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LEAN-BASED DYNAMIC CAPABILITY: CASE STUDIES OF PLURIPOTENTIAL TEAM IN FIELD THINKING

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ABSTRACT

The construction industry is rapidly adopting digital tools such as BIM to boost productivity and sustainability. Yet, the organisational and human-centric team structures required to harness these tools effectively remain a critical gap in Lean Construction scholarship. While technological advancement is heavily researched, the behavioural and organisational adaptations necessary to manage lean project delivery remain under-explored. To address this, this research investigates the concept of 'lean-based dynamic capability' through a comparative case study methodology. The paper examines the team configuration of a Japanese automobile factory construction alongside a contemporary digital Design-Build project: the Grand Ring mega timber structure at the Expo 2025 Osaka, Kansai, Japan. The analysis reveals that the successful delivery of complex digital projects relies on dynamic capability driven by two key mechanisms: field thinking (*genba)* and the deployment of pluripotential teams. Unlike standard cross-functional groups, a pluripotential team exhibits cross-over functions, allowing them to dissolve rigid disciplinary boundaries and adapt roles fluidly in response to emergent physical and digital challenges. This study contributes to Lean Construction theory by defining the pluripotential team with Japanese project delivery context as a case study, demonstrating that successful implementation of lean project management demands an equally adaptable, human-centric organisational structure.

KEYWORDS

Dynamic capability, pluripotential team, design responsibility, Toyota production system, field thinking.

INTRODUCTION

The adoption of lean management in the architecture, engineering, and construction (AEC) industry has been transforming conventional project delivery methods by shifting the focus to flow and value generation (Koskela, 1992; Koskela, 2000). Originating from the Toyota Production System (TPS) from Japan and popularised globally by Womack et al. (1990), lean management have been widely disseminated to improve productivity and waste reduction (Womack et al., 1990). While Lean Construction has been developed into practical project management approaches, such as the Last Planner System (Ballard, 2000) and Integrated Project Delivery (IPD) (Alves and Lichtig, 2020), that transform organisational structures

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throughout the project lifecycle. They involve project-based organisational integration amongst stakeholders including designers, general contractors, and trade contractors such as *Big Room* (Joshi et al. 2020). Also, recent scholarship suggests a divergence between the codified lean tools and the tacit evolutionary capabilities, which underpin high-performance manufacturing and delivery systems (Fujimoto, 2024; Shigaki et al., 2024). These developments in Lean Construction assist practitioners to cope with the changing horizon such as transformations in this digital era in the industry (Ng and Hall 2019).

FROM ORGANISATIONAL TO HUMAN-CENTRIC

Well-known lean principles such as *just in time*, *visual management* and *standardisation* focus on flow management in on-site and off-site construction (Koskela, 1992; Tezel et al., 2016; Ng and Chen, 2025). Beyond process management, *genba* (現場) requires project stakeholders to engage first-hand in the field to spot waste (Kerem et al., 2013). Originally just the Japanese word for 'worksite', it now signifies actual shop-floor conditions, linked to the principle of *genchi genbutsu* (現地現物, go and see). For Toyota, resolving problems directly at the shop floor is foundational (Ohno, 1978). In Lean Construction, *genba* embodies field-thinking that adapts lean principles to dynamic environments. Fujimoto (1999) argues Toyota's system emerged from an 'evolutionary learning capability', allowing organisations to develop competitive routines by continuously identifying and adapting solutions on-site.

Recent studies highlight a conceptualisation weakness in Japanese management, where practices rely on tacit knowledge and cultural contexts, such as *monozukuri* (making things) and *hitozukuri* (making people), rather than explicit theory (Kon et al., 2025). Through Lean Construction theories, Japanese construction operates via informal, context-dependent improvements, mirroring Toyota's evolutionary path (Shigaki et al., 2024). These intertwined cultural practices, namely *genba*, *monozukuri*, and *hitozukuri,* collectively constitute what this paper terms the 'Japan Way' of project delivery. The 'Japan Way' describes a distinctly Japanese organisational philosophy in which digitalisation, field thinking and human adaptability are not treated as separate managerial levers but as mutually reinforcing dimensions of a unified production culture. In this framework, digitalisation extends the *genba* into the virtual domain, enabling real-time coordination across design, fabrication and assembly. *Genba* field thinking then grounds digital outputs in physical reality; and the pluripotential team provides the human mechanism to navigate fluidly between both. Understanding this three-way relationship is essential to appreciating why the practices, such as those observed in the two case studies (Project T and Project G), cannot be reduced to their technological or process components alone.

