SUPPLY CHAIN DISRUPTION

A RESEARCH STUDY TO INVESTIGATE THE VALUE-TRANSFER OF SUBCONTRACTOR PROCUREMENT

ELECTRI INTERNATIONAL
THE FOUNDATION FOR ELECTRICAL CONSTRUCTION INC.

Conducted by Dr. Perry Daneshgari, President & CEO, MCA, Inc.
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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The "Winds of Change" are upon us. Specific to the construction industry over the past two decades, shifts in the Markets, Industrialization, and Disruption are having an impact on the way this industry is managed and run. Due to these changes, industry customers believe that direct purchases of material will lower their end-cost of construction. Contrary to this common belief, the variation of the cost of material has less impact on the final variation of cost of construction and its budget. It is the required services to accommodate the late changes and scheduling variations as well as the discrepancies mentioned in this research provided by Electrical Contractors and Distributors, which have the highest impact on the final cost of construction. As generations of distribution evolve the price as well as perceived advantages of direct purchasing have very little to do with the final installed cost. The cost of final construction is driven by the required accommodations of the changes and uncertainties provided by the contractors and distributors.

ELECTRI International commissioned MCA, Inc. to update its 2004 study *("Procurement Chain Management in the Construction Industry" (PCMCI))*, taking into account current industry conditions and the recent resurgence of owner and GC-direct purchasing of electrical material and equipment. The PCMCI research had investigated and modeled various methods of procurement, including the comparative risks, costs, and benefits of each. The motivation and background from the original PCMCI research still holds true, and MCA believes this behavior is advocated based on models used by Dell and other manufacturing-based companies, through recommendations of consulting companies *(e.g., McKinsey)*.

The research identified three models of procurement:

MODEL 1

Subcontractor procures the material, adds profit to it, and carries the labor, warranty, timing and correctness risk

MODEL 2

GC/owner procures the material and the subcontractor includes a line item for added labor and other risks

MODEL 3

Subcontractor and GC/owner work together to reduce structural costs by collective reduction of the risk and collaborative approach for procurement and labor management

Each of these three models has risk and impacts in the categories of time, cost, and quality. The research quantified this risk in the scenario of direct purchases, and found a **4-5%** adder is needed to cover the cost impacts. In addition, an owner/GC can expect a **19%** longer project duration when they purchase directly, and the owner/occupant of the constructed facility can have a potential **34%** cost on top of construction cost due to quality impacts of direct purchases.

For the end user, the optimal model for procurement is Model 3. However, this model requires some upfront collaboration and planning investment between the electrical contractor and GC/owner. The research found Model 2 (direct purchases by the owner/GC) leads to a **4%** disadvantage in total cost for fixtures, and an **11%** disadvantage in total cost for switchgear purchases.

Based on findings from MCA, Inc.'s previous research and findings from this research, the direct purchase models do not take into account the know-how of the value transfer between distributors and specialty contractors. In other words, there is more to the model than just "markup" and material dollars. The price and profit models used for purchasing at each point in the supply chain are disconnected from a full understanding of the costs of procurement.

Future research and implementation opportunities were also identified in this process, including:

IMPLEMENTATION

- Electrical contractors testing the models herein for validation
- ECs determining if the quantification can be used to explain the advantages and disadvantages of direct purchasing to their customers (GCs and owners)
- ECs using the research results to educate their own people on the procurement models

RESEARCH

- What are the products and services that can be offered to transfer value across the supply chain?
- What will the future supply chain look like in the age of Industrialized Construction®? Will another procurement model be needed?
- Impact of Prefabrication on jobsite safety and reliability
- Impact of Distributors' services at Generation II and III on final project cost and time
- Impact of Distributor and Manufacturer early involvement in cost, quality and timing of projects
- Usage of scientific Work Breakdown Structure at the EC, Vendor and Manufacturer levels to reduce the cost of material handling and returns
- Cost of returns on the supply chain for direct purchases

INTRODUCTION

In the transition to Industrialization of the Architecture, Engineering and Construction (AEC) industry, economic forces are working on all the 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 is trying to cut cost individually. Historically, one of the methods used to cut cost in any industry is the elimination of the middleman in the supply channel.

As true as it may be in the retail industry, usage of this doctrine has not proven successful in the B2B environment such as AEC. The reason for the lack of success of this doctrine in the B2B environment can be attributed to the fact that, in the AEC industry's supply chain, the contributed services for the final delivery are true transfer of value to the end user. In other words every current contributor in the AEC supply channel is performing a task to enable the downstream members to perform their business. There is no wasted value transfer in the current supply chain except misuse of resources, which can create extra capacity reducing the capability of the delivery system.

In other words, a better model of cost reduction in the AEC orbit is a collaborative approach to information sharing and cost reduction by reducing the waste of resources and increasing productivity and throughput. The delivery cost of the final project is not driven by the profits of each individual profit pool such as electrical contractors' profits on the material purchases, but rather lack of productivity due to late and incomplete information as well as lack of activity tracking of the electrician.

To remedy the higher cost and cost overruns of the final project, discrete activities by General Contractors or Owners to reduce costs by direct purchasing is actually counterproductive and will increase the final cost of projects due to not using the services and know-how provided by the EC and its vendors. A better method is full cooperation among all the contributors, especially the EC and their vendors in the form of prefabrication and externalization of work from the final installation site.

In this updated report, MCA researchers have used the existing data from 2004 and verified its findings. Researchers also developed a simple marketing piece for conversations between ECs and their customers as well as a cost-benefit calculator to be used to validate the lower cost to the end user when the EC is the entity which purchases the material and, with the help of its vendors, ensures lower cost and risk to the final installation site.

THREE MODELS FOR OWNER-DIRECT PURCHASING

Combining the findings from this research, and the verified 2004 research results, the common thread is that someone has to pay for the risk of the manipulation by the 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. **This risk can be mitigated through one of these three models:**

MODEL 1

Subcontractor procures the material, adds profit to it, and carries the labor, warranty, timing and correctness risk

MODEL 2

GC/owner procures the material and the subcontractor includes a line item for added labor and other risks

MODEL 3

Subcontractor and GC/owner work together to reduce structural costs by collective reduction of the risk and collaborative approach for procurement and labor management

Like any process, buffers are put into place in the construction supply chain to reduce the risk and ensure predictability of the final outcome. Every buffer requires energy to maintain and ensure its role as a risk-reducer. Just like a *"Windkessel"* which is used in the pipeline to reduce the pulsation and hence ensure smooth outflow of the liquid, buffers in the process of material supply and the construction procurement chain are put in place to ensure the smooth final assembly of the construction project.

