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Digitalization and Process Management in Construction: A Current Industry Perspective

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Despite broad experience in managing construction projects, when it comes to harnessing business operational data to efficiently manage and improve processes, the construction industry has fallen behind several other industries. Aiming to investigate this aspect in the North American construction market, this study provides an industry perspective on construction process management and its main challenges within the Architecture, Engineering, Construction, and Facility Management (AEC/FM) domain. These challenges primarily concern managing construction operations across project life cycle phases, from planning and tendering to execution and post-construction. The study seeks to explore and shed light on such complexities, particularly on critical business processes and business data requirements essential for successful project management in construction.

The main goal of this investigation is to provide a comprehensive analysis of the common trends, barriers, and insights of data-driven process management in the construction industry. The objectives include:

» Capturing construction practitioners' knowledge inputs to better understand the degree of involvement and expertise across different phases of construction projects

» Identifying and analyzing key business processes across project phases and identifying unique challenges, and their impact on the overall project timeline

» Investigating business operational data needs necessary for data-driven decision-making in construction projects

The present study adopts a qualitative approach through a series of semi-structured interviews completed between February and August, 2023, with subject matter experts that enables respondents to provide detailed insights while responding to specific and structured questions. These interviews were carefully designed and structured to include both open- and closed-ended questions derived from a comprehensive literature review framework and validated with industry professionals. These questions were formulated in a way to collect the construction process-related experience from industry professionals. In total, 18 subject matter experts from North America were interviewed. Their professional background included a wide range of professional roles and experience managing construction projects. This representation

of interviewees enriched the study to cover key business processes across construction project lifecycle phases.

The study explores the relevance of these processes documenting process bottlenecks and information exchange requirements among stakeholders reported by the interviewees and emphasizing the critical role of data in informed decision-making within the construction industry. With 32% of respondents referring to at least one process from the preconstruction phase, this phase bears the highest degree of process interplay.

Furthermore, the study observed:

» A marked increase in data production and collection by both private and public entities

» An increased need for defining a solid data strategy to support efficient operational decision-making

However, data integration from multiple siloed data sources poses a significant challenge, with missing data identified as the primary cause of poor data quality. The interview findings strongly support the observation that the construction industry has fallen short in adopting emerging technologies and data-driven decision-making approaches that consider the DIKW (Data-Information-Knowledge-Wisdom) hierarchy implementation across all projects' lifecycle phases that enable process intelligence to support and improve construction processes and project management.

The most relevant findings of these interviews are reported in this article, and a data-driven decision-making approach is introduced for enabling project and process intelligence, aiming to enhance construction performance. It turns out that:

» Processes under the preconstruction phase are notably influencing and being influenced by processes from other phases

» The project's completion timeline is significantly affected by those processes in various phases that necessitate frequent and immediate revisions or actions to maintain smooth project progress. For instance, the submittal and transmittal approval process that requires frequent stakeholder actions to ensure all technical documents are reviewed and approved in a timely manner

» While data has experienced substantial growth in the last three years and has been utilized in operational decision-making, the quality of the collected data has been subpar, leading to challenges for stakeholders in its effective use

Participants report spending a significant amount of time (more than 15 hours each week) in data wrangling that frequently ends up being wasted due to poor data quality or lack of data integration. Thus, the key barriers to adopting a data-driven approach, as identified by interview respondents are as follows:

» Unstructured data

» Diverse challenges in making data usable

» Limited or non-existent corporate data strategy to build organizational memory that strengthens business competitiveness

» Absence of real-time or semi-real-time automated data transfer, data integration, and data insights

» Lack of automated methods for process modeling and near real-time performance monitoring

» Lack of performance benchmarks on the required time to collect, analyze, and communicate data according to the type of processes being assessed in different projects

