



NAC Executive Insights

Materials Management

Key Points

- Materials management is focused on the planning and control of both the quality and quantity of materials and equipment procured and installed on a construction project.
- Materials management on engineering and construction projects differs from that associated with industrial and manufacturing activities.
- Materials management is responsible for the sourcing of engineered equipment, bulk materials, prefabricated materials, consumables, tools, and services.
- Materials management functional organization is described.
- Challenges and benefits of effective material management are summarized.

Introduction

Materials management is focused on the planning and control of both the quality and quantity of materials and equipment procured and installed on a construction project. Materials management activities are undertaken in close coordination with supply chain, logistics, and quality related activities.

Materials management on engineering and construction projects differs from that associated with industrial and manufacturing activities in several important ways:

- Variable construction site locations versus fixed manufacturing plants
- Highly customized single copy output versus repetitive standardized outputs
- Design changes during construction versus fully designed products before manufacturing
- Supply chain built on an ever-changing mix of suppliers versus a more permanent and established supply chain
- Variability in quantities with significant levels of waste versus zero-waste manufacturing approaches
- Variable delivery times versus just-in-time delivery

Despite these differences, materials management is charged with ensuring materials and equipment are procured to support schedule and are available where and when needed. Materials management is typically a core function as part of the overall procurement group. Sister functions include contracts and logistics. In addition, specialized strategic sourcing and supply chain management functions are now seen in more engineer-procure-construct (EPC) organizations, but the opportunities here are just being tapped.

Categories of Materials

Material management, in conjunction with other procurement functions, is responsible for the sourcing and efficient provision of:

- Engineered equipment
 - Electrical (transformers; motors; motor control centers)
 - Control systems (control and relief valves; instrumentation; engineered control systems)
 - Mechanical (pressure vessels; compressors; pumps; heat exchangers; material handling equipment)
 - Piping (valves; fabricated pipe; fittings)
 - Civil/structural (fabricated steel; precast structures; reinforcing steel; engineered buildings)
 - Rolling stock (transit vehicles)
- Bulk materials
 - Sand, gravel
 - Concrete, rebar, embedments, anchor bolts
- Prefabricated materials (prefabricated; preassembled; modules)
- Consumables
 - Water (potable; non-potable)
 - Fuel
 - Industrial gases
 - Offsite power
- Tools
 - Small tools and consumables
 - Construction equipment fleet
 - Specialized construction equipment
- Services
 - Construction services (modular buildings; scaffolding; forms and shoring; welding equipment and supplies)
 - Logistic services (trucking; ocean and river transport; air freight; freight forwarding)

Materials Management Functional Activities

Materials management organizations are typically comprised of the following functional groups:

- Materials control/planning — focused on ensuring materials are available on time and are fully compliant with all contractual requirements when received. They ensure material requirements defined in engineering are complete and that material takeoffs support procurement and construction schedules. They track and report the status of all materials on the project.
- Purchasing — develops requests for quotations (RFQs) and performs the subsequent analysis of the bids received in conjunction with engineering. They will make a recommendation of award

and issue a purchase order with appropriate terms and conditions. Any change orders flow through the purchasing function.

- Expediting — works with suppliers to assure on-time delivery of the right quantities to the right location consistent with the terms and conditions of the contract.
- Quality surveillance of suppliers — assures that materials and equipment are delivered in compliance with the requirements detailed in the purchase order. Quality surveillance collects supplier performance data, providing performance assurance to the contractor and client. Looks for opportunities to improve supplier performance in support of the project.
- Logistics and trafficking — focused on controlling the delivery schedule and cost associated with damage free delivery. Logistics is discussed in more detail in the Executive Insight, Logistics¹.
- Field material management and warehousing — scope varies widely on projects, so it is important that a responsibility matrix is developed at an early stage.

As outlined above, strategic sourcing and contracting (as distinguished from purchasing) are typically sister organizations as part of a broader procurement organization. Logistics will be considered together with other material management activities in this Executive Insight, although it may often represent a distinct organizational element within the broader procurement organization.

The next sections look closer at the materials management functional organizations described above.

Material Control/Planning

Material control monitors the project's material requirements to ensure shortages do not exist that impede construction. Similarly, they seek to avoid overages that impact efficient site laydown, warehousing, and logistics in addition to potentially adding to project costs through increased wastage.

Construction waste reduction represents a significant cost reduction opportunity for the industry today and material control has a key role to play here.

Material control is guided by the overall procurement strategy developed for the project and opportunities which may exist for strategic sourcing.

Material planning works closely with construction to optimize work based on availability of materials. Construction work package requirements are tied back to specific bills of materials and the status and availability of required equipment and materials confirmed.