Buffers will become less necessary if input and outcomes are more predictable. In the case of the electrical material supply channel, the role the electrical contractor plays is that of the final *"Windkessel"* of the pipeline. If the correctness of the following could be ensured, the role the EC plays in reducing the impact of these risks will be diminished. The electrical contractor is the final buffer to reduce the risk to the owners and users and ensures correct installation in spite of many degrees of freedom impacting the jobsites.

1. **Engineering**
2. **Drawings**
3. **Timing**
4. **Schedule**
5. **Delivery**
6. **Coordination among the trades**
7. **Human resource risks and variation**
8. **Safety**
9. **Weather**
10. **Inspections and government regulations**
11. **Building operation, maintenance, and usage**
12. **Project dysfunction**
    a. *Conditions / overall oversight*
    b. *You don't know until you get to it*
13. **Qualified workforce**

IMPACTS OF OWNER-DIRECT PURCHASING

When an owner or GC purchases material directly, there are risks and advantages/disadvantages in terms of cost, time, and quality. The potential impacts of these risks are explained below.

COST IMPACTS

There are three primary cost impacts that an EC may incur when material is purchased directly:

- **MATERIAL HANDLING COST.** *This cost is incurred for any labor associated with getting material and equipment from the manufacturer to the final installation location. Depending on the complexity of the equipment and material and the jobsite, this cost is between 10-20% of the total cost of fixtures and switchgear.*
- **POTENTIAL COST OF RISK IN DAMAGED, WRONG, AND/OR NON-MATCHING PARTS.** *This cost is incurred when the EC is responsible for the labor involved to address, research, and correct warranty or non-warranty related issues with the material and equipment.*
- **INSURANCE COST.** *If the material or equipment needs to be insured prior to final installation, the EC incurs this cost.*

A sample of these impacts is shown in ***Table 1*** to the right. Based on the sample numbers used, this project requires a **4.37%** adder to the project's contract value to cover the cost-related impacts.

Table 1: Example calculation of cost impacts of Owner/GC/CM direct purchases

EC Cost Impacts of Owner/GC/CM Direct purchases *Gray cells to be completed by EC; italicized are calculated values*	
Contact Value	$10,000,000
Labor Cost	$5,000,000
Material Cost	$3,500,000
Composite Rate	$60
Labor Hours	*$83,333*
Switchgear Cost	$800,000
Fixture Cost	$1,200,000
Total Material Handling Cost	*$1,000,000*
Switchgear Handling Cost (assuming EC does)	***$130,612***
Fixture Handling Cost (assuming EC does)	***$195,918***
Warranty LABOR cost as % of CV	$50,000
Potential cost of risk in damage, wrong and unmatching parts	***$50,000***
Insurance cost as of material cost	$10,000
Insurance cost	**$10,000**
Total Cost Impact (as % of gear/fixture material cost)	**$436,531**
Cost as % of Gear & Fixture Cost	**22%**
% adder needed to contract to recover the costs	**4.37%**

TIME IMPACTS

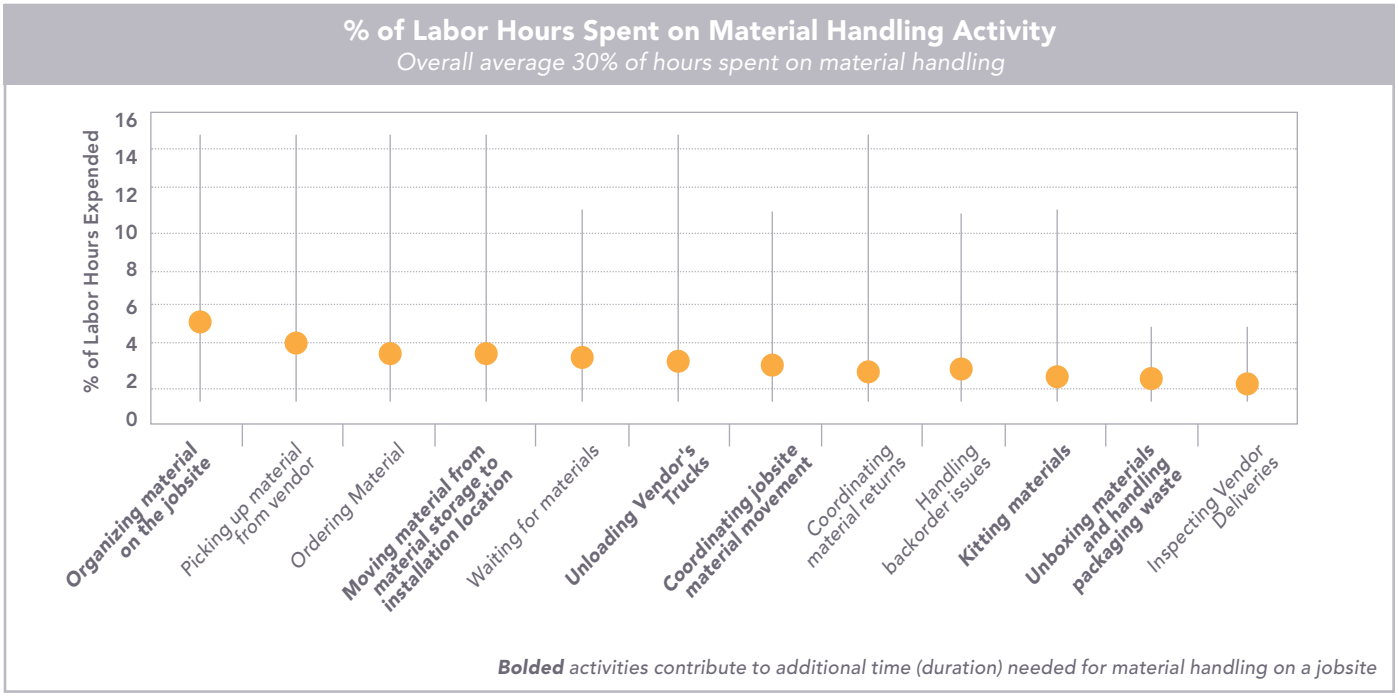
There are three impacts to time of project delivery when an owner or GC purchases material or equipment directly:

- **SCHEDULING OF EC WORK VS. GC WORK RELATED TO MATERIAL AND EQUIPMENT PROCUREMENT.** *A project typically requires 5% of its duration to be dedicated to project management and support for fixture and gear coordination. If the EC is not involved in equipment procurement, this time in the form of duration is going to be added after the fact, without having been planned by the EC.*

- **TIME NEEDED FOR MATERIAL MOVEMENT ONSITE.** *About two-thirds of material handling activities on a jobsite are related to material movement (see Figure 1). This handling time will not be built into the EC's work breakdown or project schedule and will add to the total job duration regardless of who does it.*

- **USAGE OF VENDOR'S FACILITIES.** *When equipment or material is procured by an EC, they manage the buffer of time from submittals through delivery, often using the vendor's facilities or information for storage. If the EC is not involved with the procurement process, the gear/fixtures could be subject to delay, leading to overall project delay.*

Figure 1: Categories of material handling activities, highlighting those that contribute to additional project duration if not planned and conducted by the EC for direct purchases.



A sample of time-related impacts is shown in ***Table 2***. The example project shows a **19%** adder to the sample project's duration when material and equipment are purchased directly.

Table 2: Example calculation of time impacts of Owner/GC/CM direct purchases

EC Time Impacts of Owner/GC/CM Direct Purchases *Gray cells to be completed by EC; italicized are calculated values*	
Total project schedule duration	349 days
Scheduling of EC work vs. GC Work	17.45
Time needed for material movement onsite	*22.31 schedule days*
Usage of vendor's facilities	*28 schedule days*
Total Schedule Duration Added	**67.76**
Added Duration as % of Planned Schedule	**19%**

QUALITY IMPACTS

The quality impacts resulting from direct purchases are related to risks and potential costs due to issues and errors with the product or installation. **These impacts are not as simple to quantify but are explained below.**

- **LACK OF EC KNOWLEDGE TRANSFER FROM PURCHASE TO INSTALLATION.** *Due to lack of knowledge, the EC may make installation errors that are caught at the time of installation, during punch list or, worst of all, after the structure is turned over. Some contractors call this "go-backs", which are non-warranty-related calls that the GC, or building owner/occupant would require up to a year after the structure is complete. MCA's data on productivity measurement show this can be up to 2% of the original budgeted hours for the project.*

- **MATCHING SITE CONDITIONS WITH LABOR NEEDS.** *Since the EC is not involved in the procurement, the company cannot prepare their resources adequately for what to do when the equipment or material shows up. This may mean access to the areas needed for movement, storage, or installation, not having the optimal equipment available for rigging, mounting, or even the electrical means and methods such as feeder pulls or terminations.*

- **WARRANTY ISSUES, WHICH ALSO DRIVE COST AS LISTED IN SECTION 4.1.** *However, warranty issues themselves, independent of their cost to fix, are a quality impact.*

- **FUNCTION, PACKAGING/MANIPULATION, AND DURABILITY/RELIABILITY ISSUES.** *When the EC is involved, these items are ensured based on the full knowledge of the site and work required to take the delivered material through to final installation. Without EC involvement, the material or equipment may not function as desired and no one would know until the fixtures are hanging. Switchgear may show up in five different parts and pieces that don't match or lamps may come with ballasts that go bad before the job even finishes. These quality issues with the product itself cannot be inspected or guaranteed by the EC without their direct involvement.*

If the EC needs to support any follow up work on equipment or material, due to lack of involvement on the initial purchase and design/specification of the material, the EC will incur unnecessary cost to learn the products themselves in order to work on them.

According to NIST, **65%** of the total cost of construction to an owner is incurred post-construction.[1] They will require an electrician to do a portion of this work, and the EC will not have the first-hand knowledge of the equipment and material. ***Table 3*** below shows a sample of potential quality-related costs for the sample project used in Tables 1 and 2.

Table 3: Example calculation of quality impacts of Owner/GC/CM direct purchases

EC Quality Impacts of Owner/GC/CM Direct Purchases *Gray cells to be completed by EC; italicized are calculated values*	
Expected go-backs for covering product or installation defects	$300,000
Anticipated additional work for lack of product knowledge at purchase	$3,076,923

For the sample project, the time, cost, and quality impacts of direct purchasing are shown in ***Table 4,*** including the percent adders needed to cover the EC's lack of involvement in the procurement.

Table 4: Example calculation summary of time, cost, and 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

[1]Gallaher, et al. (2004). Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry. National Institute of Standards and Technology, U.S. Department of Commerce Advanced Technology Program, Gaithersburg, MD.

MODEL EVALUATION

Based on the impacts listed in Section 4, a comparison can be made for the total cost of the three models for direct purchasing listed in Section 3, and below here:

MODEL 1

Subcontractor procures the material, adds profit to it, and carries the labor, warranty, timing and correctness risk (Table 5)

MODEL 2

GC/owner procures the material and the subcontractor includes a line item for added labor and other risks (Table 6)

MODEL 3

Subcontractor and GC/owner work together to reduce structural costs by collective reduction of the risk and collaborative approach for procurement and labor management (Table 7)

Based on findings from interviews and a survey conducted for this research with contractors, distributors, and manufacturers, the tables below show a comparison of costs for each Model.

A comparison of Model 1 and Model 2 shows there is approximately a **4% disadvantage in total cost for fixtures to be purchased directly, and 11% disadvantage in total cost for switchgear to be purchased directly.** These are cost comparisons only and do not account for the time and quality risks explained in Section 4. Other sample models for various job sizes are shown in Appendix F.

