Capital Projects Supply Chain Management: SC Tactics of a Supplier Organization

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Abstract

Supply chain management (SCM) is increasingly getting attention from companies involved in the delivery of capital projects, but some companies have strategically been pursuing SCM for many years already. Recognizing the different levels of SC maturity among engineering and construction firms, we intend with this paper to pique interest in SCM for those who are not yet practicing it. This paper describes a multitude of supply-chain tactics that one supplier organization has implemented. The company described in this case study designs, fabricates, and erects pre-engineered metal buildings and components. The company also has subsidiaries that manufacture other building products. Recognizing the value of SCM, competitors in this sector of the engineering and construction industry as well as companies in other sectors may want to assess under what circumstances these SC tactics apply to their business, and then rethink their business opportunities and corresponding SC strategy.

Introduction

Supply chain management (SCM) is increasingly getting attention from companies involved in the delivery of capital projects. While capital projects SCM is new to some companies, others have strategically been pursuing it for many years already. Tommelein et al. (2002) define:

*"SCM is the practice of a group of companies and individuals working collaboratively in a network of interrelated processes structured to best satisfy end-customer needs while rewarding all members of the chain. While SCM may be practiced on a single project, its greatest potential benefits come when it is practiced at the enterprise level, when it involves multiple companies, and when it gets applied to multiple projects over an extended period of time. Note therefore the consistent use of the plural 'project**s**' in … Capital Projects Supply Chain Management (CPs SCM).*

CPs SCM is recognized as a leading process improvement, cost saving, and revenue-enhancing business strategy practiced in today's business world. All disciplines within a business (conceptual design, engineering, procurement, fabrication, logistics, construction, accounting, and legal council, …) can be, and most often are, involved in CPs SCM."

[SCM] "is difficult because it involves managing a complex and dynamic network of organizations that operate to meet numerous different, conflicting business objectives. Managing not only the processes within individual organizations, but also considering the chain of processes while aiming for global system optimization is what is known as supply chain

management. The key to success in SCM is aligning the objectives and the corresponding production systems of all organizations in the supply chain to the fullest extent possible."

"Effective integration and optimization of supply chains can have a tremendous, positive impact on project schedules, delivery time from concept development to turn-over, costs, customer satisfaction, and, ultimately, the bottom-line success of each project as well as the long-term success of every participant in the supply chain. Companies not engaging in SCM may find themselves falling rapidly behind in performance relative to their supply-chain conscious competitors. While supply chain managers aim to reward all members of the chain, they do not guarantee all of today's players to be in the game."

SCM has emerged as a new field in-and-of its own (the term was coined by Houlihan in 1985), but it builds on advances in fields such as logistics, operations, and purchasing, and it leverages the use of information technology. SCM must be considered of strategic importance for it to be implemented successfully. Ganeshan et al. (1999 p. 843) stress that "SCM is rooted in senior-level decision making. Otherwise, SCM may well be reduced to its component functions … Of course, SCM includes implementation and operational aspects in which day-to-day operations are managed below the senior management level."

Once a company's management has decided to strategically pursue SCM, a variety of SC tactics can be considered for implementation. To illustrate, this paper describes SC tactics implemented by Butler Manufacturing Company ('Butler'). (Chapter 8 in Tommelein et al. (2002) provides more detail on the Butler case study.) Butler supplies products and services in the pre-engineered metal building market. Pre-engineered metal buildings have long clear spans to provide unobstructed open floor space that can be used for warehousing, manufacturing plants, schools, shopping centers, etc. In fact, nearly 70% of low-rise, nonresidential construction involving buildings with less than 150,000 square feet (roughly 14,000 m^2) is done with metal building systems (Shoemaker 1999, http://www.mbma.com/).

Butler serves the nonresidential construction market both domestically and internationally. It is a vertically integrated firm in that it can design, fabricate, and erect pre-engineered metal buildings and components (primary and secondary steel elements, and light-gauge roof and wall panels). It is a horizontally integrated firm in that it owns several subsidiaries that manufacture and supply doors, windows, architectural wall panels, etc. The company holds patents covering several product technologies, mostly in the cladding systems.

