

REDUCING CONSTRUCTION DURATION THROUGH INFORMATION ALIGNMENT: A FACTOR-BASED BIM FRAMEWORK

One of the most common and expensive issues in building delivery is construction duration overruns, particularly in projects with many participants, frequent design modifications, intricate trade interfaces, and strict delivery deadlines. A significant portion of schedule losses are caused by coordination failures, such as slow decision cycles, inconsistent information, parallel document/model versions, incomplete design releases, and mismatches between procurement/logistics and actual site readiness. In such environments, delays are frequently attributed to resource shortages or external disruptions. Building Information Modeling (BIM) is a digital toolkit that is becoming more and more popular, but time benefits are often limited because BIM is primarily used as a modeling activity rather than as a structured information-and-governance system that unites participants around shared and verified.

This article expands on the idea of information alignment as a system-forming variable that, by lowering coordination losses and regulating production flow, directly influences construction length. According to the study, building production is an information-driven organizational–technological system in which coordinated information sharing between the customer, designers, contractors, subcontractors, suppliers, and control bodies results in schedule dependability. The most important factors for duration performance are highlighted in a structured framework of Factors of Information Alignment, which includes data standardization (common naming/classification rules and structured attributes), transparency (clear visibility of information status, responsibilities, and changes), controlled versioning and traceability, completeness and quality of production information, process synchronization across design, procurement, logistics, and execution stages, digital interoperability within a common data environment, and disciplined communication with defined response times.

A lifecycle-based coordination loop, which includes requirements formulation, design information generation, planning integration, execution monitoring, data verification, decision adjustment, and feedback implementation, is formalized in this paper. It also explains how alignment factors and this coordination cycle interact to improve schedule reliability. A nonlinear interpretation of time benefits is supported by the proposed conceptual model: limited gains are anticipated at low alignment maturity, but significant duration reduction becomes possible after a threshold level of standardization, transparency, and synchronization is reached because of cumulative effects like fewer stoppages, less rework, and quicker constraint removal. The findings offer a methodological foundation for integrating BIM into duration-focused management systems and can be used in industrial and low-rise construction, reconstruction initiatives, and multi-stakeholder projects where synchronized and consistent information flows are necessary for accelerated delivery.

Keywords: *construction duration; schedule reliability; BIM; information agreement; design quality; construction quality; data standardization; transparency; change management; common data environment (CDE); coordination losses; flow-based construction; digital construction management.*

Introduction. High levels of complexity, multi-stakeholder engagement, expedited delivery expectations, and frequent design and scope revisions are all factors that are increasingly present in construction projects. In these circumstances, the level of coordination among project participants is just as important to construction duration performance as technology productivity and resource availability. In actuality, contradictory project information, several "versions of truth," sluggish decision processes, and frequent explanations between the customer, designers, contractors, suppliers, and control bodies are the main causes of time losses. These coordination losses lead to production flow disruptions, worse planning dependability, and eventually longer building times.

In response to this challenge, the current study advances the idea of Information Alignment as a system-forming process that connects organizational-technological choices that impact project length with information environments enabled by BIM. In contrast to isolated optimization of individual processes, the paper contends that construction production should be understood as an information-driven organizational system where schedule stability and time performance depend on synchronized information sharing.

Relevance. The increasing requirement to shorten construction times without sacrificing quality, safety, or compliance—particularly in projects with several contractors and accelerated timelines—determines the article's applicability. BIM usage in these projects has grown quickly, but because BIM is generally used as a modeling tool rather than as a governance and synchronization system, duration improvements are usually smaller than anticipated.

There is still a significant practical gap: despite the use of BIM, CDE platforms, and digital tools, construction stakeholders still encounter delays due to fragmented workflows, low reliability of information used for planning and site execution, unstandardized data, and inadequate transparency of changes and responsibilities. Because time performance and rebuilding speed necessitate systematic coordination improvements rather than incremental local optimizations, the problem is pertinent to contemporary construction management and the Ukrainian construction industry in particular.