Consequently, modern literature increasingly shifts focus from lean tools to the human and cultural environment required to sustain them. Vaidyanathan et al. (2018) argues that a true organisational lean transformation requires discarding 'command and control' models in favour of a dual approach: building bottom-up experience in lean tools at the site level, paired with top-down leadership empathy to foster a 'no-blame' collaborative culture. Similarly, Kallassy and Hamzeh (2021) emphasise that the successful application of lean is heavily dependent on the 'readiness' of an organisation's culture, noting that measuring team behavioural metrics is just as critical as measuring project performance.

Mapping this to daily operations, Asadian and Leicht (2021) identify trust, psychological safety, cohesion, and knowledge exchange as vital prerequisites for interdisciplinary teams implementing lean. This human-centricity is further validated by Aslesen and Tommelein (2016), who conclude that regardless of robust upstream planning, real-time adaptation relies heavily on the conceptual understanding and behavioural choices of individuals at the *genba*.

The evolving dynamics of these human interactions bridge the gap between rigid standards and fluid delivery realities, which is an area remaining under-discussed (Fujimoto, 1999). This evolutionary learning is defined as 'dynamic capability' (Kusunoki, 1997; Fujimoto & Matsuo,

2001), representing the collective flexibility and self-learning that allows teams to continuously evolve routines through field thinking. Whilst lean's impact on construction outcomes (Koskela, 2000; Kon et al., 2025) and processes (Ballard, 2000) is well-researched, lean-based human centricity within transforming organisations remains relatively underexplored.

FROM INTEGRATION TO PLURIPOTENTIALITY IN AGILE TEAM CONFIGURATION

Current research on construction project delivery emphasises collaboration through frameworks like IPD, which uses multi-party contracts to align interests and integrate teams (Alves and Lichtig, 2020; Fischer et al., 2017). Literature frequently cites the *Big Room* (*obeya*) for facilitating cross-functional communication and decision-making (Tazawa et al., 2017). However, these studies typically view team integration as aligning distinct, specialised roles, overlooking the latent potential for dynamic role-switching

In practice, skill shortages, complex technologies, and digital transformation, e.g., BIM and Design for Manufacture and Assembly (DfMA), demand highly agile organisational management. Megaproject resources, both human and material, face severe, unpredictable challenges. Therefore, ensuring product and production quality requires advancing beyond standard integration. In the 'Japan Way', these three forces, namely digitalisation, *genba* field thinking and pluripotential team behaviour, operate not as parallel tracks but as a unified system: digitalisation extends the *genba* into the virtual domain; *genba* discipline grounds digital outputs in physical reality; and the pluripotential team provides the human mechanism to navigate between both in real time. Within organisations, 'integration' typically refers to a cluster of distinct experts, whereas 'pluripotentiality' represents a fundamentally different architecture.

Borrowed from the field of biology, where pluripotent stem cells differentiate as needed, a pluripotential team in AEC is a highly adaptive unit characterised by functional redundancy rather than mere part redundancy. Unlike standard cross-functional teams bound by static roles, it possesses the latent capability to dissolve disciplinary boundaries. Members can fluidly and autonomously reconfigure their roles, identities, and approaches in real-time to address emergent complexities, functioning as a collective dynamic capability.

Existing research describes the membership-based employment system in Japan, where employees are not bound to rigid job descriptions but are expected to manage broader responsibilities and cover adjacent tasks. This membership-based approach contrasts sharply with the commonly adopted job-based system, fostering a holistic view of continuous improvement that naturally supports pluripotential behaviours (Kon et al., 2025).

Whilst scholarship such as Koskela (1992) have studied multi-skilled workers, pluripotentiality transcends individual cross-training. Recent scholarship seeks cohesive frameworks for emergent capabilities arising from member interactions (Asadian and Leicht, 2021) that enable fluid adaptation. Current discourse on collaborative design management (Tzortzopoulos et al., 2020) and composite construction (Shigaki and Yashiro, 2023) hints at this flexibility but lacks an explicit conceptualisation of pluripotential teams rooted in Japanese practices. A significant gap remains in understanding how teams maintain high performance through the dynamic, real-time reconfiguration of competencies inherent in the pluripotential model, rather than merely structurally integrating silos.

