A MANAGEMENT DASHBOARD MODEL FOR SUPPLY CHAIN COST ESTIMATIONS

by

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Abstract

A MANAGEMENT DASHBOARD MODEL

FOR SUPPLY CHAIN COST

ESTIMATIONS

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As many organizations are unable to alter existing accounting systems for an Activity Based-type costing requirement, a “Dashboard” Costing Model is proposed. The model will 1) empirically verify management assumptions regarding actual Supply Chain costs, 2) satisfy management’s objectives for acceptable accuracy and simplicity and 3) contribute to the current body of research by providing alternative methods of estimating Supply Chain costs within the Transaction Cost Economics framework. Future studies can expand upon this costing methodology, and test its applicability with other organizations in other industries for accuracy improvement and refinement.

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Chapter 1

Introduction

The field of Operations Management has seen tremendous growth over the past 20 years; within both manufacturing and service environments. The increase of global competition has mandated more refined methodology in each environment to address their unique requirements. As the organizational Supply Chain size and complexity increase, organizational strategies and structures must adapt; and the decision matrix for the Supply Chain Manager, by nature, continues to grow.

Supply Chain Management (SCM) has flourished within academia and practitioner circles alike (Kouvelis, Chambers et al. 2006). While overall supply chain publication volume has increased, there are observed gaps; lending to additional areas which could benefit from further research (Flynn 2008; Guinipero, Hooker et al. 2008). Further, the current literature stream is “insufficiently developed,” and vast opportunities exist (Kouvelis, Chambers et al. 2006). Thus, the current research endeavor seeks to expand the body of knowledge in Supply Chain Management literature.

1.2 Problem Statement

As the magnitude of decision-risk within supply chains increases, the ability to make sound decisions become more significant. Decisions that are formulated and their effects on the firm are key issues for Supply Chain Management (Iyengar 2005). Consider the international organization with several “dynamic” supply chains; which must change to satisfy demographic and customer demands. How would a manager evaluate the existing supply chain, with respect to adding a new supply chain? How would the manager decide to extend the services of an existing distribution center, build a new distribution center, or close one supply chain and relocate it to another area? Too, consider the organization which has emerging markets in say, China. An existing supply chain of a certain size may exist, but the question is whether to increase the size of the chain in scope, develop an additional chain(s), or reposition the existing supply chain in addition to adding the new one.

Certainly fundamental, strategic-based decisions (delivery time, low cost, stock-out policies, etc.) provide strong decision drivers. Many times, though, qualitative strategic and theoretical considerations can only justify a decision to a certain point. Cost savings/increased profit are always dominating rationale for supply chain decisions. They may relegate theory and strategy absent of direct cost considerations to a ‘backseat’ level of priority with management. However, strategy cannot be entirely dismissed, and any decision solely based on costs may negatively moderate other organizational strategic goals associated with supply chain positioning. There are significant gaps of validated models for assisting managers with supply chain cost issues (Melnyk, Sandor et al. 2007). Further review into decision models at a strategic level can benefit the supply chain practitioner, and provide interesting insight into expanding decision models.

1.3 Supply Chain Costing-general

In general, the purpose of the supply chain is to add value to the product/services as it travels through the chain (Iyengar 2005). There is a cost associated with adding that value, and given the growth of supply chains, those costs are not negligible. Management may be interested in what the total cost is to provide that value. Decisions can then be made to reduce particular costs while maintaining value within the S.C. A brief overview is made regarding supply chain cost literature including different levels, costing theory, and a few costing models.

There are three levels in supply chain costing: Direct costs, Activity-Based Costs, and Transaction Costs (Seuring 2008). Direct costs are typically addressed by Traditional Cost Accounting (TCA) methods. Activity-based costs are generated by activities that have been completed, but are not directly product-related (Seuring 2008). Finally, transactions costs represent those costs from interacting with the other organizations within the supply chain (Seuring 2008).

TCA holds a time-held tradition with organizations. Namely, this tabulation of costs is used for compiling financial statements that reflect the financial performance of the organization, departments within the organization, and the nature of costs compared to sales. While vital to the required reporting practices for most publicly-held companies, it does prove problematic for singularly estimating supply chain costs. Thus, estimation methods beyond TCA are needed.

In reviewing existing Supply Chain Costing Literature, one of the more popular costing approaches is Activity Based Costing (ABC). This approach to appropriating costs within an organization has been hugely successful, but ABC is not without drawbacks and costs of applying the methodology. Target Costing has also been proposed as a costing approach for supply chains, but like ABC has drawbacks and

limitations. Finally, a few additional costing tools/ methods have been proposed such as Resource Consumption Accounting, Logistical Costing and various Activity Based Costing models. However, as with any model/estimations, these too have their limitations.

Specifically, many of the existing Logistic Costing Models are complex and involved. While complexity may be a necessary evil for high accuracy, it becomes quite difficult to obtain the data necessary to drive such models on a routine basis. In addition, it becomes challenging to explain the inputs/outputs to management, if a model increases above a handful of variables. Overall, many of the models offered may be able to "accurately" capture the required costs and/or the cost drivers; but there is a tradeoff in functionality/ease of use. Too, while it may be possible to capture all the costs involved with the supply chain, the expense in time and effort would not be justified, despite any gained accuracy.

For the organization with large, varied systems and multiple nodes within the supply chain, modification to capture specific costs may not be possible. Thus, there seems to be very little in the way of simple, aggregate-level costing models. Many times supply chain decisions may be derived from previously derived intuitive knowledge, and much less from any kind of systematic investigation (Goetschalckx, Vidal et al. 2002). A proposed methodology should employ flexibility for answering various scenario analyses (Goetschalckx, Vidal et al. 2002). Management may already have intuition; experience in what the actual costs are. Thus, they are looking for a "confirmation" of sorts; a dashboard indicator of what costs are being incurred in a desired supply chain.

A review of costing literature will explore existing theory and methodology. The feasibility to address the required flexibility of an aggregate-level model is examined.

Chapter 2

Literature Review-Costing methodology

2.1 Conventional (Traditional) Cost Accounting (TCA)

Traditional Cost Accounting (TCA) is standard practice in virtually every publicly-held organization. Based on history, culture, and financial/ regulatory requirements such as Financial Accounting Standards Board, Traditional Cost Accounting has a fairly defined approach to capturing and identifying costs and their associated organizational designation. While mandatory for corporate cost accounting, financial reports, and a handful of financial management requirements, TCA has been questioned for many years within the literature, especially in light of the inconsistent allocation methods for indirect and shared costs (Fernie, Freathy et al. 2001). Another problem with TCA in terms of the supply chain, is that it tends to focus on cost minimization at one location, without considering a more global effect, or its influence on the overall organizational strategy (Lockamy and Smith 2000). Traditional cost techniques are required for accounting purposes, but are compiled for different rationale than that of global supply chain (GSC) management decisions. Cost management, especially within the supply chain framework, is a ripe field for research (Seuring and Goldbach 2002).