Material control/planning keeps the project team apprised of material status through the following typical reports:

- Bill of Materials (BOM) status report
- Material allocation and shortages by work package
- Expediting report

¹ Executive Insight, Logistics <https://www.naocon.org/wp-content/uploads/Logistics.pdf>

Modern supply chain dashboards provide up to date information and are part of an integrated supply chain and associated database. The use of artificial intelligence enabled supply chain² “control towers” are just finding their way into the engineering and construction industry build off experience in the industrial sector.

Supply Chain Control Tower

A supply chain control tower, a connected dashboard of data and key metrics, enables organizations to more fully understand and resolve critical issues in real time. Smarter control towers provide end-to-end visibility across the supply chain and when leveraged with advanced technologies, such as AI, break down data silos, reduce manual processes, and deliver real-time actionable insights. Smarter control towers enable collaboration across teams and supply chain partners and leverage knowledge to improve outcomes.

Four levels of control tower capabilities can be defined:

- Level 1 – Visibility of milestones and events across the entirety of the supply chain (including sub-tier critical suppliers)
 - Level 2 – Alerts based on lead times for events and significant milestones
 - Level 3 – Decision support aiding users at multiple levels to make decisions based on intelligent agent recommendations
 - Level 4 – Autonomous execution of the supply chain
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Purchasing

The purchasing function implements the overall procurement strategy³ through a defined set of transactions and importantly provides the structure and consistency that contracts require. In some procurement organizations a separate contracts group may deal with the legal aspects of purchases such as required terms and conditions.

Purchasing activities begin with the development and issuance of an RFQ (request for quotation), which introduces potential bidders to the package of equipment, materials, or services the project requires. It instructs potential bidders on the steps they must undertake in order to be considered for the specific

² Executive Insight, AI Enabled Supply Chain

³ Executive Insight, Procurement Management in Large Complex Projects <https://www.naocon.org/wp-content/uploads/Procurement-Management-in-Large-Complex-Programs.pdf>

procurement. Depending on the nature of the item of supply, an RFP (request for proposal) may be issued and a more detailed response (other than just basic pricing) may be required.

Bidder's proposals in response to either the RFQ or RFP are reviewed by purchasing and other elements of materials management and engineering and a technical and commercial summary prepared. Any omissions or areas requiring clarity are identified to bidders and subsequently a detailed bid analysis is initiated together with engineering.

Materials management's responsibilities during bid analysis include bid clarifications, commercial analysis, confirmation of schedule conformance, terms and conditions exceptions, and logistical requirements or constraints. Purchasing acts to ensure bid confidentiality and identifies any value adding elements of the bidder's proposal.

Purchasing seeks to ensure the greatest value versus lowest price outcome.

Following bid evaluation, a recommendation for award is made, the successful bidder advised, and a purchase order prepared with engineering input and issued. A purchase order is not used when erection or installation of equipment is involved.

Change orders to purchase orders occur when there are changes to price, terms and conditions, quantities, schedule, or technical elements.

Purchasing also manages the disposal of surplus materials.

Expediting

Effective expediting is a proactive function, not a reactive function. Status reporting from the supplier should not just be accepted or only challenged when certain milestones are in trouble. By then it is too late. Proactive expediting involves looking deeper into the supplier's operations and verifying its current assessments and forward forecasts. Expediting must aid the supplier and the project in anticipating problems and taking timely actions to mitigate their impacts.

Expediting resources are allocated based on supplier risk. Is their item of supply on the critical path? Are they undertaking a first of a kind operation (for them) or being required to dramatically ramp up production? Are there elements of their supply chain which we are aware are challenged either by market demands or quality performance issues? High performing suppliers require fewer expediting resources.

Shop expediting visits confirm both progress and forecast.

Supplier Quality Surveillance (SQS)

The objective of supplier quality surveillance^{4 5} is to eliminate rework⁶ and commissioning⁷ delays as a result of quality variances.⁸ Quality surveillance may be a graded effort ranging from limited surveillance (two visits per order) to comprehensive, ranging from four days per week to full 24-hour daily (24x7) presence at the supplier.⁹

A project surveillance plan identifies all equipment and material to be procured for the project that will require surveillance and the associated level of effort based on a graded approach. Any special equipment required for surveillance activities are identified in the plan and requirements for alignment meetings both with engineering and other materials management functions as well as with the supplier are detailed.

Logistics and Trafficking

Logistics is focused on putting in place the strategy and procedures to sequence all types of shipments to a project site. On projects involving modular¹⁰ or extensive prefabrication or preassembly efforts, logistics must address movements to and from those locations, especially if they are contractor controlled. All construction projects require a logistics plan. In many urban areas or operating facilities, zero or near zero onsite laydown or staging may be possible.

Logistics efforts often begin with a series of studies that include route studies that answer the simple question of how best to get from here to there. As load sizes reach or exceed traditional weight limits envelopes, logistics planning becomes even more important. This is especially true as the use of modules has increased.¹¹

Transitions from one mode of transport to another require special attention as do projects located internationally or with extensive international sourcing.