RESEARCH QUESTIONS AND OBJECTIVES

The AEC industry necessitates flexible and agile solutions to cope with the changing needs of project teams and shifting project horizons. While the various principles of Lean Construction and TPS have been widely explored in scholarship, the underlying *genba* and the dynamically evolving nature of project organisations remain under-studied. Crucially, field thinking serves as the root source for devising flexible, practical solutions in the rapidly changing environments

of factory production and site delivery. To investigate this phenomenon within the overarching principles of Lean Construction, this study shifts the focus from structural integration to team behaviour, addressing the following two research questions:

- **RQ1:** How has the concept of dynamic capability, induced by pluripotential teams, been conceptualised and adopted in lean-based construction projects?
- **RQ2:** How does dynamic capability, induced by pluripotential teams, enable successful project delivery within contemporary, highly digitalised construction practices?

To answer these questions, the study employs a comparative case study approach. To answer RQ1, it first reviews a past construction project (Project T) for a Japanese automobile factory, which naturally adopted lean principles from TPS. This is followed by a case study of a modern megaproject (Project G) that has heavily adopted BIM and DfMA to answer RQ2. Both project findings were investigated based on first-hand observations and interview data collected by the first author throughout the respective project durations. Ultimately, this work discusses how the pluripotential team model acts as a vital human-centric mechanism for sustainable project delivery in the digital era.

TPS AND ITS PROJECT-BASED ORGANISATION IN PROJECT T

To answer RQ1, this study analyses the project-based organisational structure derived from TPS by examining an automobile factory construction project completed in 2004. This project, Project T located in Central Europe, was owned by a Japanese automobile company that has been inventing and adopting TPS through its plant operations and construction projects for over 70 years. At the inception of the project, the owner established a Client Representative Team, recruiting personnel from a Japanese general contractor experienced in automotive facility construction. This team comprised professionals with diverse expertise spanning architecture, building services engineering, and construction management. Figure 1 illustrates the hybrid delivery approach, combining Conventional Design-Build with 'Construction Management with Design Management'. Nevertheless, the key analytical value lies in how this organisation evolved dynamically. It embodied the lean concept of *pokkiri* (just the right amount), applying lean principles not only to the facility itself, but to the project management structure, deploying human capital exactly where and when the physical reality demanded it.

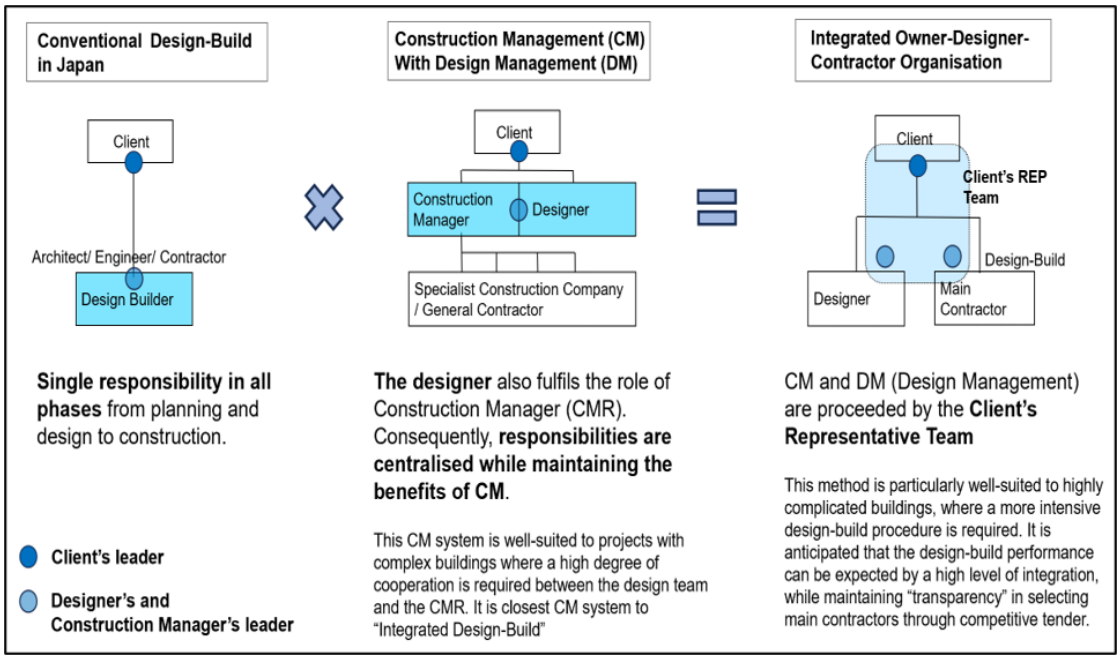

Figure 1: Conceptual structure of the integrated owner-designer-contractor organisation