Table 4 – Model 1

	Fixtures	Switchgear
Purchase Price	$2,000,000	$2,000,000
Subcontractor Markup[1]	$300,000	$300,000
Total Cost	**$2,300,000**	**$2,300,000**

Table 5 – Model 2

	Fixtures	Switchgear
Purchase Price	$2,000,000	$2,000,000
Subcontractor Risk Factor for Direct Purchase	20%	23%
Cost of Covering Sub's Risk	$400,000	$460,000
Total Cost	**$2,400,000**	**$2,460,000**

Table 6 – Model 3

	Fixtures	Switchgear
Purchase Price	$2,000,000	$2,000,000
Structural Cost Reduction Potential[1]	$475,429	$762,571

FUTURE RESEARCH

One additional outcome from this research is a list of future research for quantifying the actual hidden services provided by the EC and their vendors. **The suggested and recommended future research topics include:**

- *Impact of Prefabrication on Jobsite Safety and Reliability*
- *Impact of Distributors Services at Generation II and III on Final Project Cost and Time*
- *Impact of Distributors and Manufacturer Early Involvement in Cost, Quality and Timing of Projects*
- *Usage of Scientific Work Breakdown Structure at the EC, Vendor and Manufacturers' Levels to Reduce the Cost of Material Handling and Returns*
- *Cost of Returns on the Supply Chain for Direct Purchases*
- *What products and services can be offered to transfer value across the supply chain?*
- *What will the future supply chain look like in Industrialized Construction®? Will another procurement model be needed?*

These future research topics can provide better insight for the true cost, quality and timeliness of the material flow by value transfer to the final user.

In addition to pure research, applied research can be accomplished through testing and implementing the results of this study, including:

- *Electrical contractors testing the models herein for validation*
- *ECs determining if the quantification can be used to explain the advantages and disadvantages of direct purchasing to their GC and owner customers*
- *ECs using the research results to educate their own people on the procurement models*

APPENDIX A
SUPPLY CHAIN DISRUPTION QUICK REFERENCE

Summary letter ECs can use for simple presentation to customers

Like any process, buffers are put in place in the construction supply chain to reduce risk and ensure the predictability of the final outcome. Every buffer requires energy to maintain and ensure its role as a risk-reducer. Just as a "Windkessel" is used in the pipeline to reduce pulsation and hence ensure smooth outflow of the liquid, buffers in the process of material supply and construction procurement chain are put in place to ensure the smooth final assembly of the construction project. The buffers will become less necessary if the input and outcomes are more predictable. In the case of the electrical material supply channel, the role the electrical contractor plays is that of the final "Windkessel" of the pipeline.

If the correctness of the following could be ensured, the role the electrical contractor plays in reducing the impact of these risks will be diminished.

1. **Engineering**
2. **Drawings**
3. **Timing**
4. **Schedule**
5. **Delivery**
6. **Coordination among the trades**
7. **Human resource risks and variation**
8. **Safety**
9. **Weather**
10. **Inspections and government regulations**
11. **Building operation, maintenance, and usage**
12. **Project dysfunction**
    a. *Conditions / overall oversight*
    b. *You don't know until you get to it*
13. **Qualified workforce**

The electrical contractor is the final buffer to reduce the risk to the owners and users, and ensures correct installation in spite of many degrees of freedom impacting the jobsites. ELECTRI International commissioned MCA, Inc. to study the impact of owner-supplied or GC-supplied material and equipment. The investigation focused on evaluating the value transfer throughout the construction supply chain to the end customers. The research found this value transfer is highest in terms of time, cost, and quality, when subcontractors purchase material and equipment themselves.

Assuming the electrical contractor is well equipped to manage the risks, including all of the above-mentioned degrees of freedom impacting the jobsites, then material purchased through the existing channels will result in the lowest energy required to supply the material. If these buffers, that is the electrical suppliers and electrical contractors, are removed from the procurement chain and the input and outcome stability are not ensured, the cost of owner or GC purchased material to the final project will be much higher.

The research studied and quantified three options for owner/GC direct purchases, based on the original models developed in the 2003 Procurement Chain Management research MCA had conducted for ELECTRI:

- ***Subcontractor procures the material, adds profit to it, and carries the labor, warranty, timing and correctness risk***
- ***GC/owner procures the material. The subcontractor includes a budget item for added labor and other risks***
- ***Subcontractor and GC/owner work together to reduce structural costs by collective reduction of the risk and collaborative approach for procurement and labor management***

Below is a cost comparison of ***Model 1*** vs. ***Model 2*** using switchgear and light fixtures as examples. The calculated values are based on the median values of the labor risk as quantified in the ELECTRI research.

Model 1

	Fixtures	Switchgear
Purchase Price	$2,000,000	$2,000,000
Subcontractor Markup	$300,000	$220,000
Total Material Cost	**$2,300,000**	**$2,220,000**

Model 2

	Fixtures	Switchgear
Purchase Price	$2,000,000	$2,000,000
Subcontractor Risk Factor for Direct Purchase	20%	23%
Cost of Covering Sub's Risk for indirect purchases	$400,000	$460,000
Total Cost	**$2,400,000**	**$2,460,000**

The risks carried by a subcontractor when the owner or GC buys direct lead to additional cost, time (duration), and quality implications for a project. The table above only accounts for the labor cost risk. **The additional elements comprising each risk are listed below:**

COST

- *Material handling*
- *Labor to resolve post-purchase material issues, such as damage, incorrect, or non-matching parts*
- *Insurance cost*

TIME

- *Additional time (duration) not built-in for coordination of gear & fixtures*
- *Additional time (duration) needed to handle/move material onsite when it could have been accomplished externally*
- *Additional dedicated time and space needed for onsite fixture & switchgear storage onsite, that could have been done externally with VMI*
- *These factors add an average of 19% to the overall project schedule duration when material is purchased direct.*

QUALITY

- *Expected go-backs for covering product or installation defects*
- *Anticipated additional work for lack of product knowledge at purchase*

These factors add an average of 34% to the cost of occupancy and usage by the owner.

There have been considerable "Winds of Change" in the construction market over the past two decades, including shifts in the Market, Industrialization, and Disruption. Because of this, more and more customers believe direct purchases of material will lower their end-cost of construction. Contrary to this common belief, the variation of the cost of material has less impact on the final variation of cost of construction and its budget. It is the required services to accommodate the late changes and scheduling variations as well as the discrepancies mentioned on page one provided by Electrical Contractors and Distributors, which have the highest impact on the final cost of construction. As generations of distribution evolve the price as well as perceived advantages of direct purchasing have very little to do with the final installed cost. The cost of final construction is driven by the required accommodations of the changes and uncertainties provided by the contractors and distributors.

Additional detail and statistical analysis are available in the final report published by ELECTRI International.

