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SUPPLY CHAIN DISRUPTION: *Are You in the Construction or Logistics Business?*

The current transformation of the industry – from the traditional skilled trades production to an industrialized and externalized work environment – is changing the supply chain and its role in construction. Although industry participants may believe that direct material purchases will lower their final cost of construction, this total cost is instead driven by the required accommodations for changes and uncertainties provided by contractors and distributors.

This article will explain various procurement models, their advantages and disadvantages, and their requirements for success.

Procurement Chain Models

"Procurement Chain Management in the Construction Industry" (PCMCI) by MCA, Inc.[1] shed light on the actual cost drivers of construction projects. As shown in Exhibit 1, this research investigated and modeled the various methods of procurement, including the comparative risks, costs, and benefits of each of the procurement models. However, as the current state of production still heavily relies on the skilled trades, some of these procurement models and behaviors may or may not apply to the construction industry.[2]

The three models of procurement identified in the research are:

- *Model 1:* Specialty Contractor Procurement – the subcontractor procures the material, adds profit to it, and carries the labor, warranty, timing, and accuracy.
- *Model 2:* General Contractor Procurement Model – the GC/owner procures the material, and the subcontractor includes a line item for added labor and other risks.
- *Model 3:* Owner Procurement Model – the subcontractor and GC/owner work together to reduce structural costs by collective reduction of the risk and collaborative approach for procurement and labor management.

Based on these findings,[3] direct purchase models do not account for the know-how from the value transfer between distributors and subcontractors (as shown in Exhibit 1).

In other words, the price and profit models used for *purchasing* at each point in the supply chain focus only on the cost of the material and are disconnected from a full understanding of the costs of *procurement*. Examining further impacts and possible models can help industry participants focus on their expertise and improve the logistics, as well as reduce the total cost of material management and handling.

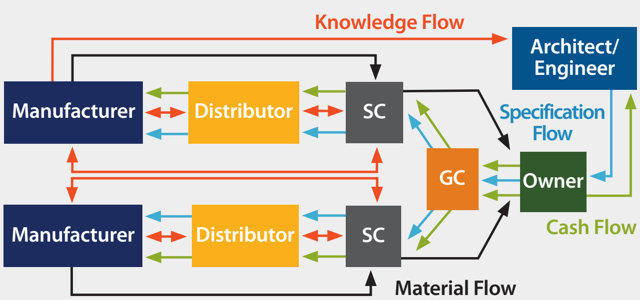
Correctly aligning each business with its core competencies will lead to the best possible outcome for all stakeholders.

Exhibit 1: Data-Based **Procurement**

Per "Procurement Chain Management in the Construction Industry" (PCMCI) by MCA, Inc., the three models of procurement depicted here each carry their own risks to time, cost, and quality, and show the flow of material, cash, specification (technical information), and knowledge among the entities.

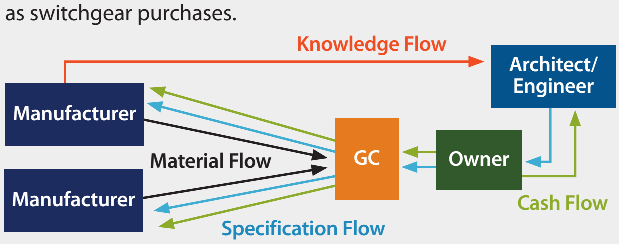
Model 1: Specialty Contractor Procurement Model

The subcontractor procures the material, adds profit to it, and carries the labor, warranty, timing, and accuracy. The research quantified this risk in the scenario of direct purchases and found that an additional 4-5% is needed to cover the cost impacts incurred by the subcontractor. An owner/GC can expect a project duration to be 19% longer when they purchase materials directly, and the owner/occupant of the constructed facility can have a potential 34% cost on top of construction cost due to material- and process-related quality impacts of direct purchases.