ANALYSIS OF PLURIPOTENTIAL MECHANISMS AND TEAM FLUIDITY

The defining characteristic addressing RQ1 was how team members adapted their competencies to specific stage requirements as a core mechanism of dynamic capability. Phase 1 (Design Management) had lasted for 12 months, followed by Phase 2 (Construction Management) lasted for 26 months. During Phase 1, rather than operating in a siloed design studio, the team engaged in establishing design criteria and specifications with immediate constructability foresight, implementing six differentiated systematic work packages, benchmarking materials and charactering specifications, creating numbering systems for all buildings and equipment, as well as conducting contractor procurement via Design and Build route.

Moving beyond a descriptive view of these tasks, the transition to Phase 2 reveals a specific mechanism of dynamic capability: role dissolution and competency spillover. Following contractor selection, the organisation shifted focus to execution. The design team was not simply reduced; rather, key personnel who had conceptualised the design seamlessly transitioned into supervision and constructability roles. Figure 2 shows the status of Phase 1 in the Design Management Phase overlapping with the early Construction Management Phase. This overlap was not merely administrative; it was a deliberate mechanism to ensure that the tacit knowledge generated during design was carried directly onto the *genba* by the very same individuals.

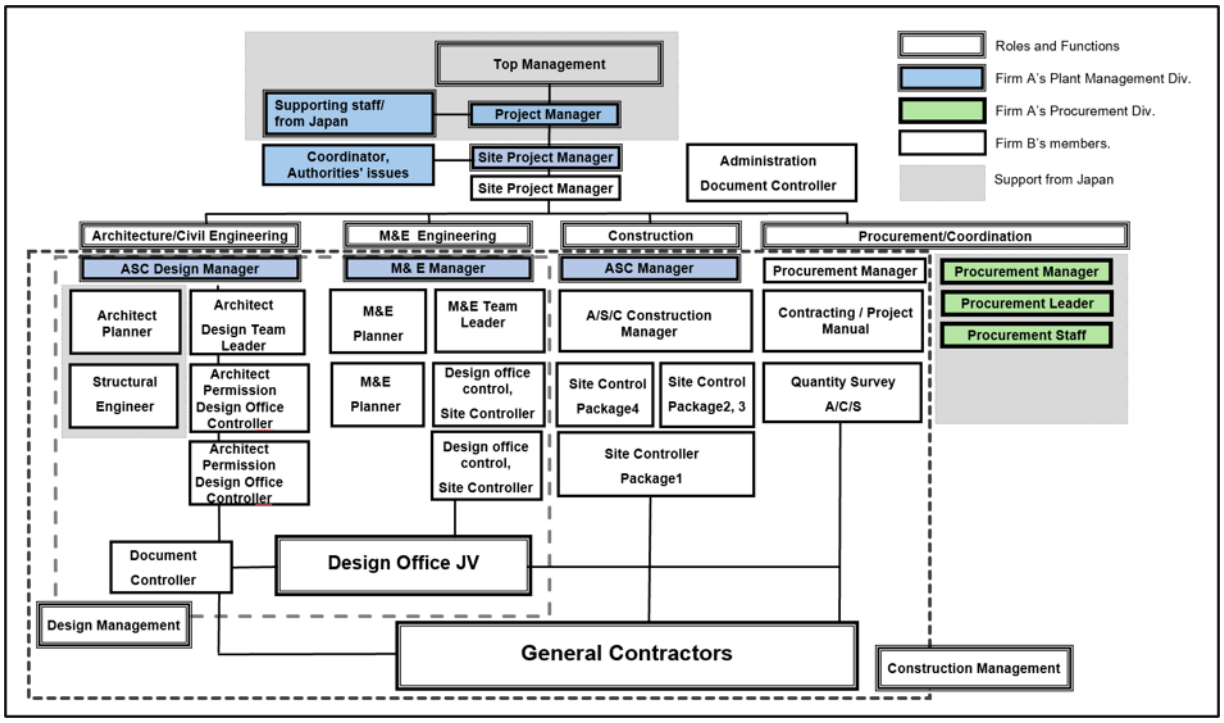

Figure 2: Project organisation chart for the automotive assembly plant in Project T

