days. For a visual representation of the VM on operational level please see J Lerche et al. (2020).

LAYER 2: LPS MAKE-READY AS A CROSS-FUNCTIONAL FORWARD-LOOKING PHASE PLAN

The second layer operationalises the Last Planner System (LPS) make-ready as a cross-functional, forward-looking phase-planning mechanism that protects the takt-based production line by ensuring work is executable before it enters the active execution window (EBBS & AND PASQUIRE, 2018; EBBS ET AL., 2018). Rather than functioning solely as a weekly planning routine, this make-ready layer is structured as a phase plan spanning upcoming shifts and loadout sequences, bringing together the specialised functions required to deliver crane-dependent operations reliably.

The purpose of this layer is to prevent flow disruption by shifting control upstream, from reactive deviation response to proactive readiness management. This is achieved through input KPI verification, where readiness conditions are checked and confirmed before work is released to the production line (Egbunike et al., 2018). Input KPIs include prerequisites such as availability of parts and tooling, permit and documentation readiness, access readiness, documentation readiness, staffing and competence coverage, quality hold-point clearance, and critical safety controls. By verifying these conditions in advance, the system reduces the likelihood that missing inputs or unresolved constraints interrupt production during execution.

In this way, the make-ready layer functions as the interface between planning and execution: it converts planned activities into reliable commitments (“can” and “will”). It stabilises flow by systematically removing constraints before they become deviations on the takt line. This strengthens pull-based coordination across functions and enables recovery actions to occur while there is still time to protect the downstream vessel-facing schedule. As shown in Table 1, the system intentionally shifts focus from reactive output metrics to proactive input verification, based on the underlying logic that stable outputs result from controlled inputs.

Table 1: KPI architecture: input vs output

KPI Type	Focus	Examples
Input (Proactive)	Process health	readiness checks, labour/resource balance, safety behaviours, prerequisite verification
Output (Reactive)	Result integrity	duration, quality rate, PPC, productivity, deviations

LAYER 3: INTEGRATED DEVIATION MANAGEMENT (HSQ + TECHNICAL)

A critical element is integrating safety, quality, and technical deviations directly into the production line rather than tracking them separately. This ensures HSQ events are understood as flow variability and treated as part of production control rather than parallel reporting.

The deviation system includes symbols for injury/near miss/quality defects plotted at the time of occurrence; “Top 5 deviations” tracking; recording of accumulated minutes per deviation; classification of whether the deviation affects total installation time (Y/N); and linkage to an NCC work order number. This makes deviations visible, quantifies their cost in real time, and enables structured learning and escalation. Each VM layer 1 solution encompasses these elements, which can’t be handled at the operational level or causing more than half a shift deviation is transferred to the tactical Obeya, where focus shifts to the number of deviations, with summarised timings in hours and trendlines week-by-week.

LAYER 4: THE SYSTEMIC LEARNING AND EVOLUTION LAYER

While Layers 1 through 3 focus on the *stability* and *execution* of the current production cycle, serves as the "Brain" of the operation. In the context of the offshore wind pre-assembly site, Kaizen is paraphrased as "Systemic Learning Loops", the process by which tactical deviations are harvested, analysed, and translated into long-term organisational changes. Layer 4 operates on a longer temporal horizon than the takt boards. It utilises the data "exhaust" from the tactical layers to drive three specific learning cycles: The Sourcing Kaizen (Upstream Integration): As identified in the project findings, a primary bottleneck was the "Procurement of material/tools." Accumulated minutes recorded on the physical board to prove the economic impact of late parts. This data allows the site team to move from anecdotal complaints to a "Sourcing Kaizen" that successfully targets reducing part wait times from weeks to days.

The Engineering Feedback Loop: Quality issues recorded during the operations are not merely fixed on-site. These "Workmanship" symbols are aggregated to identify recurring design flaws. This creates a constructability feedback loop (Fischer & Tatum, 1997), where site-level reality informs the next generation of turbine components. Re-energizing the Social System: Layer 4 manages the "Motivation of the Workforce." By visualising that site-level suggestions actually lead to systemic changes (e.g., better tools or streamlined sourcing), the artifact reinforces the Social Contract (Ghosh et al., 2019).