Problem statement. The issue discussed in the essay is that information misalignment among project participants is a major contributing factor to construction duration overruns. Inconsistent data standards, poor update transparency, missing or delayed information, poor decision traceability, and inadequate coordination between design, procurement, logistics, and execution are all signs of misalignment. These problems lead to schedule instability by:

- Decision latency (awaiting permissions or clarifications);
- rework because of inaccurate or out-of-date design information;
- interruptions to trade interfaces and sequencing;
- Inconsistency between real site preparedness and procurement/logistics;
- Loss of production flow and erratic short-term planning.

Therefore, a structured factor-based model is required to explain how alignment maturity affects construction duration performance, especially in BIM-enabled environments, and which aspects of information management (standardization, transparency, governance, etc.) determine alignment maturity.

Analysis of recent research and publications. Construction production is historically interpreted by Ukrainian scientific study in the field of construction organization and management as a complex organizational–technological system where efficiency results from coordinated interaction among participants. At keeping with this heritage, the systemic techniques created at KNUCA's scientific school highlight how organizational-technological decision consistency across planning, execution, and control determines project performance. Professor Oleksiy Tugay's writings in particular support the idea that building organizations are systemic and that coordination mechanisms are necessary to guarantee consistency between planning and execution. The article's argument that information processes should be seen as an operational coordinating mechanism rather as supplemental documentation is supported by this theoretical framework.

Additionally, a growing number of recent Ukrainian publications concentrate on:

- The quality of organizational-technological decisions in prefabricated and industrial building;
- Digitalization of construction management (shared data environments, BIM-based coordination);
- coordination of supplies and logistics in building projects;
- The dependability of short-term planning in production systems and lean-oriented methods.

According to international research, BIM and digital technologies are most effective when integrated into regulated change management, consistent data formats, and disciplined governance; otherwise, they may create parallel datasets and add complexity.

However, the investigation identifies aspects of the overall issue that remain unresolved:1. The absence of a unified factor model of information alignment specific to the length of construction, particularly linking BIM practice with time performance mechanisms (decision delay, rework, flow disruptions).2. Inadequate formalization of alignment characteristics, such as transparency and data standards, as quantifiable organizational variables rather than merely as "digital maturity" descriptions.3. Inadequate integration of factor frameworks with coordination cycles (feedback-based management throughout the project lifecycle); projects frequently talk about digital technologies or workflow cycles, but not the systemic connection between the two.4. Limited length-focused interpretation: While many studies talk about efficiency in general, they don't specifically explain how information alignment shortens project duration and improves schedule dependability through a nonlinear threshold impact (maturity tipping point).

By connecting a lifecycle coordination cycle with a structured factor framework and a duration performance mechanism, this paper fills up these gaps.

The purpose of the article is to develop and justify a BIM-enabled organizational framework in which Factors of Information Alignment act as system-forming variables that reduce coordination losses and improve construction duration performance. The study's specific objectives are to formalize the coordination cycle of information management throughout the project lifecycle, interpret construction production as an information-driven system, and structure and explain important alignment factors

(transparency, data standardization, etc.) that affect schedule reliability and time outcomes.

The scientific novelty of the proposed approach lies in defining Information Alignment as a central organizational variable that determines coordination losses and construction duration performance, and in developing a factor-based framework that operationalizes alignment maturity in BIM-enabled environments. Project delivery for low-rise and industrial building may be accelerated by advancing this technique, which creates a single information-and-management area that synchronizes participant engagement, minimizes decision delay and rework, and guarantees continuation of flow-based construction.

The study also makes a contribution by directly linking:

- an information management coordination loop based on feedback;
- with a structured factor model of information alignment, to a duration mechanism with a nonlinear threshold effect (important time advantages emerge as alignment maturity stabilizes).

Main material presentation. According to the suggested interpretation, production flow stability determines building duration. Whether or whether project participants use reliable, timely, and consistent information determines flow stability. Organizational entropy (conflicting data, redundant work, delayed choices) caused by misalignment directly results in time losses due to waiting, stoppages, resequencing, and rework.

Time performance is only supported by BIM when it serves as a regulated operational reference:

- Procurement uncertainty is decreased by consistent model-based quantities and requirements;
- Sequencing and constraint visualization are enhanced by 4D planning;
- Organized problem tracking increases accountability and decision-making speed;
- Using CDE makes modifications and responsibilities easier to trace.