Accountants using TCA may approach the organization from the perspective of an outsider; thus the production system is seen as a black box of sorts (Deo 2001). This would further explain the “ignoring” by TCA of the total supply chain effect. TCA is a standard practice within most organizations, and is not likely to change any time in the near future. The entries will make up components of any SCM costing model, or any other costing model, for that matter. The distinction, though, is that TCA have costs in “broad, aggregated categories”, which makes it difficult to conduct a more specific

cost/return analysis of a specific process/department within supply chain analysis (Christopher 2005).

2.2 Activity-Based Costing

Activity Based Costing (ABC) provides the theoretical notion to customize drivers for certain expenses, therefore determining the appropriate driver that is most relevant. Cost drivers are "areas where costs occur, whereas cost drivers make these factors change" (Wu 2005). Stated differently, the cost drivers are "quantitative measures of the outputs of activities" (Varila, Seppanen et al. 2007). In fundamental terms, the driver "influences" or "causes" the costs to be realized (Lin, Collins et al. 2001).

Challenges do exist with the cost drivers. Historically, labor has always provided a reliable cost driver. As manufacturing has moved towards service-based products and larger automated production, labor does not necessarily provide the best driver for allocating certain expenses. In one study for developing a supply chain costing model, the Voice of the Customer interviews were utilized to determine the key drivers (Wu 2005). The subjects of the interviews were higher-level managers and executives. From those interviews, a summary of the results is given here:

> 1. Supply chain costs are complex, as there are so many variables. Thus the costs should be considered as an aggregate, and not as individual costs.
> 2. The inputs to the model should have a small number of factors, so that the model can be managed, and provide useable output. (Wu 2005)

ABC cannot take the place of TCA justification of the costs/expenses. Rather, it seeks to "define further the data aggregated in traditional accounts into a more advantageous decision-making form for managers" pg. 704 (Lin, Collins et al. 2001). However, for the true ABC model, the actual cost data must be allocated in a more specific manner and to specific activities that incur those costs (Lin, Collins et al. 2001).

There is a tradeoff in ABC between the measurement cost and accuracy. The recording of the driver is not without its own added cost, and the more detailed the cost

is, the more expensive the transaction becomes (Varila, Seppanen et al. 2007). Many times companies underestimate the expense of developing and acquiring the cost drivers (Varila, Seppanen et al. 2007). When working with a single enterprise or small organization, it may be more feasible to manually separate the costs to develop estimations (Fernie, Freathy et al. 2001). With a very large, legacy system, though, it may be difficult, time-consuming, or beyond the internal politics of the current scenario to provide such detailed costs (Lin, Collins et al. 2001). Thus, it may become difficult to accurately account for the associated costs for the activity. ABC is a great method when there are costs to be shared within an organization, but does not serve well as an estimator for overall costs.

ABC has been used to focus on one point or group of activities in the chain (Fernie, Freathy et al. 2001). Finding appropriate drivers may prove to be quite challenging for the global operations, with so many different influencing factors in each of the supply chain nodes. Too, the activity (or cost driver) may be fairly subjective, and may represent different things to different members of the organization (Deo 2001).

In summary, Activity Based Costing (ABC) accounts for overhead costs over several functions accurately, but not in measuring resource productivity (Deo 2001). Despite the identified weaknesses with ABC, the cost driver notion is quite popular, and has generated various costing approaches based on the “activity” or “cost driver” notion.

2.3 Target Costing

Target costing involves making decisions based on creating a “target” from the actual costs captured within traditional cost accounting system (TCA). The supplier would estimate the desired sell price, then subtract an estimated profit (Ellram 2002). That estimated cost is then required to cover all the costs. This cost is disseminated through

every structure of the product, and apportioned to each of the product's level, so that the organization can begin to manage the incurred costs (Ellram 2002).

It is suggested that Target Costing is an optimal method used to maximize Customer Satisfaction. Customer satisfaction is then a constant, or restraint, and the organization works from there to determine costs (Lockamy and Smith 2000). Target Costing and ABC serve well when there are single strategy drivers for the supply chain, such as the mentioned customer satisfaction. However, the purpose of a Supply Chain Management costing model is to estimate the costs that exist, or may exist, given a certain set of variables (as opposed to one variable).

Target Costing is a good tool for managing costs, but not necessarily an effective tool for estimating what a particular decision within the supply chain would cost. Too, given the complex nature by which international organizations capture costs within the TCA, it is difficult to accurately identify which costs are applicable for each business function. For example, a particular supply chain may service multiple regions in different countries, and encompass a large number of product lines so all of those relative business functions must be evaluated.

2.4 Operational Based Costing

Operational Based Costing adds the contribution of each component (or resource), that adds "value" to the material in the production system (Deo 2001). It employs adding the cost contribution of each resource to the base of the unit/material going through the operation. It primarily focuses around 8 primary cost "elements" These elements are:

- machine,
- fixture,
- operator,
- space,
- contract,

- incentives,
- loss of materials in waste and
- W.I.P. materials, (Deo 2001).

By estimating each component, one can then estimate the process as a whole (Lenz and Neitzel 1995; Deo 2001).

Any simulation model has to mirror a "real" system (Deo 2001). One particular study of interest focused primarily on the supply chain/ production line at a particular facility, and used computer simulation to generate accurate resources used (Deo 2001). This study was most helpful in providing a conceptual view of breaking down the process into components for further analysis.

Deo's study (Deo 2001), however, focused primarily on the manufacturing system, and seems more attuned to the formal time/efficiency type studies found in a defined production situation, where all the variables can be more easily measured. For processes that do not have defined resources added to the process, or defined constraints for simulating the estimates, this costing system may prove problematic. Deo's study provides a valuable tool for costing within a tightly measured manufacturing process, but a more optimal method may be in order for estimating costing in the Supply chain.

2.5 Logistical Based Costing

A method is needed that considers the strategic needs of managers in making supply chain decisions. This need for an alternative approach was summed up nicely:

> "Once a product exits the factory, the costs dynamics change. Diversity of customer requirements rather than inherent differences among the products is responsible for cost in the post-production activities. Each customer has a unique combination of product attributes, sales volume, and service and industry characteristics. …. Managers need accounting systems that provide cost visibility along the pipeline" (Kosior 2004).

Logistical based costing provides a reasonable approach to estimate costs at a useful level for the manager. Logistics costing should parallel the materials flow. This

way, the customer service cost for providing the materials can be ascertained (Kosior 2004). However, a change in the cost accounting process may be in order to accurately assemble costs in this manner (Kosior 2004). The reallocating costs are relevant with many of these costing systems. They illustrate similar problems with ABC and other costing methods.

Logistical costing suggests breaking down activities to the point that a particular cost is irrelevant (Kosior 2004). For the organization with many complex processes, high volume, and highly dynamic supply chains, the effort for such detail may quickly hit a point of diminishing returns. A detailed review of various logistics models can be found in Goetshcalckx, Vidal et al, (2002).

2.6 Total Cost of Ownership Model

Another cost approach is the Total Cost of Ownership (TCO) Model (Ellram 1994; Ellram 2002; Kosior 2004; Wu 2005). TCO does call for "judgment" calls within the choice of modeling, as the goal is to try to identify 20% of the activity which comprises 80% of the costs (Ellram 1994). TCO involves viewing the purchasing process within a long-term perspective, evaluating a 360 view of impacting-business processes; thus the manager will need an understanding of the process to accurately manage all the costs involved (Ferrin and Plank 2002). TCO is heavily dependent on using the Activity Based Costing methodology (Ferrin and Plank 2002).