DMS: MEETING RHYTHM AND OBEYA ROOM

Integrating the artefact to its environment, designing the obeya room with 3 walls available, making wall 1 the project and input control space, having the high-level phase plan for the coming 12 months, and from that functions break it further down for the next 3-4 months, focusing on inputs like logistics, sourcing, health safety, quality, equipment and resources. Wall 2 ties together all the positive changes from VSM activities, kaizen events with each respective area and inputs from frontline employees. Wall 3 is the production wall, where the tactical takt schedules for the frontline high-level plans are available, with attached performance metrics, allowing the site management to ask questions. Deviations reported at the wall 3, are digitally transferred to dashboards available for the project leadership team as well.

Deviations and abnormalities related to inputs which the production team can't handle are transferred to Wall 1. Escalation to the strategic level occurs monthly through performance dialogues. Unless urgent matters require intervention, kaizen events are again applied systematically to mitigate systemic or organisational issues, with a focus on improving processes, interfaces, or collaboration.

MEETING RHYTHM AND "RELIABLE PROMISING"

The Tactical Obeya is reinforced by structured meeting rhythms designed for commitment rather than reporting; it is organised between the tactical and operational levels. Tactical level has a daily huddle: a check-in among the last planners and the cross-functional management team. Two weekly meetings, making ready with a long projection, aligning the weekly plan and adjusting the production schedule. In addition to the meetings, there are weekly gemba walks on site with the customer, and kaizen events are introduced quarterly to ensure continuous improvement and address deviations. The operational level has, Daily huddle: technicians commit to next 4-hour window; weekly review: learning and escalation using structured agenda (Opening → Input → Output → Decision). This aligns with the LPS emphasis on commitments and enables "Reliable Promising" in a multi-role environment.

INPUT VS OUTPUT

Figure 2 provides an overview of the applied metrics on the input and output sides of the production. The intention with these is to visualise the metrics that support or contradict one

another, such as turnover rates, utilisation, and productivity. TRIR and near misses, with the ladder being an early warning. Constraints resolved and downtime caused can equally show how well the system is performing. A summary of deviations shows the dominant part failing, input or output, guiding management on the operational level for where to focus more. On the input side or the tactical performance.

KPI suggestions		Input focus	Performance
Safety	TRIR, near-miss counts, days since last incident.	x	
	Near miss frequency (NMFR), near misses per 1,000 hours		x
People	Worker satisfaction (pulse survey / smiley)		x
	Monthly turnover rates	x	
Quality	Defects received	x	
	% rework / % checklists completed before sign-off		x
Logistic	Supplier On-Time Delivery (Projected)	x	
	Order lead time trend (PLI raised to parts recieved in days) order fulfillment time (indirect+direct mat.)	x	
Delivery	•Productivity: Labor productivity (earned hours vs. actual hours).		x
	•Crew utilization vs. plan (%)	x	
	•Constraints unresolved >5 days	x	
	(Downtime causes: weather-related delays, supply delays, rework)		x
	Downtime trends		x
Kaizen	Improvements implemented (from Kaizen)	x	
	Improvement savings in time (from Kaizen)		x

Figure 2: KPIs organised for input and performance.

OPERATIONAL AND TACTICAL LEVEL TAKT VISUALISATION

With focus on the tactical level: the complete loadout and its takt. Visualisation shows how trades and their total time are assigned to complete each component during loadout preparation. At the operational level, the takt is broken down into half-shifts and tracked by the hour. The operational takt display also includes HSQ visuals that indicate where in the flow an interruption occurred, enabling site teams to understand the flow. Both designs in Figure 3 are prepared for physical boards; the operational VM will be present in the Obeya room, while the operational Takt VM will be available around the work areas where the teams are set to work.