Butler uses the term 'manufacturing' in its name to refer to its designing and making of building components by cutting, drilling, and welding steel plate and by cold forming sheet metal at off-site locations dedicated to this purpose. These facilities are not job shops to the extent needed when fabricating hot-rolled steel used in conventional steel projects; nevertheless, Butler's standardized components are made-to-order to suit individual project needs. Butler facilities are therefore referred to as 'fabrication plants' and the process as 'fabrication' to make it obvious that many SC tactics implemented or under consideration by Butler apply to other engineering and construction companies as well.

Company Organization

Butler's functional units are grouped under building systems, construction services (BUCON), real estate, or architectural products. The company works through a network of local, independent general contracting firms, called Butler Builders (Figure 1)('Builders'), to sell most of its buildings on the order of 50,000 to 100,000 square feet (roughly 4,500 to 9,000 m^2). Builders market Butler's products to architects-engineers (AEs), who may offer them as a

solution to the owner (Figure 2). Once selected, Butler handles the structural engineering (a Butler engineer may act as the structural engineer of record for the project) and design detailing phases, fabricates the components, and delivers them to site. In the meantime, Builders make arrangements to erect the structure either with their own labor forces or using a subcontractor.

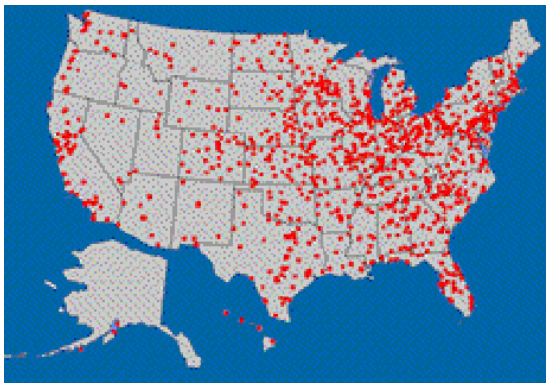

Figure 1: Network of US Butler Builders (from http://www.butlermfg.com/ services/realestate/ visited 9/10/02)

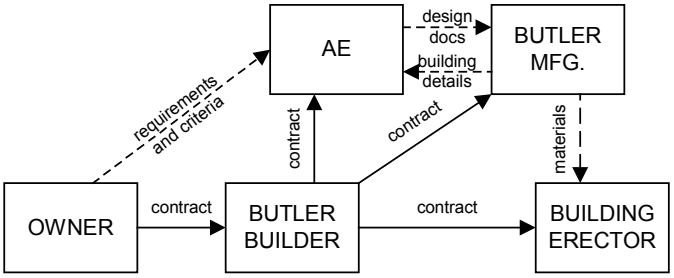

Figure 2: Butler Builder Project Delivery

In the 1970s, Butler extended its in-house capabilities to include construction by creating BUCON, Inc., initially as a design-build general contractor. While Butler uses Builders to market its products, through BUCON it maintains its own construction forces to pursue a broader range of projects independently of, or in conjunction with, Builders. BUCON operates as a separate company even though it is a wholly-owned subsidiary of Butler.

Supply Chain Management is a Business Strategy

Increased competition in global markets and heightened expectations of customers have forced firms to invest in their SCs (e.g., Simchi-Levi et al. 2000) and strategically establish various kinds of preferred relationships. Table 1 presents alternative options for SC collaboration.

Table 1: Continuum of SC Collaborative Options
[adapted from Sanderson and Watson (1997 p. 390) and McCann and Gilkey (1988)]

Type of Collaboration Structure	Vertical Integration (mergers & acquisitions)	Joint Venture	Direct Equity Position	Licensing	Single Sourcing	Preferred Suppliers	Market-Based Contracting
Mode of Governance	Hierarchical	Collaborative					Competitive
Equity Stake	100% ←		→ 1%	0%	0%	0%	0%
Description	Firms wholly owns or has controlling interest in supplies	Firm and supplier establish a third firm to provide goods and services	Firm takes equity stake in supplier	Permission to utilize a firm's patents or proprietary technology for a fee or royalty payment.	Collaborative relationship without ownership by guaranteeing business over a length ot time	Collaborative relationship with a limited number of accredited suppliers	Firm selects from available suppliers on the basis of short term contracts (no alliance)

Butler's organization today shows that company management has pursued vertical integration (design, fabrication, and construction) as well as horizontal integration (structural framing, door, windows, and wall panels) with 100% equity stake as a means to gain control over the SCs it participates in. Such a degree of collaboration is rare in the construction industry. The company's integrated nature creates a unique opportunity for superior SC performance in the otherwise fragmented AEC industry. However, Butler manages its wholly-owned subsidiaries in a

hierarchical fashion and holds each one individually accountable for maximizing profits. Because this is accomplished using performance metrics that do not necessarily foster collaboration with other subsidiaries, Butler is missing out on some opportunities to capitalize on potential synergies. In addition to managing its integrated businesses, Butler has also achieved different levels of integration with external suppliers. Indeed, the traditional make-or-buy decision nowadays is a build-buy-or-buddy decision (Champy 2002 p. 38).