In one study, a questionnaire was utilized to measure management perception in regards to multiple models needed to accurately estimate TCO (Ferrin and Plank 2002). The conclusion was that cost drivers used were primarily quantitative in nature; yet multiple respondents identified many indirect costs as relevant in the TCO model. There exists a need for models that estimate both "standard" and "unique" cost models. This

dual requirement illustrates part of the difficulty with the TCO model (Ferrin and Plank 2002)

2.7 Resource Consumption Accounting

While acknowledging the need for current accounting practices in supporting accounting management needs, the risk of attempting unique costing systems such as Activity Based Costing may outweigh the potential benefit of increased knowledge (White 2009). Thus, Resource Consumption Accounting (RCA) is proposed as a potential cost accounting method that will empower managers with useable accounting information.

While employing similar goals of the other costing methods, RCA focuses more on the manager as the primary information source. Additionally, the fundamentals of RCA are not new, deriving many core principles from German Accounting Practices that have been in use for more than 60 years. The two basic principles are reasonable enough, developing cost modeling that will maximize revenue and minimize costs. However, RCA stems from using data based on present performance; using existing data as opposed to needing to generate “new” data. This existing data is analyzed by asking a fundamental question: What causes costs? Typically, the costs are generated when resources are expended for a process. Thus, it is reasonable to building a cost estimation model based on the consumption of resources (White 2009).

The three main resource characteristics that are reviewed are capability, capacity, and cost structure. Capacity is then further detailed by evaluating the resource as productive, non-productive, and idle. It is important to evaluate the various resources and their relationships to more accurately evaluate their cause and effect relationship (White 2009). This relationship is a core component of RCA, and relies heavily on the seminal paper by Shillinglaw on Attributable cost (Shillinglaw 1963).

By focusing on the measure of resource consumption, a much more accurate cost estimation is possible. After all, the costs are incurred when resources are expended. Thus, tracking the resources seems the best approach to developing cost estimations. However, Resource Consumption Accounting (RCA) suffers from the same limitation as many of the other costing approaches: the need to capture data in a particular manner. Resources expended on a particular project on a particular day, may seem like a simple cost to assess. However, it may end up being quite complex, with the individual performing multiple tasks for several projects at one time. Too, it would still require detailed data on when the resource was consumed and for what purpose was it consumed,

Even given its limitations, RCA does provide enhancements over previous costing models and systems. Looking at the Costing Continuum/ Levels of Maturity, Resource Consumption Accounting has improved the approach towards cost estimations from the basic bookkeeping approach. RCA advances from the “reactive” cost recording approach, to a more proactive approach involving planning that is demand-driven (Accountants 2009).

With blind bookkeeping representing Level 1, RCA represents Level 11 on the Costing Continuum, due to its predictive nature for resource planning. Level 12 is simulation, which is a form of modeling representing the operation (Accountants 2009). Simulation embraces more realistic assumptions regarding production, queue times, capacity consumption, idle times, etc.; these factors are not always predictable or consistent. Simulation can enable the manager to focus on optimizing the ideal mix of resources to maximize revenue and minimize cost, within a complex environment that better represents current organizational challenges (Accountants 2009).

2.8 Miscellaneous Costing Methodologies

Various methodologies have been used for deriving cost estimates. While methodology should “complement” the theory behind costing, methodology is not without its significance in advancing costing approaches. Costing techniques, particularly the present thesis involving global supply chain representatives, are presented to management/practitioners. While interest in theory/philosophy is important, any plausible idea/approach will be quickly lost with a complex model not easy to understand, or one that requires significant explanation.

One modeling tool used was a linear program, which was subject to constraints (Kosior 2004). Based on prior logistical models used, a multiple linear programming model was used to optimize the logistical decision process (Goetschalckx, Vidal et al. 2002). The linear programming model assumed two things. First, the primary goal was to maximize profit based on cost minimization. While, intuitively, profit maximization is a very high priority, a purpose of the supply chain costing model is to provide an estimation of total costs. Assuming a constantly changing set of variables, a cost minimization linear program might fluctuate wildly, and could produce undeterminable solutions.

Second, a linear programming model requires quantitative values of the relevant costs, or, quantified estimates of the relevant costs. Given the complexity of the global supply chain, many relevant costs are difficult to obtain/estimate. Thus determining the costs increase the inaccuracy of the model. In addition, multiple linear programming models, assumptions, and constraints can quickly become unwieldy and difficult to explain to upper management.

Another approach was implemented using Excel Visual Basic Applications. Wu developed a Total Cost Ownership Model with an Excel VBA software tool for automated test equipment and systems. The primary purpose of the project was to reduce total

supply chain costs (Wu 2005). The author identified “hidden” costs associated within the TCO Model that are typically not considered. These “hidden” costs primarily centered around outsourcing, and include such things as selecting a vendor, managing the contract, etc. (Wu 2005). So based on all the estimated costs that could be relevant to the total costs (including the hidden costs), a three-tiered costing-hierarchy was proposed. Tier 1 were the “easily-quantifiable” costs, Tier 2 the “not-so-easy” quantifiable costs, and Tier 3 the “not-quantifiable” contributing costs (Wu 2005). The “Total Cost” is then a function of the three tiers of costs.

Aside from these three costing tiers, the TCO model has three components. First, the data represents the Tier 1 actual costs. Second, the node map visually demonstrates the flow paths within the supply chain. Finally, the output will display costs based on different scenarios (Wu 2005). The output from the model is a lowest-cost freight option, based on the mathematical function of all the input costs.

While the idea of TCO Model is proposed, the author acknowledges how complex the calculation would be to consider all costs involved. Thus, all costs within a hierarchical framework should be organized, and estimate the supply chain costs based on those costs identified within a particular tier of the framework (Wu 2005). The total costs are only assessed based on the more “quantifiable” values of the supply chain. The TCO Model, then, is more of a theoretical approach to conceptualizing the costs, and not a tool for calculating the totality of actual costs or even a best estimate of the costs (Wu 2005).

Too, in one Case Study one of the main issues cited as a barrier to TCO modeling is not having the information system to provide the necessary data (Ellram 1994). Thus, the model can be considered as a design tool; not an execution tool; some expenses were included; some weren’t. Too, as previously mentioned, definitions of the

supply chain differ; thus, confusion can ensue from including different costs without clearly identifying what costs the Supply Chain Cost Model is to include (Wu 2005).

2.9 Costing Summary

The various theories/ approaches are summarized in Table 2-1. Traditional Cost Accounting (TCA) provides the foundation for most every costing method considered. Grounded in accounting tradition that has been in place for many years, the accounting practices used are not likely to change. However, TCA provides little assistance in deriving supply chain costs; primarily due to its inability to identify costs associated with particular processes/supply chains.

It is an understatement to stress what impact Activity Based Costing (ABC) has had on allocating costs. Especially in light of “siblings” of ABC, it has become the central influence in more realistically assigning costs to the particular processes/functions that consume/utilize those costs. However, the main idea of ABC is developing a driver for the cost allocation. That driver most of the time will involve assessing/allocating values/costs to that driver. Large organizations with legacy systems will be resistant to such steps, as the “actual” expenditures needed to make the infrastructure change to capture that cost far exceeds any “estimated” value from the usefulness of the capture data.