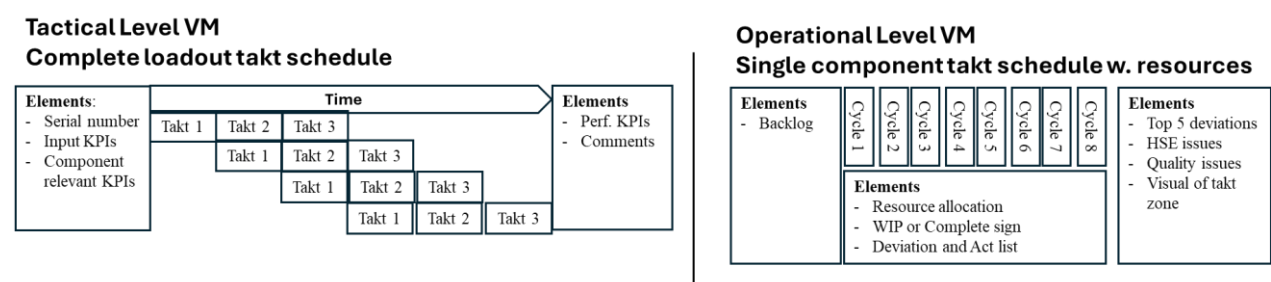


Figure 3: illustrating tactical (left) and operational (right) VM for Takt.

EVALUATION: ACHIEVING “UNDER CONTROL” OPERATIONS

COLLECTIVE BLOCKER REMOVAL

The artefact enables collective blocker removal by making disruptions visible, shared, and measurable. Deviation minutes allow crews and supervisors to quantify the cost of disruptions, supporting rapid response and reducing the likelihood that minor delays will cumulate into cumulative losses. A continuous focus on reducing waiting time will have a significant impact on the preparation of towers and nacelles; blades were excluded because the effect on this scope

was considered insignificant. Commissioning is a shared resource that handles both the final stage of tower assembly and the main scope of nacelle preparation.

Yet it was excluded from this study due to insufficient data. The expectation is that the Obeya and input focus will have a positive effect on this over time as well. Benefitting from escalation from operational level to initiate strategic improvements, by having a structured escalation pathway which emerged through the framework in Figure 1;

- Operational level: deviations logged with minutes by the technicians on the VM boards.
- Operational level: performance KPI trends, which allow for adjustments to the make-ready process.
- Tactical level: supervisors monitor accumulated minutes and countermeasures
- Strategic level: digitally traced deviations are used to launch Kaizens within given areas, while the operational measures are supported by strategic level support.

EARLY CYCLE-TIME AND PREDICTABILITY IMPACTS

From observations early evidence suggests improved predictability and narrowing of the planned vs actual gap through continuous 60-minute feedback loops. Being further enabled by the making ready process controlled by the input KPIs. Initial indicators further support a reduction trajectory from 28-day volatility toward a 20-day stable loadout cycle by reducing variability, improving coordination, and strengthening readiness verification.

DISCUSSION

THE TACTICAL OBEYA AS A SOCIAL ARTIFACT

The design of a Tactical Obeya in the offshore wind pre-assembly context represents a significant departure from traditional administrative control mechanisms. In an environment characterised by high capital intensity and tight weather windows, where vessel day rates can exceed tens of thousands of dollars per hour, the artifact functions as a critical interface for mitigating the risks of flow variability (J Lerche, Søren Lindhard, et al., 2022).

A central finding is that the Tactical Obeya is not merely informational; it is a social infrastructure. Its physical presence in a shared space enforces “equality of voice,” enabling frontline staff to surface constraints and negotiate commitments transparently. Because roles on the VM takt boards, both at the tactical and operational levels, are visually interlocked, peer accountability emerges naturally and becomes more effective than top-down control.

Moving towards peer Accountability instead of Top-Down Control, because the multi-layered VM boards are visually interlocked, the "Reliable Promising" of the LPS becomes visible to all. When a delay in stacking tower (Layer 1) occurs, its immediate impact on the subsequent commissioning window is transparent. This visibility fosters a culture of peer accountability that is far more effective than traditional, shift-based reporting in a 24/7 continuous operation (J Lerche, S Lindhard, et al., 2022).