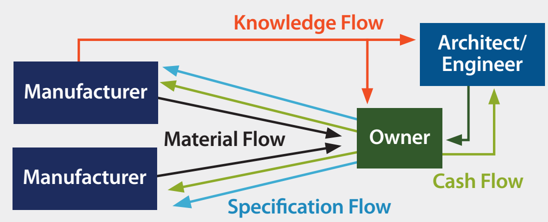
Model 2: General Contractor Procurement Model

The GC/owner procures the material, and the subcontractor includes a line item for added labor and other risks. This model leads to a 4% disadvantage in total cost for fixtures and an 11% disadvantage in total cost for specialty items or equipment, such as switchgear purchases.



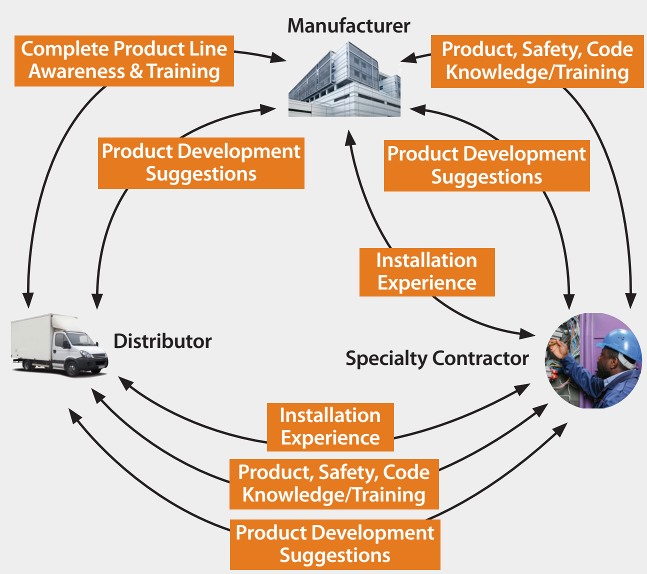
Model 3: Owner Procurement Model

The subcontractor and GC/owner work together to reduce structural costs by collective reduction of the risk and collaborative approach for procurement and labor management. As the ideal procurement model for the end user, this requires both the subcontractor and owner/GC to invest in some upfront collaboration and planning.



Knowledge Flow/Transfer in Model 1

This shows the specific knowledge transfer that occurs in Model 1 between manufacturer, distributor, and specialty contractor.



Source: Daneshgari, Dr. Perry & Harbin, Samuel J. "Procurement Chain Management in the Construction Industry." Mechanical Contracting Education and Research Foundation. 2003.

The answers to the following questions enable future industry participants to design and implement an appropriate supply chain model:

1) What products and services can be offered to transfer value across the supply chain?
2) What will the future supply chain look like following the Industrialization of Construction®?[4]
3) Will another procurement model be needed?
4) What is the impact of prefabrication on jobsite safety and reliability?
5) What is the impact of distributors' services at Generation 2 and 3 (defined later) on final project cost and time?
6) What is the impact on cost, quality, and timing of projects when the distributor and manufacturer get involved earlier?
7) Can we rely on the usage of the scientific work breakdown structure (WBS) at the appropriate level for the contractor, vendor, and manufacturer to reduce the cost of material handling and returns?
8) What is the true cost of returns, including labor, on the supply chain for direct purchases?
9) Will there be a common e-commerce platform to improve information and data flow?
10) Will digitalization, commonization, and interconnectivity (DCI™) have the ability to connect various systems and enterprise resource planning (ERP) software to enable simultaneous access to the information and its flow?