Finally, Total Cost Ownership models provide the ability to view all costs associated with a particular supply chain. As supply chains grow and increase in complexity, the ability to individually account for all these costs can become quite a task. With the increased complexity of the chains, the estimating tools to account for all these costs must also increase in complexity. All these costing methods may serve different purposes for the organization. If more accurate costing is required, then the complexity of the estimating tool may not be that relevant to gain the accuracy. If the desire is to

accurately estimate costs for managerial decision-making, simpler is better. Simplicity clearly may far outweigh the need for high accuracy with an estimating tool.

Table 2-1 Costing Approach Overview

Costing Approach:	Citations:	General:	Strengths	Weaknesses
Traditional Cost Accounting	(Lockamy and Smith 2000; Fernie, Freathy et al. 2001; Seuring and Goldbach 2002; Christopher 2005)	Standard approach to accounting for incurred costs	Consistent among organizations; follow GAAP and other guidelines	Costs in broad areas; has no association to process.
Activity Based Costing	(Deo 2001; Fernie, Freathy et al. 2001; Lin, Collins et al. 2001; Wu 2005; Varila, Seppanen et al. 2007)	Utilize a cost driver to account for costs related to a process	Allows for costs to be better aligned/associated with the relevant process that creates the cost	Has to change accounting system to capture the cost driver; driver may represent a subjective item, creating confusion.
Target Costing	(Lockamy and Smith 2000; Ellram 2002)	Determine the sell price, and work down from the sale price	A good tool for managing costs; allow for supporting primary Strategy	Does not work for estimating costs; centers around sell price; not costs.
Organizational Based Costing	(Lenz and Neitzel 1995; Deo 2001)	Adds every additional cost contribution to the base. product/service	Directly associates the costs with the process that uses them	Requires extensive knowledge of all costs associated with process; many costs may not be known.
Logistical Based Costing	(Kosior 2004)	Similar to Organizational based costing,	Takes the entire pipeline into account	Breaking down activities

Table 2.1—*Continued*

		tracks costs through material flow		costly and difficult
Total Cost of Ownership Models	(Ellram 1994; Ellram 2002; Ferrin and Plank 2002; Kosior 2004; Wu 2005)	Tiered approach for valuating all costs associated with the process	Provides ability to view all costs; acknowledges difficult to quantify costs	Can become complex very quickly; many costs difficult to estimate; or are "hidden"
Linear programming costing model	(Goetschalckx, Vidal et al. 2002; Kosior 2004)	Develop max/min model to determine cost based on constraints	Allows for true cost minimization based on all known conditions; allows for "what if" analyses	Changing variables problematic; all costs must be quantitative; confusing to explain
Resource Consumption Accounting	(International Federation of Accountants, 2009 A/B; White, 2009)	Estimate Costs by reviewing consumption of resources in processes	Enables cost Facilitates pro-active approach to cost estimation/ management	Not intuitive; costs still "captured" additionally to traditional cost methods

It may be more useful for management to model what currently exists; what is in place; rather than trying to "force" the system to a particular cost driver. Estimating costs within a specific process in a supply chain is one thing; costs throughout the entire supply chain are another. Thus, viewing the supply chain costs from a "transaction" level, as opposed to an "activity" level, may provide benefit to the organization that cannot easily modify systems to capture costs needed to accurately present the "activity" costs.

Chapter 3

Methodology

3.1 Supply chain cost-definition

Before further discussing Supply Chain Management (SCM) costing, it is important to identify what encompasses the term: Supply Chain Cost. While recent overview literature provides several definitions (Wu 2005; Guinipero, Hooker et al. 2008), most contain components of manufacturing/raw materials. That component may or may not be applicable in every SCM scenario. An organization may treat such costs differently-mfg., Supply Chain Costs, marketing, etc. Many times, the cost of mfg. a product from raw materials to the package placed ready for shipment, is well known and accounted for in a different manner. The cost from shipment forward, is the area of interest.

Thus, one proposed definition of Supply Chain Cost is: The sum of the costs beginning at the moment product leaves the manufacturing facility. This definition follows a more defined path of the finished product; considering only those costs involve in "taking" the product from the mfg. facility and delivering it to the customer. This definition of Supply Chain Costing may represent more of the philosophy and culture at an organization, and less of the more formal textbook definitions of Supply Chain Cost.

3.2 Model Development

Using this definition of Supply Chain Cost and the identified weaknesses with existing costing literature, a model is required which satisfies the following considerations:

- Develop a tool for estimating Supply Chain Costs for a large, global organization competing in a global market.

- The tool will be a top-down dashboard approach; not a bottom-up approach because:
    - Specific cost drivers cannot be utilized as changes cannot be made to the accounting system to capture them.
    - The total, real S.C. costs are not known (at the bottom); thus they need to be estimated (from the top).
- An empirical estimation model will be utilized:
    - It is difficult to utilize traditional Operations Research /Industrial Engineering models, as the need to be explained/ understood by upper management.
    - The general approach will utilize a triangulation method.

The literature review encompassed accounting theory and costing models related to supply chain costing. In that overview, most authors call for practical-based research that is useful and easily implemented by the practitioner. In addition to the model being useful and practical, theory and sound research practice should provide the needed foundation, building on the current state of OM literature.

Given the weaknesses identified within the cost accounting literature, this thesis seeks to address supply chain costing theory within the Transaction Cost Economic (TCE) perspective. These issues are addressed within an organizational framework for the desire to implement useful, sound decision tools.

3.3 Methodology-Using Case Study

The history of Operations Management has been primarily dominated by a history of statistical analysis and quantitative modeling (Meredith, Raturi et al. 1989). However, given the changing nature of Operations Management, a broader range of research methodologies are needed (Meredith, Raturi et al. 1989). One such methodology is the Case Study.

From the 2005 POMS conference, Marshall Fisher suggests that a Case Study, and/or observations/interviews with managers is an ideal way to begin the research process (Sanders 2009). It is recommended that practical research not only be practical

in theory, but also have “Operational Validity”. Simply, research should be easily and accurately implemented by the practitioner (Dess and Markoczy 2008).

In an editorial in Operations Management Research, the point is further stressed to extend the diversity and approach with Operations Management research (Markland 2009). By lamenting the overuse of survey research, Markland illustrates two examples of conducting research as a part of industry; illustrating the value of field research and the benefits that can be gained. For research to be relevant, it has to be based on real problems and real solutions (Markland 2009).

Within the Supply Chain Literature, there appears to be a surplus of survey studies, while the Case Study/content analysis methodology seems to be lacking (Guinipero, Hooker et al. 2008). One five-year review of published OM articles suggested that only 8% of the studies were case-based (Stuart 2002). It is also suggested that more literature is necessary on Global Supply Chains, especially utilizing the Case Study approach (Guinipero, Hooker et al. 2008). One example of this literature is a Case Study analyzing Supply Chain Costing (Fernie, Freathy et al. 2001). Simply put, there is a need to provide less-complex solutions to supply chain issues than may have been proposed in times past (Kouvelis, Chambers et al. 2006).