APPENDIX B
KEY RESULTS FROM 2004 PCMCI RESEARCH

The original PCMCI research was motivated by the same symptom occurring today, namely direct purchases by owners and GCs. MCA, Inc. found that alternative procurement models were being sought, due to the dissatisfaction of the time, cost, and quality of construction for end users. **The research led to development and evaluation of three procurement models:**

1. **SPECIALTY CONTRACTOR PROCUREMENT MODEL (SCPM)**
2. **GENERAL CONTRACTOR PROCUREMENT MODEL (GCPM)**
3. **OWNER PROCUREMENT MODEL (OPM)**

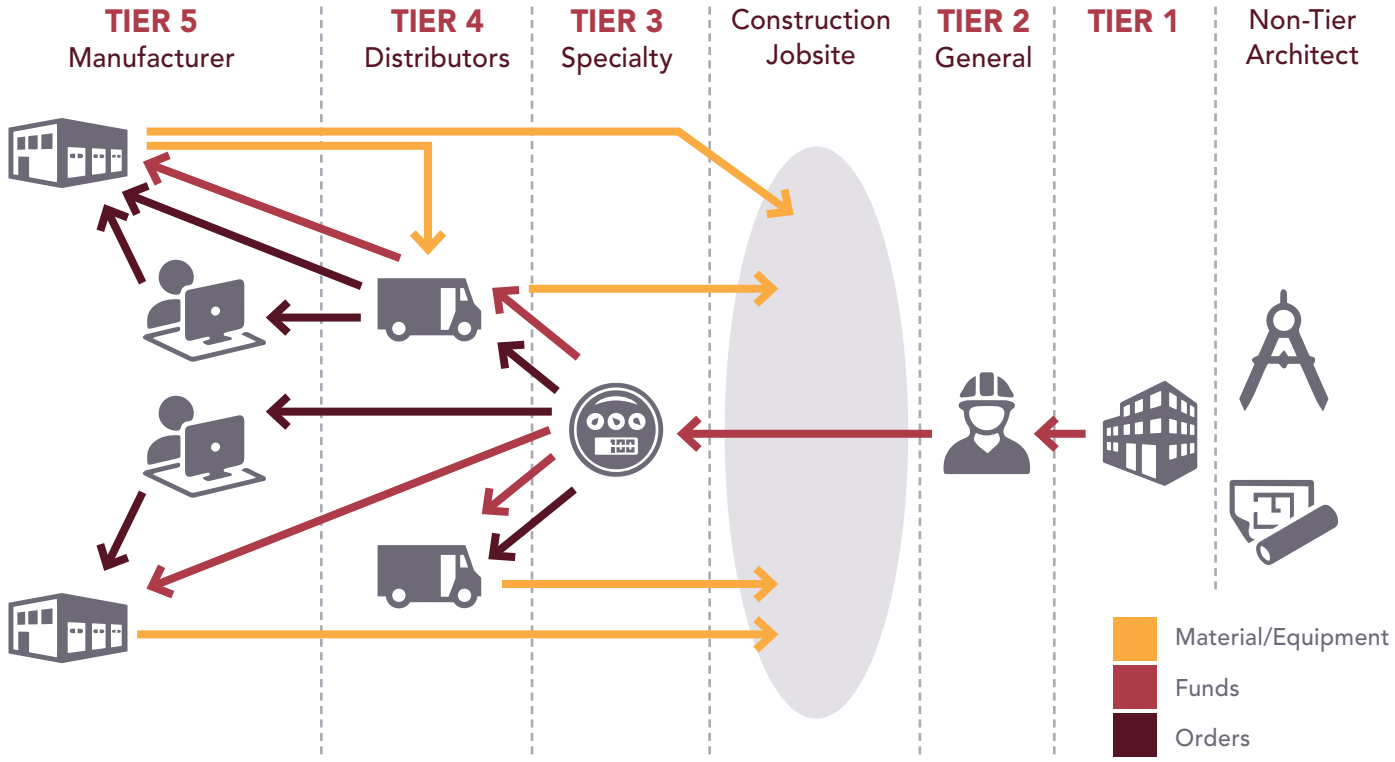
The tables and figures below show the definition and flow of each model, the services offered in each model, and the cost/savings of each model. Each supply chain model is defined by the method in which transfers are handled. The transfers between each tier can be categorized into three major groups: ***Tangible; Service; Knowledge.***

The 2004 report ultimately recommended a horizontal supply chain model as an alternative and as the best model for time, cost and quality.

Table B-1

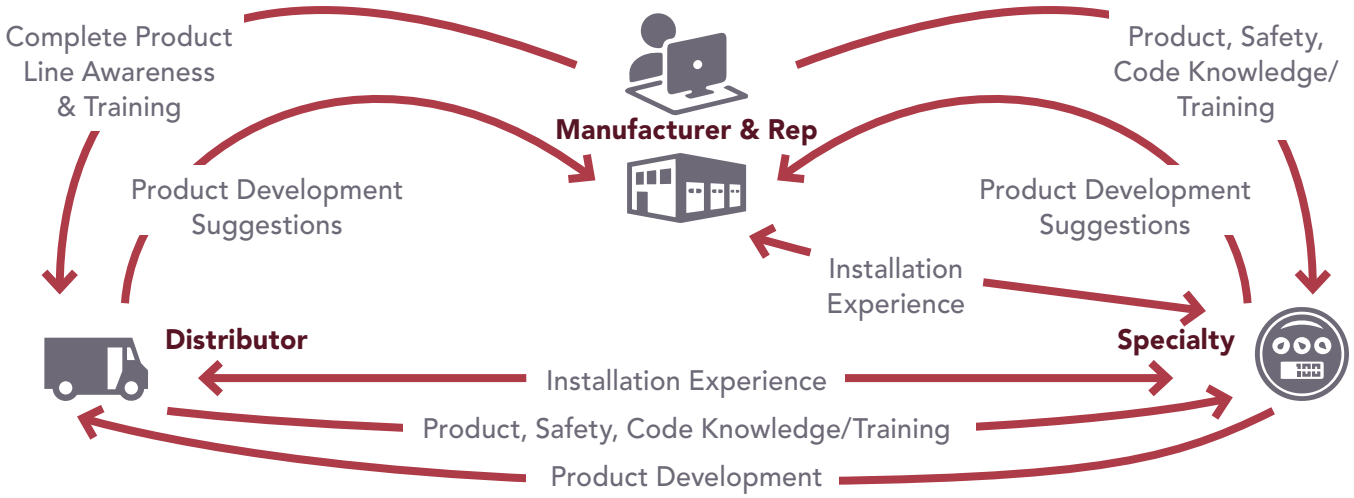
	Definition	Cost	Time	Quality	Customer Benefits
Specialty Contractor Procurement Model (SCPM)	Specialty contractor procures material and equipment for the project owner.	Material and equipment cost are similar between SCPM and GCPM.	Material and equipment cost are similar between SCPM and GCPM. Procurement occurs once specialty contractor is selected.	The overall quality in this model is above average. Problems and delays occur less frequently than in GCPM or OPM.	This model offers high value for project owners with relatively low risk.
General Contractor Procurement Model (GCPM)	General contractor procures material and equipment for the project owner.	Material and equipment cost are similar between SCPM and GCPM.	Procurement can occur before SC is selected.	The overall quality in this model is average. Problems and delays occur much more frequently than SCPM or OPM.	This model offers average value to the project owner with relatively high risk.
Owner Procurement Model (OPM)	Project owner procures material and equipment.	Material and equipment cost are slightly less expensive than SCPM or GCPM.	Procurement can occur before the GC or SC is selected.	The overall quality in this model is average. Problems and delays occur more frequently than SCPM, but less frequently than GCPM.	This model offers highly variable value to the owner depending on the type of project owner.