DYNAMIC CAPABILITY IN PRACTICE

Throughout the 38-month project, team composition was continuously adjusted 'as the situation required'. This dynamic capability was driven by the mechanism of redundancy of functions. When complex physical clashes occurred, the integrated organisation avoided structural bottlenecks, bypassing the slow, traditional paradigm of issuing formal Requests for Information (RFIs) to distant design consultants. Instead, utilising their latent pluripotentiality, the team engaged in responsive, decentralised decision-making directly at the *genba.* An architect from the Client Team could assess an engineering change, collaborate with the builder, and approve the adjustment simultaneously. Project T demonstrates how dynamic capability manifested in a lean-based organisation. Lean principles such as *continuous improvement* (*kaizen*) were sustained not merely by top-down process tools, but by a human-centric, fluid team structure. By intuitively reconfiguring roles and sharing cross-disciplinary responsibilities, the team maintained production flow, establishing a precedent for the pluripotential team model.

To further distinguish, the organisational model from Western IPD practice in European and North American projects often achieves client integration through multi-party relational contracts that formally bind the owner, designer, and contractor into a shared risk-reward structure throughout all project phases, including construction (Alves & Lichtig, 2020; Fischer et al., 2017). In Project T, however, client integration took a different form: the project owner embedded its own personnel directly within the contractor-led Client Representative Team, creating a unified delivery entity rather than a coalition of independent parties. This membership-based integration model, characteristic of the 'Japan Way', blurs the boundary between client and contractor at the human level, enabling the fluid role reconfiguration that is central to pluripotential team behaviour. Project G further illustrates this distinction: as a single-entity Design-Build project, the contractor took over a full execution design and delivery responsibility; the client's primary interface was conducted through the completing genba rather than through ongoing contractual integration.

CASE STUDY OF A MEGA TIMBER DESIGN-BUILD PROJECT

To answer RQ2, this study examines Project G: the Grand Ring at the Expo 2025 Osaka, Kansai, Japan as the world's largest wooden architectural structure. The Ring as shown in Figure 3 features a circumference of approximately 2km, an inner diameter of about 615 metres, and a height ranging from 12-20m. (SED, 2025). To manage the immense scale, the Ring was divided into three sections (North-East, South-East, and West). The execution design and construction for these sections were delivered by three separate Joint Ventures, each led by one Japanese major general contractor. This study focuses on the West Section managed by a leading Japanese Design-Builder. Unless stated otherwise, the ensuing exposition of the project approach and the relationship between designer and builder is based on BUILT (2024) and Kawamata (2024).

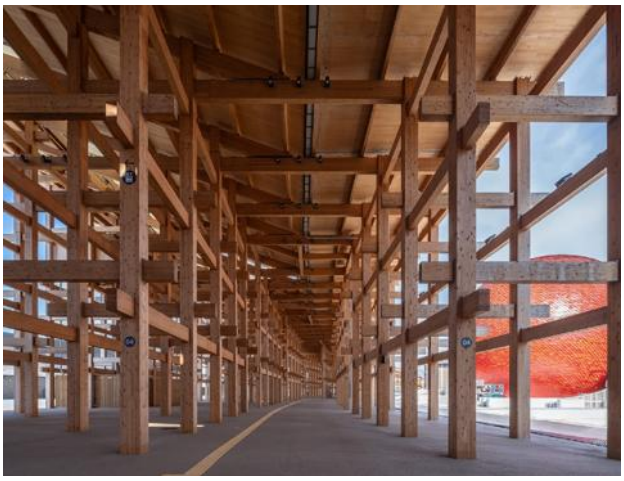

Figure 3: The Grand Ring view from the ground level (Photo © Takenaka Corporation)

The project mandate heavily emphasised environmental sustainability alongside a stringent, unmovable delivery deadline. Recent literature highlights that sustainable construction introduces complex design and supply chain risks that traditional management frameworks often struggle to mitigate (Othman and Abdelrahim, 2024). Furthermore, achieving true sustainability requires the meticulous application of lean principles to prevent both material and process waste (Khodeir and Othman, 2018). In highly specialised projects such as the Mass Engineered Timber construction, traditional delivery methods often suffer from extreme fragmentation. As Tommelein and Ballard (1997) identified, the coordination of distinct specialty contractors (e.g., timber fabricators, structural detailers, and site erectors) frequently creates structural bottlenecks and production delays. Project G inherently faced this risk: the digital complexity of the timber connections required unprecedented coordination between the digital design environment and the physical fabrication and assembly stages.