Therefore, when governance, standardization, and transparency regulations are in place, BIM becomes the operational architecture of information alignment.

In addition to a timetable, effective duration management in construction necessitates a reliable coordination system that continually converts project data into actionable choices and then validates the outcomes in the field. Time losses in multi-stakeholder projects are primarily caused by the lack of a repeatable cycle that guarantees the following:

- the correct information is generated;
- it is validated and released;
- it is integrated into planning;
- execution is monitored;
- deviations are closed through corrective decisions.

Information coordination is understood in this study as a feedback-based management loop that runs the course of the project. The shift from disjointed communication to systematic participant synchronization is formalized by this loop. The cycle includes the following stages:

1. Requirement formulation and constraint definition.

In addition to defining functional requirements and scope bounds from the outset, the project also identifies constraints that have a direct impact on length, such as site access restrictions, regulatory inspections, lead times for procurement, and sequencing assumptions. Information requirements (EIR/IR) and "construction-ready" criteria—the

degree of accuracy and completeness the information must attain before execution can begin—are crucial components of requirements.2. Create and organize information.

2. Design information generation and structuring.

To be utilized for planning and procurement, design outputs (models, drawings, specifications, quantities) must be created in an organized manner. The primary duration risk at this point is the early dissemination of conflicting or insufficient information. When geometry, quantities, and interfaces are coordinated before to release, BIM provides value by avoiding subsequent rework and stoppages.

3. Planning integration (4D/production planning linkage).

Planning must include the generated data, including work packages, building techniques, sequencing, and constraint elimination. This is where BIM-enabled 4D logic becomes crucial: tasks should be connected to work packages or model components so that schedule dependability is based on confirmed data rather than conjecture. One of the most frequent causes of hidden delays is an inadequate connection between design data and planning.

4. Execution monitoring and field feedback (progress + issues).

The project must consistently record issues and progress during construction in an organized manner (e.g., percent complete by work package, limitations log, RFI status, clash/issue status). The speed at which deviations are detected determines duration performance; the earlier a deviation is detected, the less of an influence it has on the critical route.

5. Data verification and validation.

Verification of monitoring data is necessary (e.g., actual completion vs. claimed completion; installation quality vs. "done" status). Verification guarantees that reality is reflected in the information system. Verification shields the flow from misleading signals; in many projects, "paper completion" produces false readiness and causes downstream problems.

6. Decision adjustment and change-impact control.

Decisions, such as rescheduling, resource reallocation, delivery window revisions, or design adjustments, are modified based on confirmed facts. Decision latency is now the primary duration mechanism; delays increase when approvals and explanations take too long. As a result, the cycle necessitates response-time commitments, escalation pathways, and well defined decision responsibilities.

7. Feedback implementation and information update (closing the loop).

Updated models, updated work packages, updated procurement orders, and updated constraints are examples of corrective choices that must be put into practice and mirrored in the information environment. This terminates the loop and stops the same problems from happening again

This coordination cycle transforms management from reactive control into predictive coordination: rather than "responding to problems," the project continuously maintains information readiness and constraint removal before activities reach the site.

Even if the coordination cycle (Figure 1) outlines how information should be shared, projects still fail when essential alignment requirements are not met. As a result, Information Alignment needs to be broken down into operational drivers, or Factors of Information Alignment, which collectively define the information environment's maturity and capacity to facilitate quick, dependable building.

Four primary processes are used in this research to treat the Factors of Information Alignment as organizational–technological variables that directly affect construction duration:

1. Decision delay reduction;
2. a decrease in interface failures and rework;
3. stabilization of the dependability of short-term planning;
4. coordinating logistics and procurement with execution preparedness.



Figure 1. Information coordination cycle across the project lifecycle (feedback-based loop supporting schedule reliability).

Factors of Information Alignment (F1 – F8).

F1 - Data standardization

Definition. A unified set of rules for naming, classification, attribute structure, and document/model organization (including templates and common coding).

Duration mechanism. Standardization reduces ambiguity and prevents parallel datasets (“different names for the same object”), which lowers RFI volume, accelerates approvals, and enables faster planning integration. It also improves procurement accuracy by ensuring consistent quantities and specifications.