Figure B-1: Basic flow of material/equipment, funds, and orders in SCPM with a single specialty contractor



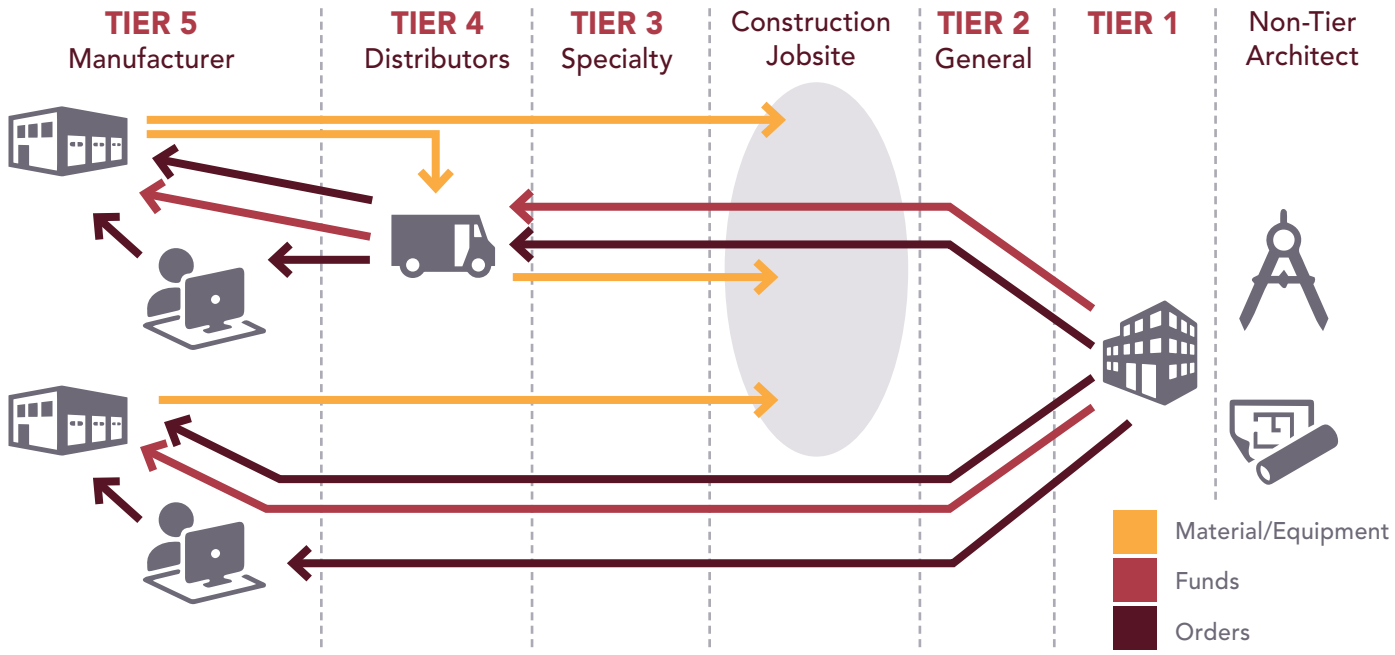
Depending on the manufacturer, the specialty contractor (SC) may order material through a manufacturing representative or distributor. If the SC orders through distribution, the distributor may supply material from stock, order material from the manufacturer, or have the manufacturer supply directly to the customer.

Figure B-2: Knowledge transfer which takes place in the SCPM



A constant flow of experience, knowledge, and training occurs in the SCPM.

Figure B-3: Basic flow of material/equipment, funds, and orders in the OPM



In the OPM, owners order material through manufacturing representatives, distributors, or directly from the manufacturer. Material is supplied by either the distributor or manufacturer.