Current research should focus on improving the value of research to the practicing community. In discussing rigor vs. relevance, the charge is given to increase the amount of practical-based Supply Chain Research (Flynn 2008). In short, does the research have practical relevance? Is the research useful, understandable, and interesting for the practitioner? These cited articles certainly do not dismiss the notion of diminishing sound theory and statistical methodology; poor research benefits no one. Rather, researchers should be about producing work that benefits the practitioner

community; not producing pieces to be read, relished, and respected solely within the academic community (Flynn 2008).

The value of Case Study lends to unique advantages of relevance, understanding, and exploratory depth (Meredith 1998). While the study provides an ideal approach to view a research question of interest, the process of conducting the Case Study should be clearly identified. The following definition more clearly defines what should encompass the Case Study:

> "A Case Study typically uses multiple methods and tools for data collection, from a number of entities by a direct observer(s) in a single, natural setting that considers temporal and contextual aspects of the contemporary phenomenon under study, but without experimental controls or manipulations" (Meredith 1998).

One method is following the traditional five-stage research process model (Stuart 2002). The steps are:

- defining the research question,
- developing the instrument,
- gathering the data,
- analyzing the data,
- And then disseminating the findings.

Literature review will bring the research question to light, demonstrating the need and relevance for asking the particular question. The research question can assist in formulating the appropriate instrument for conducting the Case Study and clarifying the site selection. Gathering and analyzing the data is a logical step after developing the instrument, with dissemination following up the process (Stuart 2002).

3.4 Case Study-Iterative Triangulation

While the five-step process represents the "traditional" approach, additional methodology employed within the five-step process may provide a richer Case Study experience, and allow for better results for the proposed research question. In developing OM theory, it may be necessary to embrace approaches that facilitate more induction and

description, and rely less on quantitative tools (Lewis 1998). One such approach may involve observing the operational setting in its natural state, then cultivate opportunities from those observations (Lewis 1998).

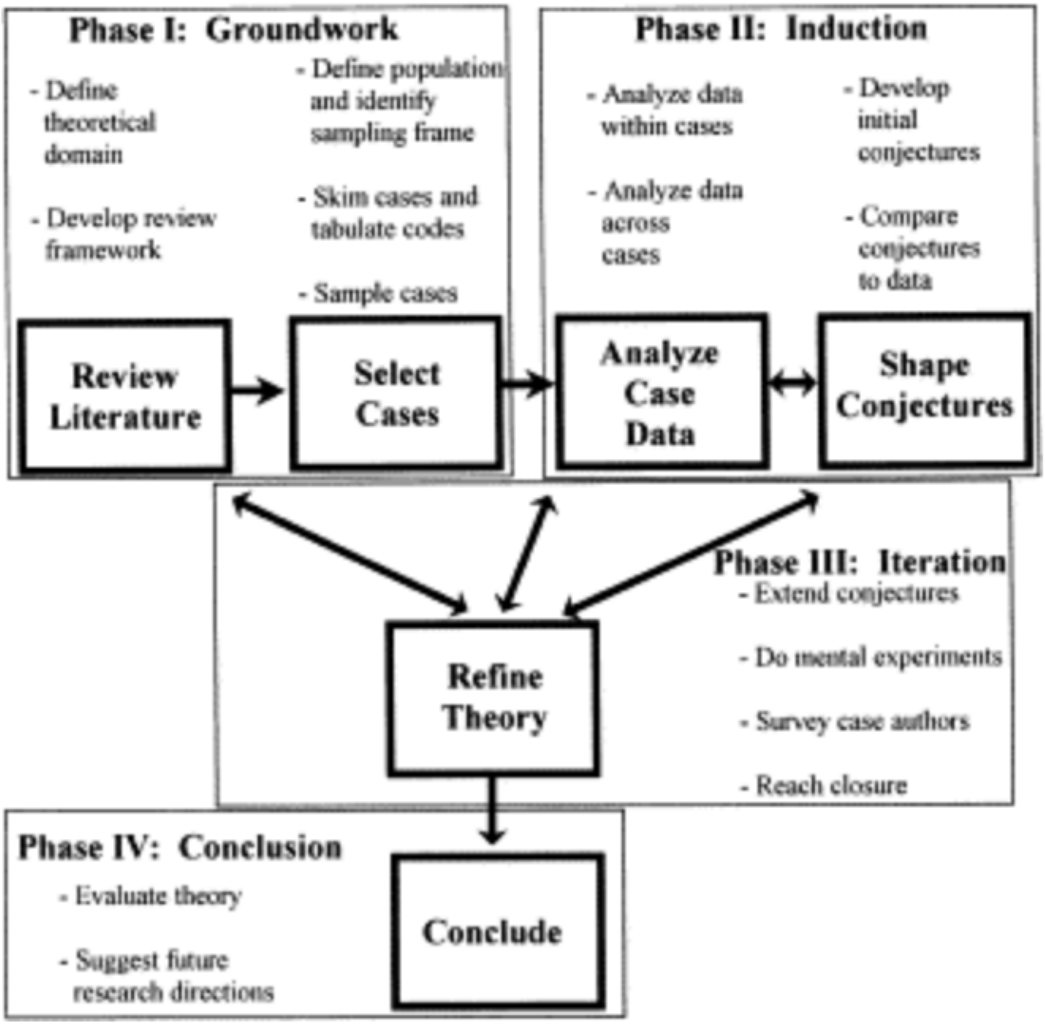

Figure 3-1 Methodological Process (from Lewis, 1998)

Iterative Triangulation (Refer to Figure 3-1) involves dynamically working among the literature review, case evidence, and intuition (Lewis 1998). While each methodology has limitations used individually, the research process is strengthened significantly by also combining the three methods. While the Iterative Triangulation approach focuses on using existing Case Studies, the methodology could greatly enhance the approach when conducting new Case Studies.

The ability to selectively choose and control the site selection may be limited. Thus iterative processes can be utilized to originate exploratory theory from one Case Study; which then guides the research instrument in the second Case Study (Lewis 1998). The data from the first Case Study is analyzed and assessed against the literature, then coupled with research experience and intuition. This provides the groundwork for the purpose of a second Case Study.

So extending the methodological process proposed by Lewis, a similar approach can be employed with model development.