Supply Chain Tactics

Butler has taken a leadership role in shaping the SCs it participates in. The company is strategically pursuing SCM and, accordingly, has been implementing SC tactics. Examples are:

Identify Core Competencies: Butler has defined as a core competence the design and fabrication of its name brand product, the Butler Building. This is not to say that the company has not pursued other product development and marketing efforts in its 100-year history (http://www.butlermfg.com/companyinfo/history.asp), but this product stands out as the hallmark of the company's success over the years. The key to exploiting a company's core competence is to maintain strategic functions in-house (Hamel and Pralahad 1990), and this is exactly what Butler has done.

Optimize SC Roles and Responsibilities: Butler can design/engineer, fabricate, and erect metal buildings and components, but this does not mean that it always performs all these functions in-house. Instead, Butler's Building Division and BUCON can play any combination of roles.

The company tries to optimize SC roles and functional responsibilities based on individual project needs, wrt. for instance, the solicitation of work, system selection, design support, and construction management and execution. Alternative configurations of SCs Butler is involved in reach across company boundaries, upstream to third-party suppliers, downstream to independent contractors including Builders, and they sometimes include direct competitors. Figure 3 illustrates alternative SCs that may or may not involve Butler's Building Division (shown as 'Butler Mfg.'), Butler Builders, BUCON, and other designers, fabricators, and contractors. The thickness of the lines in the figure reflects the frequency or commonality of occurrence of SC relationships. The model that Butler historically has pursued is shown by the thick line connecting Butler Mfg.-Butler Mfg.-Butler Builder-Butler Builder.

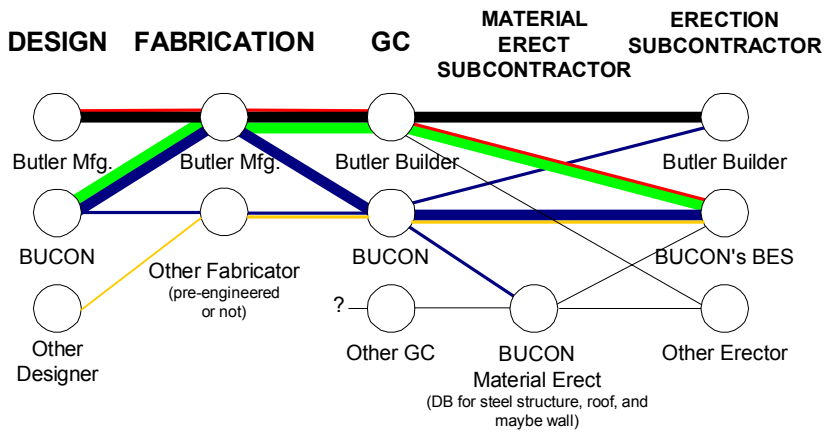

Figure 3: Alternative SC Roles and Configurations used by Butler

Develop Alliances with Architectural Design and Construction Service Providers: The product distribution network established through Butler Builders gives Butler a geographic presence around the world, with access to numerous potential customers (facility owners), architectural firms, and the local labor market (steel erectors).

Standardize & Modularize: The company offers a limited number of products (building types,

component types, and colors) to serve a specific market segment. Selection is done by system, which makes design, raw materials sourcing, inventory control, and fabrication relatively easy and fast. Modular systems have numerous benefits, ranging from a reduced need for design computation when used in repetition to component interchangeability, reduced fabrication equipment setups, ease of shipping and erection, etc.

Each product line is defined by means of parametric designs, so that customization can be done at a marginal cost. Custom design aims at optimizing materials savings because the cost of design is small compared to the cost of materials and manufacturing—the latter two accounting for nearly 85% of the product cost. By creating more unique designs for tapered primary elements made from welded steel plate and by using standardized parts for secondary members, Butler achieves a structural solution with economy in materials so that their buildings compete on delivery time and cost with conventional steel buildings for these light-industrial applications. The threshold for economic superiority varies, however, with the market prices for steel.