Figure B-3: Basic flow of material/equipment, funds, and orders in the OPM

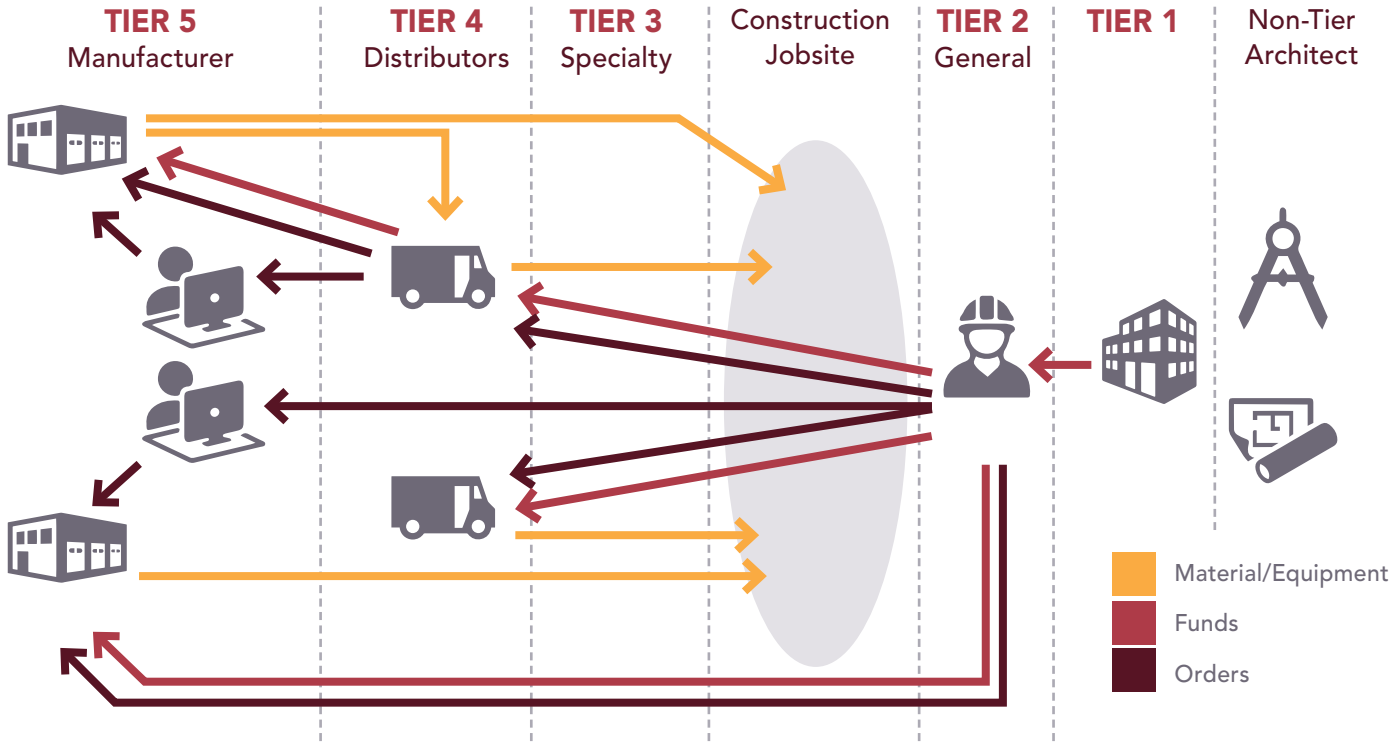


Table B-2: Services available from each member of the procurement chain in the SCPM

General Contractor	Specialty Contractor	Distributor	Manufacturer
• Coordination Amongst Trades • Intermediary for Information, Specifications, and Problems	• Formal/Informal Design Optimization • Material Management • Product Knowledge • Installation/Product Experience • Freight Management • Packaging Management	• Material Kitting • Minimal or No Restocking Fees • Free Delivery • Just-in-Time Delivery • Inventory Buffer for Manufacturer • Sales and Service for Manufacturer • 24/7 Customer Service • Crib Management • On-site Storehouse • Free Design Consulting • Free Bid Assistance • Immediate Product Replacement - Warranty • Single Source Supplier for 100's of Manufacturers • Product Training • Shared installation Experience with Multiple Contractors • Product Awareness • Application Experience	• Software for Tracking, Billing, Pricing, etc. • Product Knowledge & Support • Product Training • Product Awareness • Application Experience

Table B-3: Services available from each member of the procurement chain in the GCPM

General Contractor	Specialty Contractor	Distributor	Manufacturer
• Coordination Amongst Trades • Intermediary for Information, Specifications, and Problems			• Software for Tracking, Billing, Pricing, etc. • Product Knowledge & Support • Product Training • Product Awareness • Application Experience

In GCPM, distributors and specialty contractors are removed from the procurement chain so their services are no longer available.

Depending on the situation the project owner faces, each model provides a certain level of value. Overall, SCPM and OPM generally provide the highest value to the owner. GCPM does have some positive features, but does not provide the same value as SCPM or OPM. ***Each model can be summarized as follow:***

SPECIALTY CONTRACTOR PROCUREMENT MODEL

The traditional subcontractor purchasing model is SCPM, in which material transfers from manufacturer to distributor to subcontractor. SCPM offers the most value for the owner for the majority of projects. Subcontractors, via their distributors, have access to the largest number of manufacturers – thereby having access to the greatest product selection. General contractors often run into problems with manufacturers due to the refusal of these manufacturers to bypass distributors and sell material directly.

GENERAL CONTRACTOR PROCUREMENT MODEL

The general contractor purchasing model (GCPM) can potentially offer a greater time savings if the design specifications are correct and "time until occupancy" is at a minimum. Problems arise when "time until occupancy" is a pressing concern and projects begin with incomplete or incorrect design specifications due to the rushed nature of the project. GCPM cost savings and product selection did not provide better value than the SCPM to the owner.

OWNER PROCUREMENT MODEL

The Owner Procurement Model (OPM) appears to be viable for repetitive projects with little variation in design. However, the scope of this research did not provide the details necessary to draw a conclusion on this model's value to the owner. The key to the OPM is that the owner must have an in-depth knowledge of the work the specialty contractor performs. OPM has been successful for big-box retailers, chain-stores and utility companies. Big-box retailers and chain-stores typically reuse design plans for many of their stores – having perfected the design and equipment specifications on earlier projects. Electrical utility companies often have the expertise, through years of purchasing electrical equipment, to purchase equipment for electrical contractors. In addition, utility companies often have long-term partnerships with electrical contractors. The contractor can then influence the purchasing patterns of the utility company.

HORIZONTALLY INTEGRATED PROCUREMENT MODEL (HIPM)

The project owner will achieve the best value by utilizing a procurement chain that is horizontally integrated. The savings attained through increased productivity can substantially outweigh the direct cost of material or equipment. This is the desired future state of the procurement chain.

The prevailing, existing, and alternative procurement chain models are not satisfying the needs of most project owners. In order to improve procurement chain management in the construction industry, a new model should be instituted, one which utilizes the benefits of horizontal integration. Through horizontal integration of the procurement chain, the project owner and each member of the procurement chain will be able to complete a construction project at lower cost for everyone involved.

Every owner must look at how each of the three categories is impacted by the model he or she selects. The advantages each model offers to a project owner depend greatly upon the type of project as well as the actions of the parties involved in the project. As procurement chain members begin adopting the horizontally integrated structure, the project owner will find the best value can be achieved through the Horizontally Integrated Procurement Model.