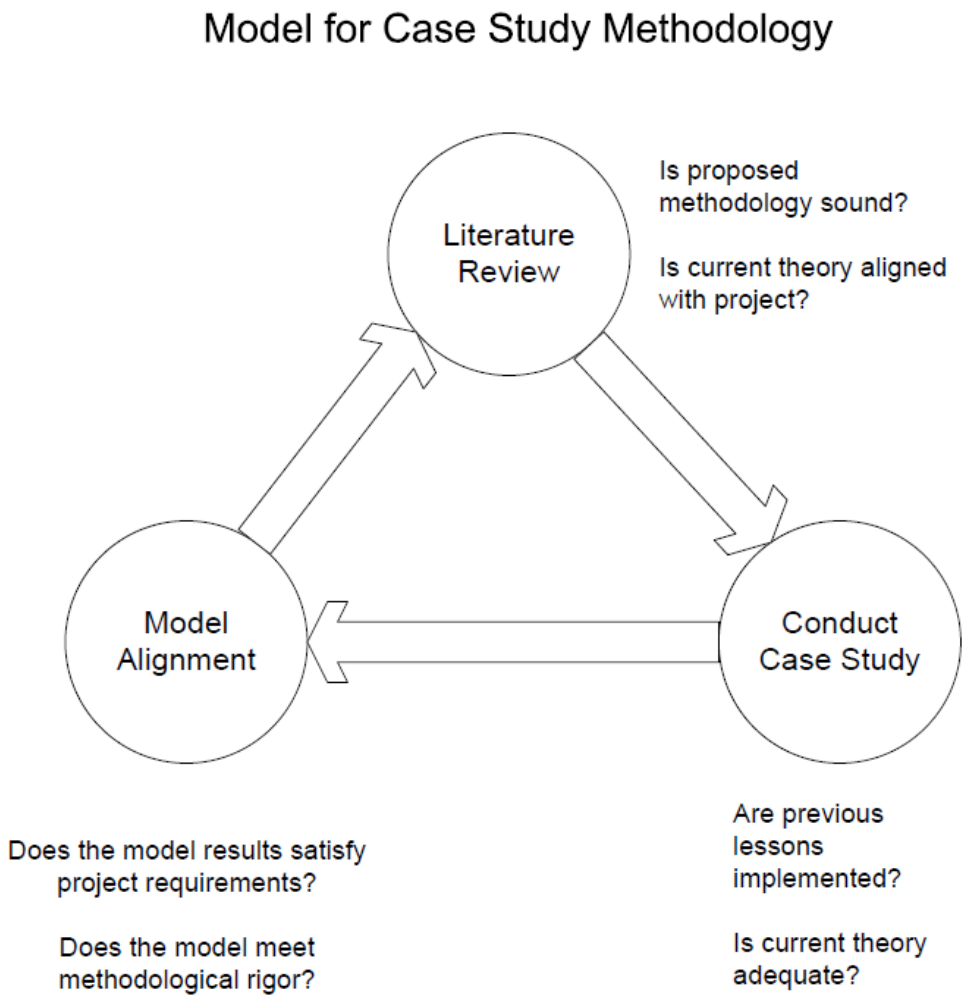

Figure 3-2 Model for Case Study Methodology

Literature review should always provide the basis for the research process. That basis then provides a perspective to guide the Case Study. If one does not have some

theory based upon which to conduct the research, the entire endeavor may prove frustrating; and represent more of a “shot in the dark”, rather than a sound research endeavor.

After the Case Study has been completed, model alignment occurs. So similar to the Phase 3 iteration in Lewis’ model, the results of the Case Study are compared with the goals/objectives of the thesis.

- Did the research accomplish the desired goals?
- Are the results consistent with the current theory?
- If they aren’t consistent with the current theory, is there a research opportunity present that was not previously considered?

These questions then guide the iterative process of proposing a new Case Study, further review/formulation of theory, model refinements, new objects of interest, etc. So for the current thesis:

- Iteration 1 represents approximately 70% of the costs
- Iteration 2 represents approximately 80% of the costs
- Iteration 3 represents approximately 85-90% of the costs

The process can continue until management goals are satisfied, research interests are satisfied, the efforts reach a point of Diminishing Returns, etc.

In summary, the listed model considerations provide the boundaries for the cost model. The model development will be conducted using Case Study methodology. Given the problem description and the literature review, a Case Study can provide the conduit to test the general research question(s) and provide the opportunity to collect data for verifying the research question(s). The perspective upon which costs will be compiled should be “guided”. A theoretical basis should be cultivated to represent the best method of viewing the process. Transaction Cost Economics will provide the theoretical basis.

3.5 Data gathering

Given the identified gaps in costing literature and the exploratory work from the Case Study, the initial model is then proposed. Data to test against the proposed costing model is evaluated. Relevant cost data (Cost Of Goods Sold, distribution costs, redress costs, # of affiliates handling the product, etc.) is gathered and compared against the model. If the results are not in alignment with the expected results, the next iteration is started.

Chapter 4

Literature Review-Transaction Cost Economics (TCE)

Despite the great value Transaction Cost Economics (TCE) has provided in the literature for explaining costs in terms of activities (transactions), Operations Management (OM) has capitalized on this valuable theory (Grover and Malhotra 2003). While there have been several studies within OM employing Transaction Cost Economics, many OM topics (supply chain integration in particular) may be better served by viewing through the TCE lens (Grover and Malhotra 2003). Given the previously cited limitations for many of the other cost estimation functions, the present need may be well served by estimating supply chain costs from a TCE perspective. A brief overview of TCE will now be presented.

There are two keys assumptions for TCE - Bounded rationality and Opportunism (Grover and Malhotra 2003). Bounded rationality deals with the human ability to have and process all the relevant information needed for a particular transaction. Bounded rationality is a cut-off point to accurately processing all the needed information. There is error present in handling/processing that information. That error has a price, and in terms of TCE, bounded rationality increases the transaction costs (Grover and Malhotra 2003). These costs are apparent by the very fact that no perfect contract has/can be written; contracts have disclaimers/ conditions surrounding the agreed-upon exchange, etc. So bounded rationality and the magnitude of the uncertainty plays an important component when discussing TCE. Second, opportunism is a by-product of having human behavior influencing the transactions. This behavior can take many forms such as cheating and

lying; or simply capitalizing on a perceived “opportunity” to better one’s economic situation (Grover and Malhotra 2003).

Three key constructs of TCE are asset specificity, uncertainty, and governance mechanisms (Grover and Malhotra 2003). Asset specificity deals with the uniqueness of the resources needed to complete a transaction. For example, say a cellular phone manufacturer needs to extrude a particular part for an application. That extruded part will only work for that one model of phone, and as a cell phone is widely considered consumable electronic, the phone will not be on the market for long. Any assets that are required to extrude that part and are unique to that one part (a die set, for example) and cannot be used for anything else would result in high asset specificity.

Thus, in TCE high asset specificity will increase transaction costs, as the ability to use that asset for other ventures decreases as the specificity increases (Grover and Malhotra 2003). Next, uncertainty refers to the magnitude of unknowns that could affect a transaction. So high uncertainty could easily drive bounded rationality.

Finally, governance mechanisms involve the process for controlling the flow through the Supply chain. It can range from total vendor control, to partial vendor control, to complete control on the part of the firm over the process. The governance mechanism typically is seen as a Dependent Variable (DV), given the Independent Variables (IV) of transaction costs, asset specificity, and uncertainty (Grover and Malhotra 2003).

Examples of this IV/DV relationship are presented. XYZ corporation assembles DVD players; they mfg. some of the plastic parts that go into final production, and purchase the rest from vendors. Vendor 1 has been performing this service for a while, but tends to increase their prices every time the contract is renewed (opportunism). While XYZ management is less than enthused about the increased price, vendor 1 has what they need to produce XYZ’s part (high asset specificity) and they have a pretty stable

working relationship (low uncertainty; unbounded rationality). Based on these considerations, XYZ chooses to continue to outsource to vendor 1 (market governance).