Understanding Procurement

Understanding the cost to the industry and devising a lower cost of material logistic management requires that we *stop* thinking about *material* and *start* thinking about *procurement*. Procurement brings things together from where they are to where they are needed for installation. Data-based procurement accounts for material and information handling for:

- Ordering, over-ordering, and returns
- Receiving, waiting, unloading, and sorting
- Keeping track of back orders and knowing where they are
- Moving material into, within, and out of the jobsite
- Preparing and packaging material for installation
- Reordering lost materials and managing what happens with double orders
- Managing tools and equipment
- Moving to accommodate jobsite condition changes
- Handling delivery mistakes, damages, and storage to be used later

At a high level, the procurement phase of a project can be broken down into four areas:

1) Subcontracts
2) Tools and equipment
3) Materials
4) Tracking

Visibility

Within each of these areas is an expanded WBS (Exhibit 2).[5] Ideally, each of the boxes in the WBS can display data gathered to understand the system. The work associated with procurement and its aftermath, when it doesn't go smoothly, is often not made visible by subcontractors. It is typically included as a line item on the overall project schedule, but lacks the intricate connections that make or break a project's completion, such as:

- Late decisions or changes in decisions by end users
- Unknown or delayed lead times
- Unknown material location or shipping status
- Submittal process and potential delays

All of this information is available somewhere in the construction project process; but, without a collaborative model that focuses on information rather than material costs, these details and connections are overlooked, causing downstream time, cost, quality, and other issues for the owner.

Exhibit 3 shows the process of procurement that a subcontractor should follow for Model 3 to be successful. The procurement process and the segments of material purchasing and services are included because they form the model for collaboration.

The process for effective procurement is designed to promote collaboration within the supply chain; it has very little to do with buying material and nothing at all to do with the lowest material price. This collaborative process is intended to share information for the specific purpose of lowering the total project cost by maximizing the transfer of value to the owner.

Procurement Model 3 Requirements: A Potential for Disruption

Once procurement is understood as a process that transcends buying and selling and the work involved with that process is made visible, then Model 3 can be used successfully. To fully focus on structural cost reduction, the role of distributors and vendors will need to change.

Over the past 20 years, distributors have been asked to move beyond supplying material and into providing services. However, this change to the business model has not been embedded into distributors' technology infrastructures, which is what has allowed them to scale their "buying and selling" over the years.

The services are provided outside of the vendor's ERP systems, making them inconsistent and often unreliable. If they provide services, then they either lose money or don't know the cost of the services well enough to know if they are making money. If they don't provide the services, then they are at a competitive disadvantage.

This situation brings the potential for disruption by a market player that understands the role of knowledge, material, and cash flow from raw goods all the way to building occupancy and maintenance.