BIM linkage. Implemented through classification systems, shared parameter dictionaries, standardized LOD/LOI requirements, and consistent work package definitions in the CDE.

F2 - Transparency

Definition. Visibility of information status, ownership, and readiness—who produced it, who approved it, what version is current, and whether it is “construction-ready.”

Duration mechanism. Transparency accelerates decision-making and reduces hidden waiting. Crews stop less often because they can trust the status of information. It also prevents “silent changes” that cause late-stage rework.

BIM linkage. Implemented via CDE workflows (status codes, approvals, issue logs), dashboarding of RFI/issue aging, and clear role-based accountability.

F3 - Version control and traceability

Definition. Controlled revision management with a complete history of changes, including what changed, why, when, and how it impacts schedule and cost.

Duration mechanism. Traceability prevents execution on outdated information and reduces rework-driven delays. It also allows faster root-cause analysis when deviations occur.

BIM linkage. Implemented through model revision control, change logs, BIM issue tracking (BCF), and structured “freeze points” for critical packages.

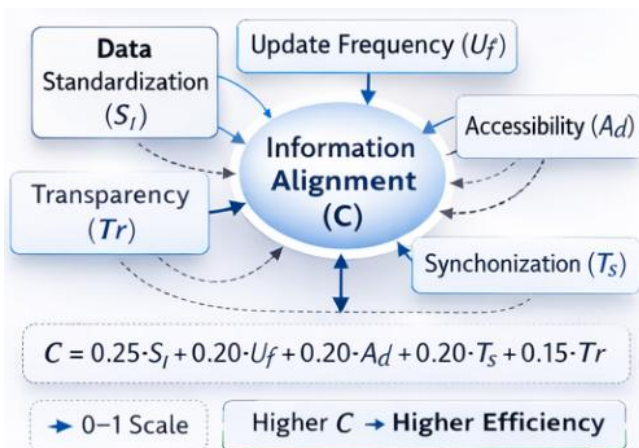


Figure 2. Factors of Information Alignment in BIM-enabled construction projects (determinants of coordination loss and duration performance).

F4 - Information completeness and quality (“production-ready data”)

Definition. The level of completeness and constructability of information required for execution, including interfaces between disciplines and method constraints.

Duration mechanism. High-quality production information reduces RFIs, trade clashes, and site stoppages. It improves short-term plan reliability because work packages are truly executable.

BIM linkage. Implemented via model coordination, clash detection, constructability reviews, and acceptance criteria for design release into execution.

F5 - Process synchronization (design–procurement–logistics–execution)

Definition. Alignment of information release schedules with procurement lead times, delivery windows, and site readiness, treating the project as one synchronized production system.

Duration mechanism. Synchronization reduces idle time (waiting for materials/approvals) and avoids early deliveries that create site congestion. It stabilizes flow and reduces resequencing.

BIM linkage. Implemented through 4D planning, constraint logs, and linking BIM quantities/specs to procurement and delivery planning.

F6 - Interoperability / digital integration

Definition. Consistent and lossless data exchange between BIM tools, CDE, scheduling, procurement, and field execution systems.

Duration mechanism. Integration reduces transaction time and prevents data mismatches that cause late corrections. Faster updates = faster coordination cycles.

BIM linkage. Implemented through standardized formats (IFC/BCF where applicable), API integrations, and shared master data structures.

F7 - Communication discipline and decision cycle speed

Definition. Structured coordination routines and response-time rules: meeting cadence, escalation paths, target times for RFIs/approvals, and decision logs.

Duration mechanism. A slow decision cycle is a direct duration driver. Discipline reduces waiting and ensures constraints are removed before they reach the site.

BIM linkage. Implemented through issue management workflows linked to model elements and regular look-ahead planning tied to information readiness.

F8 - Feedback and verification loop (site-to-model-to-plan)

Definition. Continuous monitoring of execution, verification of progress, and systematic updating of plans and models based on field reality.

Duration mechanism. Early detection prevents critical path damage. Verification prevents “false readiness,” reducing downstream delays and rework.