APPENDIX C
INTERVIEW STRATEGY AND OUTLINE

TYPES OF COMPANIES TO TALK WITH

- Electrical contractors
- GC's
- Owners
- Distributors
- Manufacturers
- Manufacturer representatives
- *Taskforce assignment: send information on any of the above that MCA should speak with*

TOPICS FOR DISCUSSION

- For all interviewees:
  - *What are your current practices of material purchases?*
  - *How do you go from purchasing to procurement?*
  - *What business, technical, and integration risks do you encounter related to procurement/procurement model used on projects?*

- For owners:
  - *Do you rely on your subs for your material purchases or do you prefer to purchase yourself?*
  - *What is the value of the procurement model you follow in terms of:*
    - Money – cost / savings / income
    - Time
    - Knowledge
    - Other

- For manufacturers/distributors:
  - *Do you have any tracking of who buys from you (i.e. contractor, GC, Owner)?*
  - *What is the value of subs buying from you?*

MEANS OF DISCUSSION

- Telephone or onsite
- Taskforce members are welcome to participate in the discussions or onsite visits

TIMELINE

- Conduct interviews Feb-Mar
- Tabulate results by 3/31/17
- Translate results, in synthesis with rest of the research, to quantified model

APPENDIX D
SURVEY INSTRUMENT

ELECTRI Supply Chain Disruption Survey
Please Complete Survey by May 30,2017

ELECTRI International is conducting research of Supply Chain Disruption, through a third-party research firm, MCA, Inc. This study is about the impact of **direct material purchases** done by GC's and owners on electrical contractors, distributors, and final customers.

This survey will provide MCA, Inc. with data that will be used to populate a model that quantifies the cost and risk associated with direct purchase by owners and general contractors. Your response will be helpful in assuring that the model is quantified with a well-rounded and well-represented sample of the industry. The final deliverable for this research will be a position paper that can be used by ELECTRI and NECA member contractors to educate their costumers and their own employees about the implication sand options for direct procurement of material that will avoid unnecessary risk and cost for all parties.

Please be assured that **any company information submitted will be used solely for the completion of this project** and will not be shared or otherwise identified with individual companies. The information you provide will only be seen by key researcher's involved in the project, and specific survey responses will not be shared with anyone.

If you have any question on this survey or the associated research study, please feel free to reach out to MCA, Inc. at 810-232-9797, or email Dr. Heather Moore at hmoore@mca.net.

Thank you for your quick response,
ELECTRI International

ELECTRI Supply Chain Disruption Survey

Please Complete Survey by May 30,2017

Please return your completed survey to MCA, Inc. using either method below:

1. Print, complete, and return the survey to MCA, Inc. via fax (810-232-9746), or scan/email to supplychain@mca.net.

Survey Respondent Information:

- Company name (optional): _____
- Name of person completing the survey (optional): _____
- Telephone number and/or email (optional): _____
- Main location / headquarters of business (City & State): _____
- Selection of other geographies in which you or your company does business (if applicable):
  - ☐ Global
  - ☐ National (across U.S. & Canada)
  - ☐ Regional (outside of one state)

*If you are completing the survey as a **distributor** please refer to **Section 1.***
*If you are completing the survey as a **contractor** please refer to **Section 2.***
*If you are completing the survey as a **manufacturer** please refer to **Section 3.***

Section 1 – Distributor

1. What is your annual revenue? _____
2. What is your overhead allocation as a percent of revenues? _____
3. What is your annual revenue on Fixtures? _____
4. What is your annual revenue on Gear? _____
5. Approximately what percent of you Fixture/Gear sales are direct to GC or owner? _____
6. What is your typical or average percent markup on Fixtures? _____
7. What is your typical or average percent markup on Gear? _____
8. What do you think about the owner/GC direct purchase model? _____

ELECTRI Supply Chain Disruption Survey

Please Complete Survey by May 30,2017

Please return your completed survey to MCA, Inc. using either method below:

1. Print, complete, and return the survey to MCA, Inc. via fax (810-232-9746), or scan/email to supplychain@mca.net.

Section 2 – Contractor

1. What is your annual revenue? _____
2. What is your composite rate? _____
3. What is your annual cost of Fixtures? _____
4. What is your annual cost of Gear? _____
5. What percent of you projects have Fixture and/or Gear? _____
6. What is your average markup on Fixtures? _____
7. What is your average markup on Gear? _____
8. What do you think about the owner/GC direct purchase model? _____

Section 3 – Manufacturer

1. Do you price directly to GC's or owners? _____
   a. If so, why? _____
   _____
   b. If not, why not? _____
   _____

APPENDIX E
ADDITIONAL TABLES OF PROCUREMENT MODEL COMPARISON FOR DIFFERENT JOB SIZES

The tables below are additional examples of Model 1 vs. Model 2 total cost for a small, medium, and large project size.

Large Project Example	Fixtures	Switchgear
Purchase Price	$15,000,000	$20,000,000
Subcontractor Markup	$2,250,000	$2,250,000
Total Material Cost for Model 1	**$17,250,000**	**$22,250,000**
Subcontractor Risk Factor for Direct Purchases	21%	23%
Cost of Covering Sub's Risk for indirect purchases	$3,148,980	$4,615,306
Total Cost for Model 2	**$18,148,980**	**$24,615,306**

Medium Project Example	Fixtures	Switchgear
Purchase Price	$2,000,000	$2,000,000
Subcontractor Markup	$300,000	$225,000
Total Material Cost for Model 1	**$2,300,000**	**$2,225,000**
Subcontractor Risk Factor for Direct Purchases	21%	23%
Cost of Covering Sub's Risk for indirect purchases	$419,864	$461,531
Total Cost for Model 2	**$2,419,864**	**$2,461,531**

Small Project Example	Fixtures	Switchgear
Purchase Price	$385,000	$550,000
Subcontractor Markup	$57,750	$61,875
Total Material Cost for Model 1	**$442,750**	**$611,875**
Subcontractor Risk Factor for Direct Purchases	21%	23%
Cost of Covering Sub's Risk for indirect purchases	$80,824	$126,921
Total Cost for Model 2	**$465,824**	**$676,921**

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