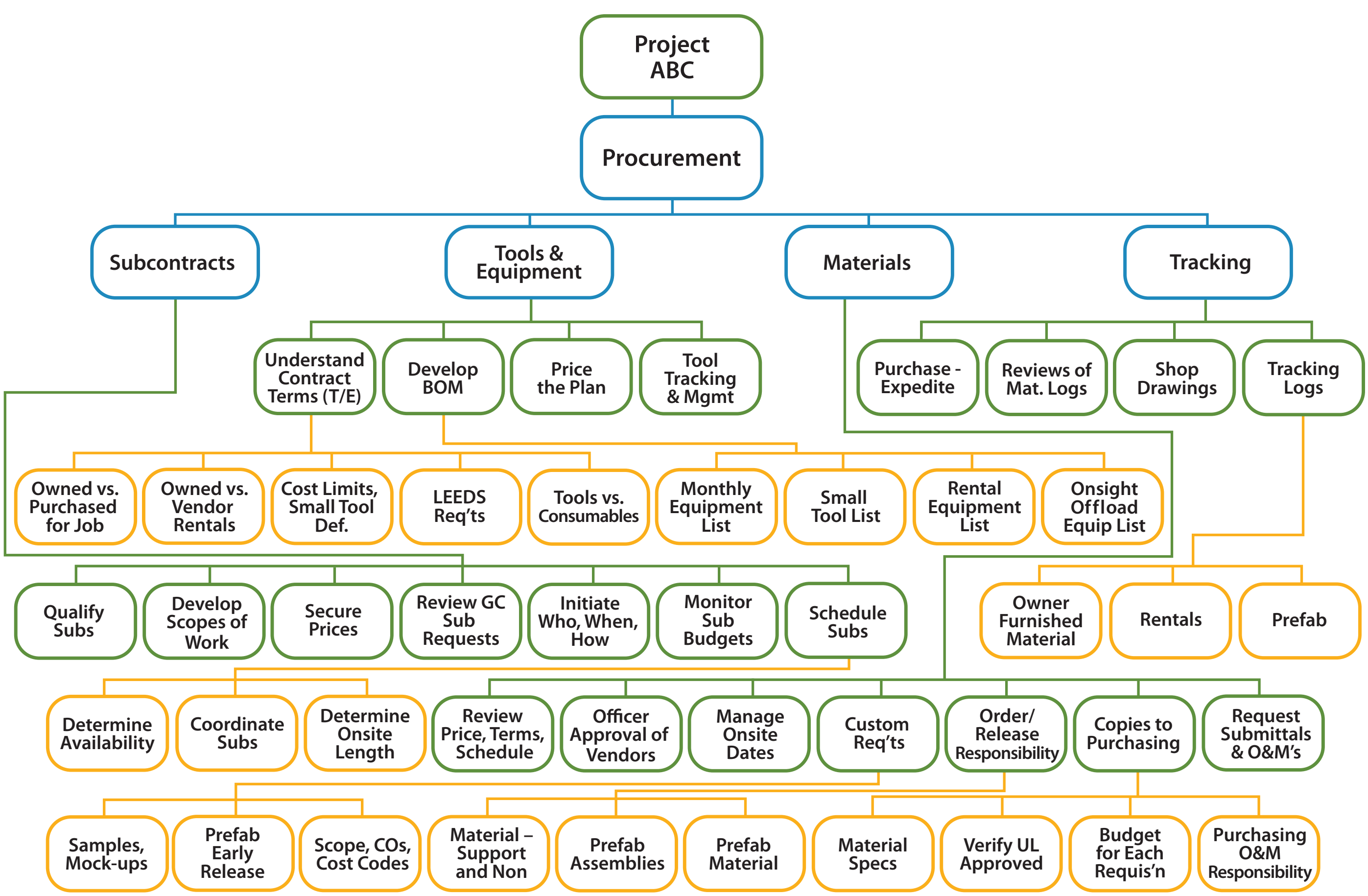
Generations of Distribution Classification

MCA has developed a model for classifying distributors in terms of their ability to support the needs of the installing contractor in a way that transfers value through the contractor to the owner. This classification is scaled from Generations 0-4. Exhibit 4 shows the Generations of Distribution and their current state of evolution.

Generation 0 is simply the point of entry for a supplier to become a distributor of material to the industry. At this point, they must have material to sell.

Generation 1 distributors provide general services that are beneficial to the contractor and help transfer value to the owner; however, these services are provided "blindly"; the distributor is still responding to one-off requests that likely

Exhibit 2: **The Four Segments & Boundaries of Procurement**



aren't bringing the collaboration and lowest total installed cost required for procurement Model 3. Generation 1 shows where the distribution is well represented in today's marketplace.

In Generations 2 and 3, the distributor is customizing solutions for the needs of a particular project and may even begin to proactively engage with the installing contractor to plan and identify ways to lower the owner's total cost.

On the horizon is Generation 4, which has the potential for full supply chain disruption. In this role, the distributor is the logistics provider to the entire construction project, and they use data-driven procurement to directly transfer value to the owner.

In the transition to industrialization of the architecture, engineering, and construction (A/E/C) industry, economic forces are working on all participants in the delivery system of the final project. To stay competitive and reduce the cost while sustaining growth and profitability, every one of the profit pools in the delivery chain are trying to cut costs individually.