CROSS-PHASE PROCESS MANAGEMENT

A comprehensive list of business processes across each phase of a construction project's lifecycle is shown here [1].
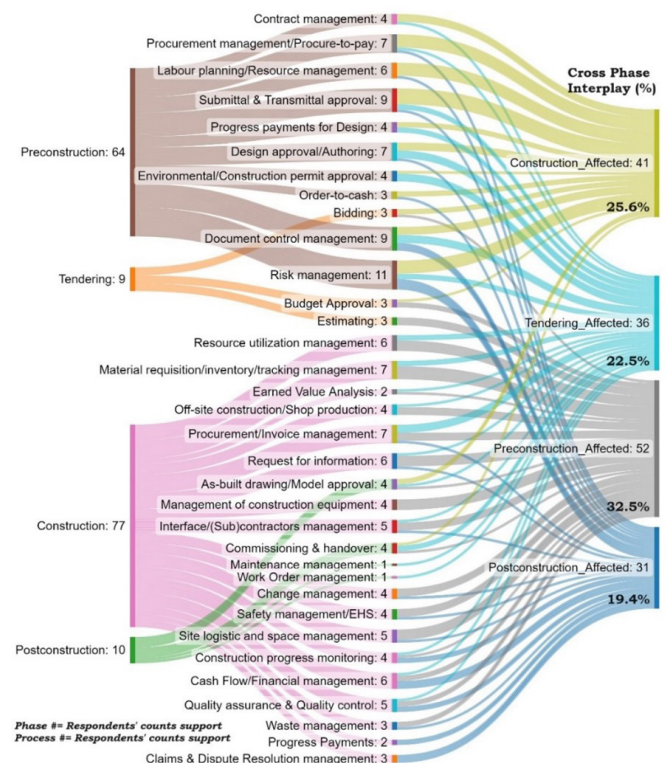
These processes were identified based on an exhaustive analysis of the literature, validated by industry experts. The interviewees were tasked with indicating the process interplay or intertwinement, the degree to which each process contributes to affecting other phases' processes. This diagram was derived from analyzing the interviewees' responses to questions such as those described. The three main parts of the diagram show the distribution of processes across different project phases, the number of responses supporting the importance of each process, and the percentage of cross-phase interplay. The connections demonstrate the flow and influence of each process from one project phase to another, indicating which phases are most affected by these processes and to what extent. The cross-phase analysis presented reveals that with 32% of all identified processes, the preconstruction phase bears the highest number of process interplay indicating that decisions or actions taken in preconstruction are highly influential on the later construction activities.

To better understand the challenges hindering these processes, the main process bottlenecks perceived by the interviewed industry experts for high-impact processes of each phase are presented in the table below. These bottlenecks can have a direct impact on project timelines that result in cost overruns. For instance, inaccurate estimations, overpricing, and inadequate material tracking during the Bidding and Material Management business operations diminish process efficiency, increase costs, and potentially lead to significant project delays.

DATA-DRIVEN DECISION MAKING

To ascertain business data requirements, a crucial initial step involves outlining business goals, comprehending core processes, monitoring main business KPIs, and identifying information needs. As respondents grapple with effectively collecting and utilizing data, it becomes imperative to establish a data strategy capable of providing visibility over business operations. As part of this, for example, a Data Insight Generator (DIG) [2] can be implemented and supported by advanced digital technologies/platforms. This procedure should encompass the determination of the data needed to be collected and their data types, automated data acquisition, data quality enhancement, structuring data, the implementation of information systems to facilitate data integration and data analytics to subsequently extract valuable insights for decision makers and stakeholders.
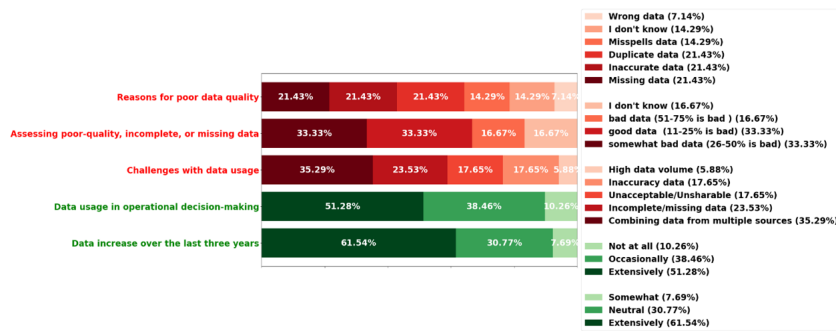
In recognition of the transformative potential of data-informed decision-making in enhancing process efficiency and facilitating cross-phase management, 14 data-related inquiries were posed to industry experts. In this regard, they are depicted above, underscoring a pressing concern within the construction industry, highlighting the critical need for enhancing data quality and improving data usability for enabling data-driven decision-making processes across various project stages.