Vendor 2 is much more problematic than vendor 1. Vendor 2 is late delivering products to XYZ, and claims that it is difficult to retool and make the parts, given the low volume ordered. Vendor 2 provides a critical component to the process, and XYZ management has expressed dissatisfaction with production stopping due to the one component not being available. It will not require that much capital or ground space to make the part in-house, but will require some training (low/medium asset specificity; lower uncertainty and opportunism). Thus, management decides that this process is better done in-house (firm governance structure).

The various Transaction Cost Economics scenarios could easily manifest through the entire Supply chain, and depending on the volatility of the market, could change continuously. The point is that TCE provides a framework for viewing transactions and making decisions regarding make/ buy, breaking points; and provide more quantitative estimations as to the economic feasibility of continuing with a particular firm/agent relationship. There is a constant “evaluation” between transaction and production costs; and the value of the difference and the goals of management will influence switching governance structures.

One study suggests the entire supply chain can be evaluated from the perspective of Transaction Cost Economics (TCE) to determine efficiencies and appropriate governance structure (Iyengar 2005). Iyengar uses inventory stock from publicly available Input-Output Tables for a measure of supply chain performance. It is theorized that the flow of information should lower transaction costs due to increased efficiency. More activities would be outsourced; thus, the supply chain length would increase due to suppliers seeking market-based transactions. Iyengar concluded that

supply chains are increasing in size over time, thus leaning towards market governance (Iyengar 2005).

The Iyengar study provides a very useful basis for viewing Supply Chain Costs from an economic perspective, rather than previously discussed Cost Accounting perspectives. However, the methodology is of little value for the present thesis, as the data is obtained from publicly available input-output tables. Too, typical limitations are noted regarding the NACIS codes and the input-output table construction (Iyengar 2005). Gathering and analyzing data for the entire supply chain would be time consuming and costly; and many times visibility in the supply chain is limited past one level. So it is a useful approach to consider the efficiency of the supply chain, and take a more aggregate view of the costing process.

Given a particular industry, transaction costs could take any number of unique forms. For example, a pharmaceutical industry may have a complex knowledge asset for a particular process. Transaction costs may represent a cost of managing the knowledge transfer to perform the particular action by a market agent. That transaction cost would then be evaluated against the production cost offered by the market agent. Given the time/money dedication for developing, validating, and approving processes, the transaction cost of transferring a process to an external vendor can be quite significant.

It is reasonable to view the Supply Chain and its operations through other theoretical lenses besides Transaction Cost Economics. For example, the product-handling process within the affiliates could be viewed as being a unique resource. Thus, within a Resource Based View (RBV) the organization may not wish to outsource the product-handling within the super-performing affiliates; if the activities represent a competitive advantage. Whether to outsource the activity would then depend on the

strength of the resource position and the potential for opportunistic behavior (McIvor 2009).

TCE remains the more desired theory for this thesis, given the circumstances of the supply chain. First, the “product” is very similar-receiving the similar goods, “redressing” with similar labels/cards (if applicable), and shipping to customers. Too, while efficiently meeting regulatory requirements could be construed as a competitive advantage, most all affiliates are conducting the regulatory requirement fulfillment the same way; most have very similar requirements. Each affiliate has similar resources doing similar activities, but some appear to be more expensive than others. Viewing and managing the affiliates with higher-than-normal costs is the primary objective.

So of higher interest is if the affiliates are performing similar transactions at similar costs, or if their costs are higher/lower than the group in general. Significantly higher costs may represent inefficiencies in the Supply Chain (that may reflect opportunism). While lower costs may represent best in class, or possibly a situation to view about how distribution costs are reported.

In conclusion, this literature review cites several approaches for estimating the costs incurred throughout the supply chain. Many of the approaches rely on key assumptions; one of which is identifying a cost driver, and then accurately tabulating those costs associated with the cost driver. While conceptually simple, logistically it may prove exceedingly difficult to enact the necessary changes in the accounting system, initiate appropriate levels of education and training, and drive change in procedures to accurately record the cost driver expenses. An alternative costing method is needed that can estimate costs within an existing accounting framework.

Transaction Cost Economics is a powerful theory with Operations Management (Grover and Malhotra 2003). Iyengar’s study utilized TCE in estimating whether the

length of the supply chain is growing over time; suggesting increased market governance. While quite useful in the theory and application within the supply chain, the methodology is quite limited to the publicly data available used. Too, given the limitations cited by the author, a more flexible costing method is needed; which can offer simplicity to the user, and utilize existing costing estimates in-place within the Traditional Cost Accounting values. Little research has been conducted in empirically measuring the transaction costs; as they have historically been approached conceptually (Grover and Malhotra 2003). In summary, the Case Study process will be viewed through the lens of Transaction Cost Economics.

Chapter 5

Methodology-2nd Iteration

5.1 Preliminary

It would be ideal to be able to guide the Case Study process based on the formal/ classic steps for conducting research. However, researchers do not always have that luxury. Too, direction from management within organizations may dictate a particular methodology/ approach. Such is the results from the following Case Studies. First, a general review of site selection.

5.2 Site Selection-Venture, Inc.

To suggest that Venture, Inc. has enjoyed tremendous growth globally is an understatement. It is quite clear by the consistent financial and social success of the organization that sound management has always been in place. However, process improvements are always welcome in any organization. Given the fast growth of the organization and the increased desire to more closely manage the supply chain, the global supply chain group is ideal for modeling strategy implementation tools. Thus, given the scope of a large, financially successful, global organization with multiple supply chains, the need for additional decision tools to achieve organizational strategies is warranted.

The first observation regarding complexity is not trivial; several issues play into the mix. One of which is that Venture, Inc. utilizes a legacy accounting system. Due to the evolution of the system, there are not specific entries in the system for “supply chain” entries. One supply chain center (one member of one supply chain) may enter shipping and receiving charges separately. Another may choose to enter them as one freight charge entry. Thus, it is extremely difficult to obtain “actual” costs for many of the

proposed Supply Chain Cost drivers, as the system is primarily designed for capturing conventional costs.

Too, the system designed for capturing conventional costs is not uniform between Supply Chain Centers, thus adding more confusion to any proposed cost estimation. Also, given the global nature of the supply chain, expenses may be presented differently in the accounting system for tax purposes. Finally, many of the supply chains want to pass on the cost of goods to the next chain partner without having all the different expenses outlined. Rather, there is no incentive to have an identified driver for each supply chain node to explicitly detail the costs from the individual affiliate's perspective.

The second observation is one of the influencers of this thesis. The Supply Chain Management group had received a Supply Chain Costing Model previously similar to the Wu model (Wu 2005), but due to the complexity and the number of inputs required, it was not utilized. Too, due to the fact that it could not be updated and have the data refreshed; thus, the model served little use. Any proposed costing model should recognize the complexity of the system, approach it from an aggregate level, and maintain simplicity as best as possible.

Thus, all the Supply Chain Costs can be broken down into a compilation of costs, based on how easily they can be quantified. While it would be ideal to include some measure of all the costs, it is more realistic to establish the model based primarily on the quantifiable costs. Too, it keeps the model simple and understandable (Wu 2005). Additionally, by establishing levels of costs, there is rationale to propose that the simple, quantifiable costs can be a reasonable predictor of the higher tier, less quantifiable costs. (Wu 2005). It is important to remember that an estimating model serves the primary purpose of providing a management tool for high-level Supply Chain Decisions, and not for calculating Total Supply Chain Costs (Wu 2005). Calculating actual costs can be

effectively accomplished using Conventional Costing, depending on the consistency in which those costs are recorded.