The typical doctrine of cutting cost in many industries is to eliminate the middleman from the supply channel; however, this has not proven successful in business to business (B2B) environments like A/E/C. Given the A/E/C industry's supply chain, the contributed services for the final delivery are true transfer of value to the end user; that is, every current contributor in the A/E/C supply channel is performing a task to enable the downstream members to perform their business. This is also why each member's contribution cannot be substituted by another less focused, less competent member without degrading the overall value.

In the current construction supply chain, there is no wasted value transfer except misuse of resources. This waste creates excess capacity, which inherently reduces the capability of the overall project delivery system.

A better model of cost reduction in A/E/C is a collaborative approach to information sharing and cost reduction, reducing waste, and increasing productivity throughout. The delivery cost of the final project is not significantly driven by the profits taken by each individual profit pool (such as electrical con-

Exhibit 3: **The Process of Procurement**

Management Planning Functions

Procurement Plan

Step 1
- Identify risks
  - Business risk
  - Integration risk
  - Technology risk
- Selection of partner
- Kickoff meeting
  - Superintendent
  - Contract manager
  - Purchasing
  - Vendor
  - Tools
  - Safety
- Material management meeting
  - Bill of materials
  - Special handling

Procurement Team Planning Functions

Procurement Schedule

Step 2
- Get overall schedule
  - Completeness
  - Changes
- Develop job strategy
  - Communication with GC/owner
- Factor in lead time for materials
  - Completeness
  - Changes

Job Delivery

Step 3
- Understanding dates and times
- Specific delivery location understanding
- Appropriate vehicle and equipment notification
- Proper notice of delivery
- Proper ID of what is delivered
- Back orders or undeliverables immediately communicated to field
- Field notification of obstacles or site changes to vendor
- Weekly feedback or critique of both what went right and wrong

Procurement Team Management Functions

Job Material Movement & Management

Step 4
- Assume the "how it gets delivered" is correct
- Prepare the location for transport
- Be specific – communicate your needs
- Be realistic based on site conditions
- Ensure vendor is properly equipped
  - one person vs. two people
  - Racks
  - Pallet jacks
  - Lift gates
  - Open trucks

Risks:
- How to deal with delays
- Changing site conditions
- Emergency orders

Returns

Step 5
- Sort/count
- Document (in standard form) – inform PM
- Field schedules pick-up
- Vendor schedule appropriate manpower
- Communicate credit amount to PM
- Verification of credit from vendor (terms of return)

Risks:
- Who is responsible for sorting?
- When/how should returns happen?

Lessons Learned & Post-Mortem

Step 6
- Must be continuous and ongoing communication
- Supervision peer groups
- How well did the plan work? Positives and negatives
- Increased trust to encourage feedback and learning
- Share across the organizational level

tractors' profits on material purchases). Rather, the delivery cost of the final project is significantly impacted by the lack of productivity due to late and incomplete information as well as lack of activity tracking by the electrician.

To remedy the higher cost and cost overruns of the final project, direct purchasing by GCs or owners to reduce costs is counterproductive; without the transfer of knowledge or services provided by the subcontractor and its vendors, the final cost of projects will increase. The better method is full cooperation among all the contributors (Model 3) – especially subcontractors and their vendors in the form of prefabrication and externalization of work from the final installation site, with distributors operating at Generation 2 or beyond and contractors using the process of procurement.

MCA's research[6] identified three key areas that are impacted by members of the supply chain stepping outside of their individual core competencies and attempting to reduce costs in areas in which they do not directly add or transfer value to the final project:

1) Increased material handling time, effort, and cost

2) Time delays and increased project duration

3) Degraded quality, which requires rework and added expenses

In the case of direct purchasing by the owner or GC, *someone must pay for the risk of the material manipulation by the contractor's labor at the point of final installation on the jobsite.* The issue at hand is the required risk management by the subcontractor in order to procure, deliver, adjust, and manipulate the material for final installation, which carries a cost. Unless Model 3 is implemented, the risk and cost must be quantified to the owner. Results from the full report[7] are summarized in the following sections:

Material Handling Cost & Risk

- Organizing material on the jobsite
- Moving material from the storage location to the
installation location
- Unloading the vendor's truck
- Coordinating jobsite material movement
- Kitting materials
- Unboxing materials and handling packaging waste

Exhibit 5 shows a complete list of the activities reported and their percent of labor time expended. In addition to material handling, if the subcontractor is not involved with procurement, then potential costs are incurred for damaged, incorrect, and/or unmatching parts. The total labor adder to the cost of the material/equipment is about 4.5%.