PLURIPOTENTIALITY AND DIGITAL-PHYSICAL INTEGRATION

To mitigate these risks, the main contractor utilised a Design-Build contract to design an adaptable organisational structure. Rather than just describing their technological stack, the critical analysis here focuses on the *human mechanism* that operated the technology. While BIM and DfMA were the digital foundation, the *capability* to use them effectively was driven by the deployment of a pluripotential team. Unlike traditional project schemes where designers pass the design drawings to construction managers, Project G dissolved these boundaries. The team operated with a high redundancy of functions. For instance, structural engineers did not limit their scope to load-bearing calculations; they actively immersed themselves in the timber fabrication logistics. Conversely, site engineers requested the designers to modify the upstream

BIM models at the design phase to reflect real-time *genba* constraints. When a complex clash was predicted in the digital model regarding, for example, a specific timber joint, the team could collaboratively resolve the issues, adjust the fabrication orders and update the site assembly sequences simultaneously in a decentralised manner.

Project G is a successful experiment in integrated design-build. The team erased the lines between design and construction. By drawing on the TPS, specifically Just-in-Time delivery and off-site pre-assembly, the project navigated spatial constraints and labour shortages to finish ahead of schedule. The influence of the TPS transformed Project G from a traditional construction job into a sophisticated logistical operation. In correspondence to Ohno (1978), the team replaced the traditional 'push' system of construction (delivering materials to wait on site) with a 'pull' system (Just-in-Time delivery). Project G demonstrates the evolution of the 'Japan Way' into a high-tech production system that fuses digital platforms with physical logistics.

The management system in Project G relied on four core pillars.

Early Optimisation and DfMA: To address severe labour shortages, the team front-loaded construction planning using DfMA. By re-engineering the timber erection method to be compatible with standard steelworkers, they eliminated the reliance on scarce, specialised wooden assemblers. This early optimisation, driven by genba field thinking, simplified the process so effectively that even junior staff could manage the assembly.