Re-energising and encouraging the social contract, by visualising that operational-level suggestions lead to systemic changes through Kaizen (Layer 4), similar to what is suggested by Stevens et al. (2023) transferring knowledge between projects, the artifact reinforces the social contract. Workforce motivation is sustained when technicians see that their logged "deviation minutes" directly inform strategic Kaizen events, such as streamlining the procurement of critical tooling.

Some limitations should be acknowledged. First, the study is based on a single embedded case in a highly specific offshore wind pre-assembly context, which limits direct generalisation. Second, the evaluation relies on early implementation evidence and operational indications rather than a complete longitudinal before-and-after dataset. Third, some relevant performance

dimensions, including portions of rework and commissioning-related effects, were not captured with sufficient consistency to support stronger causal inference. Finally, learning-curve effects associated with introducing a new control system may have influenced both behaviours and observed outcomes. Accordingly, the findings should be interpreted as evidence of artefact relevance and early utility, rather than definitive proof of performance impact across settings.

PRACTICAL IMPLICATIONS: FROM FIREFIGHTING TO PROACTIVE FLOW

Traditional planning tools, such as digital Gantt charts, often fail to make real-time execution status actionable at the workplace, leading to reactive "firefighting." The Tactical Obeya addresses this by reframing preconditions and emphasizing Health, Safety, and Quality disruptions not as isolated incidents, but as a fundamental part of the flow interruptions.

By decomposing work into half-shift Takt intervals, the system creates a "heartbeat" for the site. This allows for the detection of deviations within 60-minute feedback loops, ensuring that minor equipment issues or missing parts do not escalate into systemic delays that jeopardise the vessel or delivery schedule. This is further supported by the input-based control logic, very similar to the make ready process (Ballard & Tommelein, 2016; Ebbs & and Pasquire, 2018). The system intentionally shifts focus from reactive performance output metrics (e.g., productivity) to proactive input verification (e.g., permit readiness, documentation, and resource balance). This proactive stance is essential for protecting the production rhythm from the high-variability supply chain inherent in offshore wind components.

CONCLUSION

This paper presents a design-science contribution to production planning and control in the offshore wind sector through a multi-layered Tactical Obeya system. By integrating visual management with Takt planning and the Last Planner System, the artifact addresses the critical need for real-time execution control in environments characterised by extreme capital intensity and tight vessel schedules. The system synchronises specialised crews through a shared "execution heartbeat," transforming the pre-assembly site from a bottleneck into a stabilised interface between land-based supply chains and offshore installation.

The study demonstrates that the tactical Obeya functions effectively as a social artifact. Beyond its technical utility, it institutionalizes "equality of voice" and fosters a culture of peer accountability. In the context of 24/7 operations, this visual transparency enables frontline technicians to surface constraints that were previously obscured by digital Gantt charts or siloed reporting. By reframing safety, quality, and technical deviations as integrated flow interruptions, the artifact replaces reactive firefighting with a proactive, commitment-based coordination logic. In practice, the shift from retrospective output reporting to proactive input verification (e.g., permit, tooling, and part readiness) provides a robust mechanism for reducing variability. Quantifying disruptions into "accumulated deviation minutes" provides the data needed to bridge the gap between tactical execution and strategic improvement.

Taken together, the findings suggest that Tactical Obeya can be designed as a layered execution-focused control environment that links takt rhythm, make-ready protection, deviation management, and systemic learning within one shared structure. In relation to the first research question, the study shows how such an artefact can be configured through integrated boards, meeting rhythms, escalation rules, and cross-functional visibility. In relation to the second research question, the study indicates that the artefact may influence flow variability and coordination by making readiness failures and execution disturbances visible earlier, thereby enabling more proactive intervention and more reliable commitments. At the same time, the strength of this claim remains bounded by the exploratory and case-based nature of the evaluation.

Finally, this work extends the Lean Construction literature, specifically regarding Obeya, Visual Management, Takt, and LPS, by operationalising the transition from weekly planning to hourly execution. It demonstrates that integrating multi-domain deviation control can provide a predictable production rhythm in high-interdependency logistics environments. Future research should continue to explore the implementation of this and further refine the elements included in the model.

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