⁴ Executive Insight, Redefining Quality <https://www.naocon.org/wp-content/uploads/Redefining-Quality.pdf>

⁵ Executive Insight, Quality Transformation <https://www.naocon.org/wp-content/uploads/Quality-Transformation.pdf>

⁶ Executive Insight, Rework

⁷ Executive Insight, Project Startup

⁸ Quality rework of piping at the V.C. Summer nuclear plant was a major cause of delays that led to ultimate abandonment of the project.

⁹ In one instance the supplier was taking fully inspected components and placing them in the assembly line to be inspected again (knowing that they would pass inspection) and replacing the inspected components with complete but uninspected ones. 24-7 presence and other measures were necessary to ensure performance. (Note: a viable alternative supplier did not exist)

¹⁰ Executive Insight, Modularization

¹¹ On one modular move that required the nightly closure of two-way traffic on the only access road to a remote site, it was necessary to assemble platoons of modules transported on SPMTs and create turnouts after each night's move.

Field Materials Management and Warehousing

Responsibilities related to field materials management must be clearly spelled out and encompass client, engineering, suppliers, contractors, and the various functional groups of materials management. Materials typically managed by field material management include:

- Tools (small tools and consumables; construction equipment fleet and specialized construction equipment)
- Rental/leased construction and office equipment
- Formwork
- Sand, gravel
- Concrete, rebar, embedments, anchor bolts
- Spare parts

Field materials management builds relationships with local suppliers for ancillary and critical needs and must communicate continuously with construction, suppliers, and the client.

Field materials management begins with the receipt of materials, which in turn begins the control function. Quantities and quality are confirmed and recording and tracking initiated. Bar codes and RFID tracking greatly aid in materials management. Confirmation of quantities and types against short- and medium-term construction materials forecasts helps control the development of onsite material surpluses.¹²

Documentation is checked for completeness and accuracy and any discrepancies noted and resolved.

Field materials management directs the storage of materials and any required special environmental conditions or security. Storage locations are graded with respect to levels of protection and may include:

- Laydown yards
- Warehouses (onsite, offsite; climate controlled or conventional)
- Contractor/supplier warehouses or laydown yards (onsite, offsite)
- Client (spares)

Field management issues requested materials, equipment, and tools to construction consistent with release of construction work packages and associated bill of materials. Generally, issue dates are linked to mobilization dates and attention should be placed on the master schedule to ensure their delineation. Field management must ensure that the labor and equipment required to move materials from storage to the construction workforce are available.

Tracking and reporting of issued materials are linked with their receipt.

¹² Executive Insight, Inventories – A Key EPC Consideration for Achieving Capital Efficiency
<https://www.naocon.org/wp-content/uploads/Inventories-%E2%80%93-A-Key-EPC-Consideration-for-Achieving-Capital-Efficiency.pdf>

Challenges and Benefits of Effective Materials Management

Materials management can be both a source of challenge as well as benefits on a construction project. Common challenges often begin with inadequate planning and poor communications. Owner's requirements must be closely reviewed and costly or impractical ones elevated for resolution at the earliest possible date. The material management organization must be well managed, using strong process and procedural controls that minimize the need for frequent workarounds.

Materials management must provide a proactive focus on expediting and also closely monitor for excessive inventories. Scope¹³ and schedule changes impact material management together with all other construction activities.

Effective materials management is a significant contributor to craft productivity, enabling workforce planning and minimizing rework.¹⁴ Material surpluses, much of which may enter construction waste streams, are reduced and improve overall project cost.

Warehouse and laydown storage areas are minimized through effective materials management as is the risk of damage to stored materials and equipment.

Effective materials management supports schedule performance.

Summary

This Executive Insight has defined materials management as focused on the planning and control of both the quality and quantity of materials and equipment procured and installed on a construction project. Materials management on engineering and construction projects differs from that associated with industrial and manufacturing activities.

The scope of materials management includes the sourcing of engineered equipment; bulk materials; prefabricated materials; consumables; and tools and services, and is undertaken together with engineering and other elements of the procurement organization. The various functions of the materials management functional organization provide insight into the breadth of activities to be undertaken.

This Insight also has summarized the challenges and benefits of effective materials management.

About the Author

Bob Prieto was elected to the National Academy of Construction in 2011. He is a senior executive who is effective in shaping and executing business strategy and a recognized leader within the infrastructure, engineering, and construction industries.

¹³ Executive Insight, Know What You Are Trying to Accomplish: The Primacy of the Scope Baseline
<https://www.naocon.org/wp-content/uploads/Know-What-You-Are-Trying-to-Accomplish-The-Primacy-of-the-Scope-Baseline.pdf>

¹⁴ Studies have shown the potential for 6-12 percent in labor savings.

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