Should it be of value to the customer, the company can also deliver an entirely customized product. By categorizing designs according to degree of customization, Butler fine-tunes the efficiency of its design function while still taking advantage of its fabrication capabilities.

DFX or 'Design for manufacturability, constructability, maintainability, or lifecycle performance, etc.': The X in DFX refers to the consideration given in the design process to various downstream stakeholder values.

a. **Design for Fabrication:** Butler has integrated and streamlined its processes for order taking, design, and fabrication. For example, its design computer program is tailored to each plant's fabrication capabilities, and design specifications are generated to match plant capabilities and outsource requirements.

b. **Design for Constructability:** Butler has developed several products for the explicit purpose of improving safety and ease of construction. Examples are:

b.1. **Fall protection and insulation support system:** Butler developed a system to offer construction workers protection from falls and provide continuing support for roof insulation (after http://www.butlermfg.com/ products/roof/skyweb.asp). Greater safety benefits all in the SC. This system consists of an open mesh fastened around the perimeter of the building. It protects workers from falling off the leading edge of the roof during construction but does not eliminate the fall hazard from the remaining perimeter of the roof. The mesh remains a part of the roof system and supports roof insulation.

b.2. **Sealant that mistake-proofs the installation process:** Due to fabrication and shipping constraints, roof panels are necessarily limited in length. To cover a large span, panels therefore have to overlap and sealant must be applied in-between them to make the connection watertight. Construction workers may find it difficult to know how tightly to secure the panels: the panels must be close enough together for the sealant to be effective but not too close for the sealant to be squeezed out and thereby rendered useless. To remedy this problem, Butler worked with a supplier to engineer a new kind of sealant (a putty-like material with tiny, hard cubes dispersed in it) that a construction worker cannot compress too much during installation. This sealant comes in a roll with layers separated by removable, non-tear plastic strips, one side of the strip being precut lengthwise to allow for positioning of a screw through it.

c. **Design for Lifecycle Performance:** Butler extends performance warranties, and to ensure these can be met, it is building the appropriate degree of quality into its products. The aforementioned sealant helps not only with constructability but also with long-term performance

for the facility owner/operator.

Develop Products Jointly with Suppliers: The sealant supplier's involvement in Butler's design of watertight roofing system is an example of joint product development between seller and buyer.

Multi-project Sourcing, Pre-project Sourcing, and Centralized Sourcing: Butler's raw materials include steel, aluminum, and wood. Steel is the company's largest purchased commodity. It constitutes 70 to 80% of Butler's fabricated product cost. To buffer against potential price fluctuations, Butler annually enters into national agreements for steel purchases. Cost increases are generally recaptured in product sales prices (Butler 2000). Typically, the Building Division centrally establishes one contract with each supplier based on the material requirements for its product forecast. The mills then quote annual pricing based on these forecasts. We speculate that if Butler were able to reduce the seasonal variability of its demand for steel, or shift the timing of peak demand, steel mills might provide even better pricing.

License Patented or Proprietary Products to/from Third Parties: Butler has licensing agreements with companies it does not own. One example is the agreement in place with suppliers of coil metal for wall and roof panels that is delivered coated. The coating should not crack, peel, or otherwise deteriorate in Butler's cold-forming process, as any of these would jeopardize long-term performance. The coating process relies on proprietary knowledge and Butler shares it only with a select few, strategic suppliers. To assess performance, Butler systematically samples and tests product coupons of each and every coil received at any of its plants. Another example is the agreement Butler has with the Swedish company that makes the tool needed to field-fabricate the Butler standing roof seam, which Butler rents to its customers.

Invest Equity in Suppliers of Related Products: Butler aims to increase the attractiveness of its buildings as compared to non-Butler alternatives by packaging the sale of the structure with the sale of other building components. This should help Builders to be more competitive in the market. Depending on the project, in addition to the building structure, Butler may supply wall panels, doors, windows, ventilators, and rainwater drainage systems.