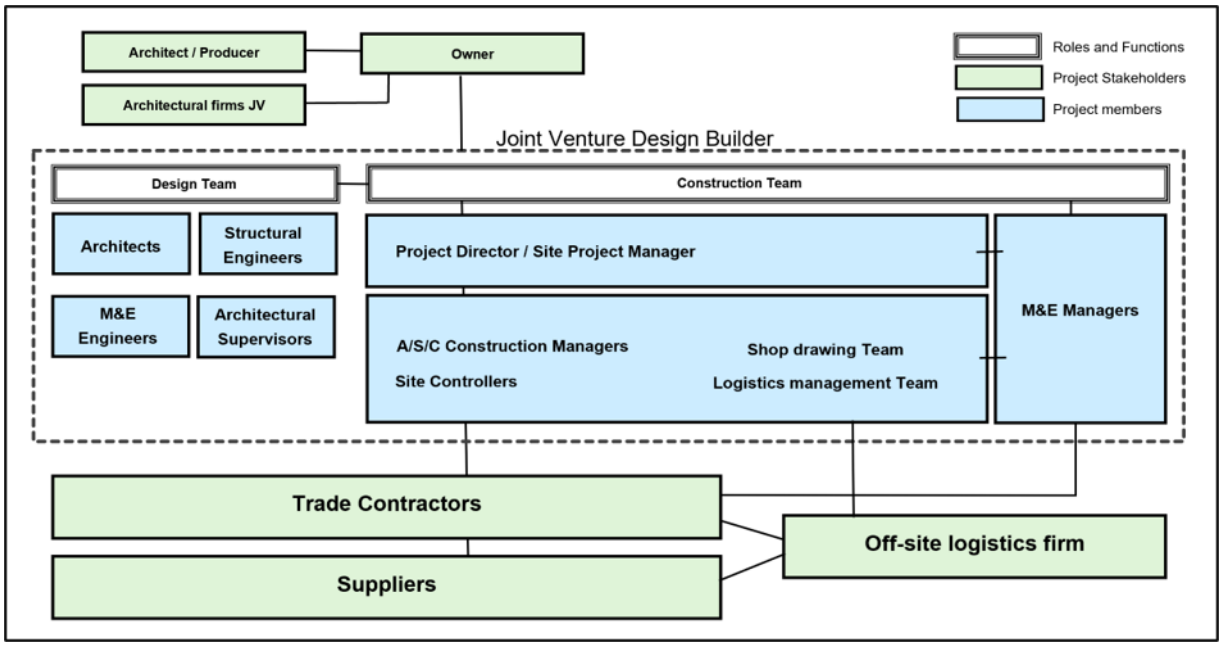

Figure 4: Project team organisation in Project G

Open BIM Strategy: To manage complex geometries, the team adopted an Open BIM platform approach, allowing fluid data exchange across various applications (including e.g., Rhinoceros and Grasshopper). This system was accessible to all project members, both inside and outside the site organisation. Constructability was validated physically through 3D printed models and life-size mock-ups, evaluated collaboratively by both designers and builders.

Off-site Logistics and Visualisation: Managing over 200,000 distinct components required integrating a professional logistics provider directly into the extended project team. A consolidation warehouse enabled Just-In-Time delivery. To control this inventory, the team implemented a *Mieruka* (Visualisation) system: Excel acted as the database, Power BI visualised real-time progress across the supply chain, and Microsoft Teams shared these

insights instantly amongst all stakeholders, ensuring everyone understood the project's primary status.

Digital Fabrication: The project established a seamless digital thread to manage intricate geometries. Design data flowed directly from the Open BIM environment to the fabrication machinery. By integrating the timber material suppliers as core members of the extended team, fabrication ran synchronously with site activities, ensuring high precision and eliminating the need for manual, time-consuming craftsmanship.

PLURIPOTENTIAL TEAM CONFIGURATION

The project involved the deployment of a pluripotential team capable of reconfiguring across roles. This includes the designers engaged with the physical reality of assembly and the builders engaged with the aesthetic integrity of the design. Foundation changes to pre-cast were suggested by the builders and collaborated by the designers. Also, the shop drawing team and the logistic control team using Power BI and Microsoft Teams to visualise the logistics of all timber material and metal fixture elements are both in the site team. Although each member focused on their specific role, the daily briefing sessions led by the project manager ensured that everyone remained focused on the same goal.

DISCUSSION

TWO MANIFESTATIONS OF PLURIPOTENTIALITY

The two case studies empirically reveal that dynamic capability does not rely on a single, rigid organisational template. Rather, it adapts to the temporal and technological constraints of the project. In Project T (the automotive factory), the size and function of the project team underwent continuous **mutation** depending on the specific project phases. While the designers, engineers, and construction managers possessed distinct titles, they did not operate in isolated silos. Instead, team members consistently monitored one another to collectively identify shifting priorities. This mutual observation allowed the team to organically mutate its functional focus to resolve physical challenges at the *genba*.

Conversely, Project G (the mega timber structure) presented a different empirical reality due to its highly digitised nature and compressed Design-Build schedule. In this case, the roles and functions of the team members were **fixed**. The project manager clearly delineated these roles from the outset, and team members focused strictly on their designated technical responsibilities. However, the team avoided traditional fragmentation through relentless information sharing. Through daily communication led by the project manager, every specialist maintained a comprehensive understanding of the project's primary goal, allowing them to execute their specific roles in harmony with the wider project needs.

Table 1 summarises the key distinctions between the two projects. While both cases demonstrate dynamic capability induced by pluripotential teams, they differ fundamentally in delivery model, team configuration, and the mechanism through which pluripotentiality was exercised. Project T, operating under a Client Representative Team model embedded within the contractor organisation, achieved dynamic capability, with structural pluripotentiality, through the physical mutation of roles across project phases. Project G, delivered under a single-entity Design-Build contract with a compressed schedule, has achieved dynamic capability, with cognitive pluripotentiality, through shared cognitive alignment across fixed specialist roles. The primary lesson drawn from comparing the two cases is that pluripotentiality is not a fixed organisational template but an adaptive property. The same underlying human-centric principle manifests differently depending on the project's technological complexity, delivery timeline, and cultural context.