It is notorious that the readily available noisy data is being used for decision-making, which not only results in process inefficiencies but also can eventually lead to project failure. Therefore, considering these aspects can help construction organizations to better establish an effective data management strategy to increase their corporate memory. It should be noted that, to ensure clear understanding, the terminology used in the questions was clarified for the interviewees at the start of each interview section. For

Phase	Process	Identified Bottlenecks
Tendering	Bidding	Missing or Incomplete Drawings; Contractors' Overpricing; Unreliable and inaccurate Estimations
Pre-Construction	Contract Management	Legal department revision; information management; BIM not specified in the contract; Inexperienced Project Manager
	Design Approval	Poor communication; lack of visibility on approvers; delays in revision times; delays in approval times
	Submittal/ Transmittal Approval	Poor track of logs; manual workflows; revision delays
	Procurement Management	Lack of monitoring of vendors' prices; poor visibility on vendor agreements; foremen not ordering from partner vendors
Construction	Material Management	Unplanned daily orders by supervisors; poor inventory management; ordering much more than needed; poor material tracking
	Construction Progress Monitoring	Reporting more progress than the real one; poor visibility on remaining work and time to complete it; Overlapping activities too much
	Site-Space Logistics Management	At peak time conflicting cranes/machines
	Change Management	Getting all answers at the right time from different parties involved; poor coordination; contract clauses not specific enough; scope and exemptions not detailed enough; getting clients' approvals; change revisions; delays in estimating and submitting change
Post-Construction	Commissioning & Handover	Lack of process visibility; Non-standard punch list process; Inexperienced Owners

example, distinctions were made between 'bad data' (data with inconsistent values) and 'wrong data' (consistent values, but inaccurate).

PROJECT AND PROCESS INTELLIGENCE

Based on the aggregated information from completed interviews, a conceptual model is proposed to provide a connected high-level view of the life cycle phases of construction projects supported by data and Information Communication and Technological (ICT) advancements on Artificial Intelligence, Business Process Management (BPM), Process Mining, and Building Information Modeling (BIM). The proposed model adopts the DIKW (Data-Information-Knowledge-Wisdom) hierarchy implementation across all projects' lifecycle to enable process intelligence as depicted below. It highlights:

» The importance of acquiring, collecting and contextualizing business data for capturing process knowledge;

» Monitoring the performance of construction operations

» Building business knowledge assets to enable data-informed decision making that enhances process efficiency during the whole life cycle, leading to project success

of construction organizations to transform raw data into information and knowledge assets that enable process intelligence to monitor and enhance business processes across the lifecycle of construction projects.
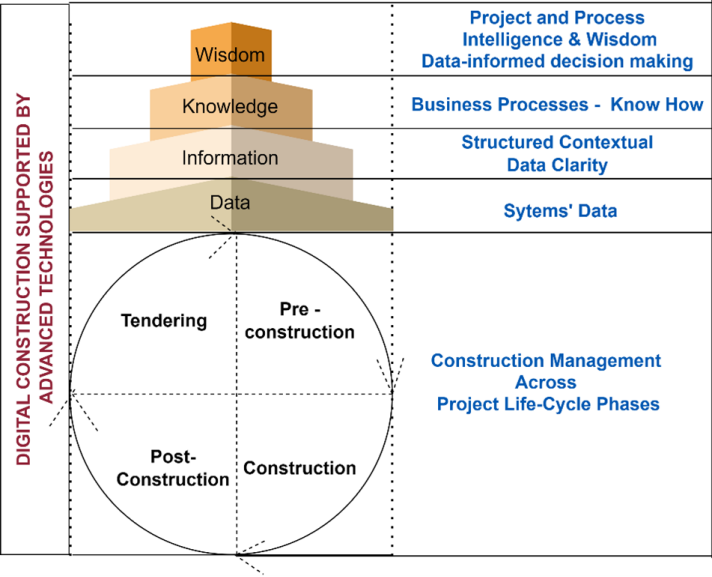
These insights are gleaned from respondents' feedback, particularly focusing on the recent trends in data growth, usability, suitability, and more. Additionally, this research has crafted a conceptual model based on the DIKW hierarchy that aims to support the digital transformation journey

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About the Article

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