In effect, Butler has expanded its core competencies by buying suppliers of related products. In 1984 it acquired the firm that helped to found VISTAWALL, which today offers a "broad line of engineered aluminum framed curtain wall, windows, storefronts, entrances and skylights" (from http://www.butlermfg.com/companyinfo/history.asp). Butler became even more vertically integrated by acquiring door and window suppliers. In March 1997, it acquired certain assets of Rebco West, Inc., a west-coast manufacturer and distributor of entrance doors and storefront products. In June 1997, it acquired Moduline Windows, Inc., a manufacturer of architectural windows for the nonresidential buildings market (Butler 2000). Most recently, the company "formed a strategic alliance to market the… patented Acsys Panel System [which] is an energy efficient and cost effective substitute for insulated metal stud wall assemblies… This alliance is consistent with our objective of giving our builders a competitive edge in the commercial market" (from http://www.butlermfg.com/ media/files/200209a.asp visited 9/10/02).

Develop Customer Relationships: Butler is attuned to providing value to its customers, which include owner-operators as well as Builders. The company conducts research and development in order to make its products more appreciated by customers in terms of the delivery process (e.g., ease of order pricing, delivery lead time) as well as lifecycle performance (e.g., quality products with long-term performance warranty). By distributing design and fabrication

capabilities around the country to be close to delivery locations (limit shipping cost, localized design specialization), the company can be responsive to Builder needs.

Obtain Performance Feedback: Butler meets with its Builders to understand the business challenges they face. It also hears their constructability problems, and it may subsequently tackle them in research and development efforts.

Invest in Customers: An obvious example of Butler investing in a customer is the creation of its construction subsidiary BUCON, which therefore is an in-house customer.

Improve Product Demand Forecasts: In order to provide a single point of contact with large corporate owners, Butler has established a Corporate Alliance group. Because these owners have facilities around the country, sometimes even around the world, no single Builder is in a position to serve them consistently. In developing close relationships with such owners, Butler can promote the use of its products and improve its ability to forecast demand, which are valuable to sourcing, production, etc.

Lease Build-to-suit Facilities: Butler's Real Estate subsidiary works as a build-to-suit developer. It provides financing backed up by its parent organization and, by working through its Builders or BUCON, delivers a turnkey project for lease back to the customer.

Related business models such as build-own-operate[-transfer] (BOO[T]) or variants thereof, have been successful in other sectors of the construction industry, such as the privatization of road construction. The use of such delivery models creates opportunities for improving SC performance and should be considered by engineering and construction firms, for instance those involved in power plant delivery.

Butler management must have considered other SC tactics but not all are feasible to implement. An example is pooled procurement. While investigating how to further enhance its buying power, Butler—a significant purchaser of steel—has found that the needs of its building business do not support the idea of pooling steel purchases with buyers from other industries. Steel mills are typically configured to support the construction market—not the construction market and another market segment. In other words, pre-engineered metal building manufacturers buy from different mills than do automobile manufacturers or appliance manufacturers.

Lessons Learned

SCM is being practiced in the engineering and construction industry today. The Butler case study exemplified how SCs for the delivery of capital projects may get configured to suit project requirements. It illustrated that organizations may change over time to expand and exploit their core competencies in order to be more competitive and provide greater value to customers. The case made clear that suppliers, such as Butler, play an important role in the capital projects SC.

Few research reports have been written on SC configuration to meet project requirements; more are needed. The delivery of capital projects poses interesting questions regarding SCM. These questions differ significantly from questions tackled in manufacturing settings, in which SC relationships typically are more stable and longer lasting.

To generalize the lessons learned from this case, note that many of Butler's SC tactics are also being implemented by competitors striving to gain market share in the pre-engineered metal buildings industry. One may argue that the effective use of many of these SC tactics is characteristic for companies in this industry sector. This effectiveness is explained, by Butler's market dominance and success that creates an example for others to follow, but conversely, it

also may be explained by the nature of the product that appears to lend itself well to the application of SCM. SCM practices are drivers of industrial organization, and vice versa, industrial organization serves as an enabler to SCM.

Conclusions

This paper has presented a range of SC tactics available to engineering and construction firms that wish to increase the competitiveness of their business. These tactics all are used in practice today, not only in the pre-engineered metal buildings industry. The intent of the paper was to inform industry practitioners of opportunities provided by SCM. Recognizing the business value of the application of SCM, practitioners in all sectors of the engineering and construction industry may want to study this paper and assess under what circumstances various SC tactics apply to their business. This may lead them to rethink their practices and business opportunities.

Acknowledgments

This case study was funded by a grant for Project Team 172 'Improving Construction Supply Chain Performance' from the Construction Industry Institute (CII) whose support is gratefully acknowledged. Any opinions, findings, conclusions, or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of CII.

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