Table 1: Comparative summary of Project T and Project G.

	Project T	**Project G**
Delivery Model	Client Representative Team + Design-Build + Construction Management	Single-entity Design-Build
Client Involvement	Client embedded in delivery team (with Client Representative)	Client Supervision, Contractor-led
Team Structure	Fluid, roles mutate across phases	Fixed, roles specialised from outset
Pluripotentiality	Structural Pluripotentiality	Cognitive Pluripotentiality
Key Lean Instrument	*Genba* field presence, *pokkiri* resourcing	Daily briefing, open BIM, *mieruka* (visualisation)
Outcomes	Production flow sustained through role reconfiguration	Two months ahead of schedule

THEORETICAL INTERPRETATION: DYNAMIC CAPABILITY

Theoretically, these findings demonstrate that dynamic capability, induced by pluripotential teams, can be achieved through both structural and cognitive means.

Answering RQ1, Project T exemplifies *structural pluripotentiality*. The team's ability to physically mutate and fluidly shift functions across phases provided the essential flexibility needed to maintain production flow. Answering RQ2, Project G exemplifies contemporary *cognitive pluripotentiality*. Because the complexity of Mass Engineered Timber and BIM requires deep, uninterrupted specialist focus, physical role-switching was impractical. Instead, dynamic capability was achieved through a 'holographic' team mindset. Daily communication ensured that the primary goal was universally understood, empowering specialists to execute their fixed roles with high autonomy, instantly aligning their highly specific digital tasks with the overarching needs of the physical *genba*.

It must be acknowledged, however, that pluripotentiality and multi-skilling carry inherent organisational risks that a purely optimistic reading of these cases would obscure. Role ambiguity, cognitive overload, and the blurring of professional accountability are well-documented risks associated with multi-competence demands on individuals (Worley and Doolen, 2006). In both Project T and Project G, these risks were mitigated by the specific cultural conditions of the 'Japan Way': a pre-existing high-trust environment, a membership-based employment system that normalises broad responsibility and strong psychological safety within the team (Asadian and Leicht, 2025; Gomez et.al., 2020). This contextual dependency is a critical limitation of the pluripotential model with its exportability to Western construction markets characterised by job-based systems and adversarial contracting cannot be assumed without further research.

CONCLUSION

The construction industry is increasingly reliant on complex digital tools such as BIM and DfMA to deliver sustainable megaprojects. However, this study concludes that technological adoption alone is insufficient without an equally adaptable human-centric organisational structure. By examining a historical lean project alongside a contemporary digital megatimber project, this research introduces the concept of the 'pluripotential team' as a vital mechanism for generating dynamic capability. Whether manifesting through the structural mutation of roles

or through intense cognitive alignment around a shared goal, pluripotential teams provide the redundancy of functions necessary to bridge the gap between abstract digital models and the unpredictable realities of the physical *genba*.

LIMITATIONS AND RECOMMENDATIONS

Whilst this study provides empirical observations of dynamic capability within Japanese project delivery, its primary limitation is its specific cultural context. The highly cohesive, pluripotential behaviours observed in both Project T and Project G are representative of the 'Japan Way' of project management, which relies heavily on a pre-existing culture of high trust, psychological safety, and a membership-based employment system.

Consequently, a compelling avenue for future research involves investigating the deep sociological and philosophical roots of this organisational behaviour. For example, the Japanese philosopher Watsuji (1935) suggested that human existence is essentially shaped by relationships (*aidagara*), whereby individuals are both unique entities and members of society. This perspective offers a valuable theoretical framework for understanding the 'Japan Way'. It suggests that the deeply ingrained cultural propensity for teams to operate as a pluripotential unit, naturally dissolving role boundaries to support the collective rather than retreating into individual silos, is a direct reflection of this relational worldview.

Furthermore, it is hypothesised that this relational focus originates from traditional Japanese agricultural practices, specifically rice cultivation in historical villages (*mura*), demanding intense, synchronised collective action. As this study lacks the specific anthropological data to empirically verify these cultural linkages, future interdisciplinary research combining construction management with organisational sociology is recommended. Investigating these profound roots will be critical for determining whether the pluripotential team model can be successfully exported to Western construction markets, which are traditionally characterised by highly individualised, job-based systems and adversarial contracting paradigms.

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