Project Duration Extensions

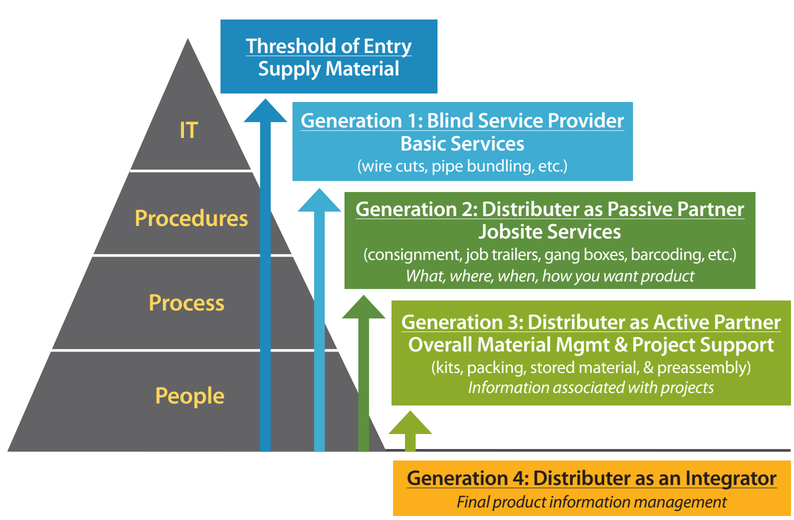
- Scheduling of subcontractor work vs. GC work; if subcontractors are not involved in direct procurement, they will need time (duration in the schedule) after-the-fact for coordination and planning/layout of the material and equipment.
- Time needed for material movement onsite, which will not be known/planned for if material is procured directly unless Model 3 is used to take this into account.
- Usage of vendor facilities for storage and buffers to equipment delays.

The impacts highlighted in Exhibit 5 drive extensions to schedule duration. For example, as shown in Exhibit 6, in a 349-day schedule, about 17 additional days will be needed for scheduling, project management, and equipment coordination; about 22 additional days will be needed to move the material onsite; and another 28 days due to lack of access/usage of vendor's facilities will be needed for major equipment and material storage. This amounts to an approximate 19% increase in schedule duration.

Quality Impacts

- Lack of subcontractor knowledge transfer from purchase to installation. MCA's data on productivity measurement

Exhibit 4: **Distribution Industry Disruption**



shows that this can be up to 2% of the original budgeted hours for the project.

- Matching site conditions with labor needs, which may mean access to the areas needed for movement, storage, or installation; not having the optimal equipment available for rigging and mounting; or even the electrical means and methods such as feeder pulls or terminations.
- Warranty issues, independent of their cost to fix.
- Function, packaging/manipulation, and durability/reliability issues. Quality issues with the product itself cannot be inspected or guaranteed by the subcontractor without their direct involvement.