BIM linkage. Implemented via field data capture, element-level progress status, punch lists/QA checks, and controlled updates to planning.

Conclusions. The research demonstrates how coordination losses caused by information misalignment among project participants have a significant impact on construction duration performance. The study identifies information alignment as a key factor influencing schedule dependability and delivery time by seeing construction production as an information-driven organizational–technological system. Only when integrated into a structured alignment framework that is backed by standardization, transparency, traceability, synchronized processes, and feedback-based coordination does BIM improve time performance.

The suggested structure provides a methodical explanation of how aligned information lowers decision delay, rework, and flow disruptions by connecting the lifecycle coordination cycle with a factor model of information alignment). The findings establish a methodological foundation for additional study on quantitative alignment maturity indicators and validation using actual project data on rework rates, RFI cycle times, and delays.

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Скорочення тривалості будівництва завдяки узгодженню інформації: факторично організована BIM-система

Однією з найпоширеніших і найдорожчих проблем у сфері будівництва є перевищення термінів будівництва, особливо в проектах з багатьма учасниками,

частими змінами в проєкті, складними торговельними інтерфейсами та суворими термінами виконання робіт. Значна частина втрат у графіках спричинена збоями в координації, такими як повільні цикли прийняття рішень, суперечлива інформація, паралельні версії документів/моделей, неповні релізи проєктів та невідповідності між закупівлями/логістикою та фактичною готовністю об'єкта. У таких середовищах затримки часто пояснюються нестачею ресурсів або зовнішніми збоями. Інформаційне моделювання будівель (BIM) – це цифровий інструментарій, який стає все більш популярним, але переваги в часі часто обмежені, оскільки BIM в основному використовується як діяльність з моделювання, а не як структурована інформаційно-управлінська система, яка об'єднує учасників навколо спільного та перевіреного.

У цій статті розширюється ідея узгодження інформації як системоутворюючої змінної, яка, знижуючи втрати в координації та регулюючи виробничий потік, безпосередньо впливає на тривалість будівництва. Згідно з дослідженням, будівельне виробництво – це інформаційно-орієнтована організаційно-технологічна система, в якій скоординований обмін інформацією між замовником, проєктувальниками, підрядниками, субпідрядниками, постачальниками та контролюючими органами призводить до надійності графіка. Найважливіші фактори тривалості виконання виділяються в структурованій структурі факторів узгодження інформації, яка включає стандартизацію даних (загальні правила найменування/класифікації та структуровані атрибути), прозорість (чітку видимість статусу інформації, обов'язків та змін), контрольоване версійне керування та відстеження, повноту та якість виробничої інформації, синхронізацію процесів на етапах проєктування, закупівлі, логістики та виконання, цифрову сумісність у спільному середовищі даних та дисципліновану комунікацію з визначеним часом реагування.

У цій статті формалізовано цикл координації на основі життєвого циклу, який включає формулювання вимог, генерування проєктної інформації, інтеграцію планування, моніторинг виконання, перевірку даних, коригування рішень та реалізацію зворотного зв'язку. Також пояснюється, як фактори узгодження та цей цикл координації взаємодіють для підвищення надійності графіка. Нелінійна інтерпретація переваг у часі підтверджується запропонованою концептуальною моделлю: обмежені вигоди очікуються при низькому рівні зрілості узгодження, але значне скорочення тривалості стає можливим після досягнення порогового рівня стандартизації, прозорості та синхронізації завдяки кумулятивним ефектам, таким як менше зупинок, менше переробок та швидше усунення обмежень. Результати пропонують методологічну основу для інтеграції BIM у системи управління, орієнтовані на тривалість, і можуть бути використані в промисловому та малоповерховому будівництві, реконструкційних ініціативах та проєктах за участю багатьох зацікавлених сторін, де синхронізовані та послідовні потоки інформації необхідні для прискореного виконання.

Ключові слова: *тривалість будівництва; надійність графіка; BIM; узгодження інформації; Якість проєктування; Якість будівництва; стандартизація даних; прозорість; управління змінами; спільне середовище даних (CDE); втрати координації; будівництво на основі потоків; цифрове управління будівництвом.*