Exhibit 5: **Categories of Material Handling Activities, Highlighting Those That Contribute to Additional Project Duration If Not Planned & Conducted By the Subcontractors for Direct Purchases**

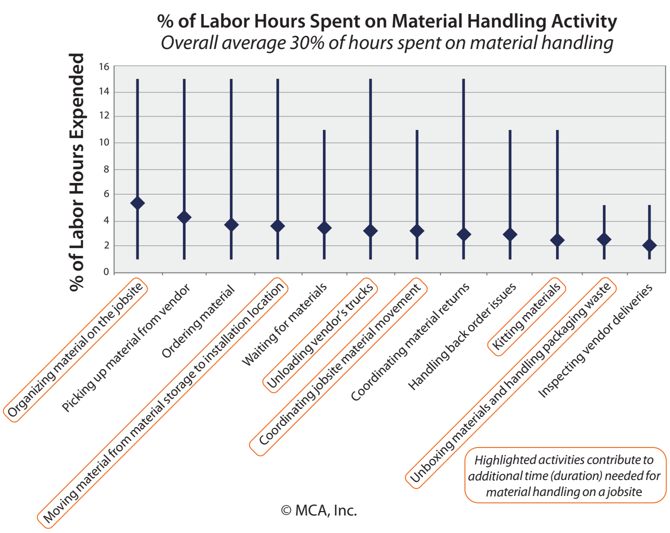


Exhibit 6: **Example Calculation of Time Impacts of Owner/GC/CM Direct Purchases**

EC Time Impacts of Owner/GC/CM Direct Purchases	
Total project schedule duration (days)	349
Scheduling of EC work vs. GC work (days)	17.45
Time needed for material movement onsite (days)	*22.31*
Usage of vendor's facilities	*28*
Total schedule duration added (days)	**67.76**
Added duration as percent of planned schedule	**19%**

Exhibit 7 indicates the time, cost, and quality impacts of direct purchasing. This is just one example scenario where electrical fixtures and switchgears are purchased directly.

Conclusion

At the end of the day, the most productive job is the most profitable one. And the one with the best collaboration and planning to utilize the competencies and expertise of each stakeholder is always the most productive. When the total project cost and tolerated waste are minimized by all involved, everyone makes money.

To achieve this goal, each stakeholder must perform the duties that they are uniquely most capable and equipped to perform, while leaving others to perform the duties of which they are also most capable. ■

Endnotes

1. Daneshgari, Dr. Perry. "Procurement Chain Management in the Construction Industry." ELECTRI International and MCA, Inc. February 2004. *electri.org/product/procurement-chain-management-in-the-construction-industry* and Daneshgari, Dr. Perry. "A Research Study to Investigate the Value-Transfer of Subcontractor Procurement." ELECTRI International. June 2018. *electri.org/product/a-research-study-to-investigate-the-value-transfer-of-subcontractor-procurement.*

2. Daneshgari, Dr. Perry. "A Research Study to Investigate the Value-Transfer of Subcontractor Procurement." ELECTRI International. June 2018. *electri.org/product/a-research-study-to-investigate-the-value-transfer-of-subcontractor-procurement.*

3. Ibid.

4. Daneshgari, Dr. Perry & Moore, Dr. Heather. "Industrialization: Is Construction Next?" *CFMA Building Profits*. January/February 2020. *www.cfmabponline.net/cfmabp/20200102/MobilePagedArticle.action?articleId=1645219.*

5. Daneshgari, Dr. Perry. *Agile Construction® for the Electrical Contractor*. MCA, Inc. April 22, 2010.

6. Daneshgari, Dr. Perry. "A Research Study to Investigate the Value-Transfer of Subcontractor Procurement." ELECTRI International. June 2018. *electri.org/product/a-research-study-to-investigate-the-value-transfer-of-subcontractor-procurement.*

7. Ibid.

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Exhibit 7: **Example Calculation Summary of Time, Cost & Quality Impacts to Overall Project for Direct Purchases**

EC Summary Impacts of Owner/GC/CM Direct Purchases			
EC contract value	$10,000,000		
Overall fixture & gear purchase	$2,000,000		
EC markup "saved" if purchased directly	$270,000		
Cost adder for direct purchase	$436,531	4.4%	Adder to contract value
Time adder (# days)	68	19%	Adder to project schedule duration
Quality risk (% of contract value)	$3,376,923	34%	Potential cost for quality issues during occupancy/usage