Global Supply Chain has developed strategy which governs current decisions regarding the creation of a new supply chain, whether to use an existing affiliate, etc. that are independent of cost. Much of this has to do with having little knowledge of costs (the purpose of the present thesis). When the question was posed to Venture, Inc.-Supply Chain Management what their strategies are, the below three were listed as primary strategic considerations:

- Capacity of existing Distribution Center
- Transportation infrastructure
- Delivery time/ service level

For example, the Supply Chain Manager may be looking at China to assess possible options. The manager may want to bypass the affiliate and strip out a particular RDC (regional distribution center). The above three strategic factors would be given primary consideration in making the decision. However, a certain estimation of costs would be useful. As discussed previously, Strategic factors are a driving force, but so is cost. Thus, the Supply Chain Manager may want to reconsider the decision if the estimated costs are predicted to be overly burdensome. So, the need is to develop some reasonable estimation of costs.

5.3 Are Key Cost Drivers Possible?

Part of the challenge for Global Supply Chain Management is the tremendous growth that has occurred. Within the supply chains, business models evolved autonomously due to need and survival, with Global Supply Chain (GSC) management having little time or ability to implement more consistent models for each node in the Supply chain. Thus, Traditional Accounting Methods were modeled around local

practices, local management input, and various considerations within each country, instead of a uniform, global entry system.

Accounting for freight is a good example. One affiliate may enter a single entry for freight charges incurred for shipping and receiving. Another affiliate may have separate entries for freight in, and another one for freight out. Still another may add additional charges deemed appropriate for a freight charge entry. While each individual affiliate allocates costs based on their local tax code, accounting principles, and immediate upstream/ downstream requirements, these entries provide little (or no) ability to target similar costs among each GSC partner.

As with many large organizations, the different GSC partners have entered the family at different times, with some systems being newer and other systems being older. The older systems are more difficult to implement change, in light of the cost/benefit analysis for making system changes. Even with sound rationale for building a consistent business accounting model for all GSC nodes to utilize, that revision represents a huge cost, in terms of time, labor, effort, and system modifications. Even if management decisions are made to change the reporting system, it is unclear to upper management what level of detail should be added for reporting detailed Supply Change costs given the added time/cost expense.

5.4 Case Study Overview

The purpose is to develop an analytical tool for estimating costs of any given supply chain within the company's global operations to facilitate decisions regarding extending, moving, creating, or eliminating a particular supply chain. While discussion may be made of a particular Organizational Strategy other than cost, Supply Chain Cost is always a significant driver for any Supply Chain Decision.

The Global Supply Chain group requested a dedicated group to work on a collaborative effort to develop solutions for the cost modeling situation. They theorized that a feasible solution exists, but was not sure how to approach it. Also, management knew they may be too close to the problem, and a fresh pair of eyes would be welcome.

Using existing accounting reports from two international affiliates within the Supply chain, a detailed analysis was made of the Supply Chain costs; with the purpose of finding an appropriate cost driver. All the invoices at the two chosen affiliates (Country1 and Country2) were pulled and analyzed, and the costs were placed in detailed line item entries. So fairly detailed spreadsheets were generated outlining labor, rent, insurance, freight in, freight out, taxes, etc. From these spreadsheets, major contributors of the Supply Chain costs were evaluated. These contributors would be used to establish estimations for future decisions. Such decisions might be regarding utilizing existing Supply chain structures, expanding into new distribution nodes, and determining the efficiency of existing Supply chains.

There were two main groups in this Case Study: 1) Analyze the existing Supply chain structure within the continental US, and 2) Develop a basic model of Supply chain costs for Country1 and Country2 distribution centers. Group 1 primarily relied on publicly-available data for analysis. This included population centers, distribution centers listed on Venture, Inc.'s website, and data provided by the major carriers Fed Ex and UPS.

Group 2 is the more applicable focus on specific costs. They were provided two spreadsheets by Venture, Inc.-GSC. These spreadsheets conveyed itemized costs for the distribution centers in Country1 and Country2.

Given analysis of the applicable spreadsheets, These are the top five or six categories identified:

Country2-

- Payroll expenses: 54.11%

- Freight and postage: 18.85%
- Miscellaneous expenses: 12.97%
- Depreciation : 4.34%
- Occupancy: 4.34%

Country1-

- Outbound Freight: 31%
- Inbound Freight charges: 14.9%
- Salaries and Wages: 14.56%
- Personal property taxes: 9.19%
- Site and overhead: 10.2%
- Welfare expense: 7.5%
- Inbound Taxes and duties: 7.3%

5.5 Supply chain Cost Drivers

The groups also performed a literature review to determine others studies that have identified common cost centers. The following cost centers were proposed:

- Inventory carrying costs
- Procurement costs
- Order processing costs
- Transportation costs
- Warehousing costs
- (Lambert et al, 1998, cited in (Lin, Collins et al. 2001)

The results presentations to GSC management were well received. While there was no disagreement that the costs proposed comprise a large portion of the total costs, the standardizing of costs in the previously cited cost centers was decreased in priority, with the realization that it would be very difficult (and time consuming) to quickly develop an estimating model based on the cost buckets for all the different supply chains.

Ideally, the accounting system could be structured with sub-fields where the components listed in the cost initiative could be captured. In the short term that goal may be a difficult one to reach. Thus, in reviewing the actual costs, the main costs from the two distribution centers should be considered the primary goal. It was proposed that

Venture, Inc. supply chain should make system modifications to capture the following specific supply chain costs when they are incurred:

- In-Bound Freight
- Out-Bound Freight
- Direct labor-DC (distribution center)
- O/H-DC (distribution center)
- Distribution Cost labor (Assumption is made that this entry can be currently obtained).

Based on the analysis from Country 1 and Country 2, literature review and management input, these cost drivers should capture 70-80% of the supply chain costs.

The proposed next steps for the costing initiative were as follows:

- Output: standardized buckets of the top DC operational costs used to develop a model with finance for on-going capture of these costs into the standard finance and accounting systems.
- Categorize redress costs into buckets and obtain survey estimates from the supply chain affiliates.
    - Input: Survey results from entities above
    - Output: Classification of redress costs into buckets

5.6 Cost Drivers-post analysis

Despite the presentations being well received and the general knowledge of the value of the Supply chain costs being beneficial, getting changes implemented is another matter. Problems occur in several areas. First, the various distribution centers work fairly independently of each other. Thus, there is natural resistance to going in to the entire chain and forcing system changes.

Too, while there is strong motivation on the part of the supply chain group to add repository buckets in the accounting system for specific costs associated with the supply chain, there is no motivation on the part of the distribution centers to enact this change. Each distribution center utilizes their own system/method for the accounting entry for specific costs, and there does not appear to be any motivation for changing that pattern. Next, it takes funds and management approval to make system changes to collect

specific costs of interest. Currently, the initiative is not crucial enough to warrant elevation.

Consider the example of one manufacturing facility developing products within three different lines: line 1, 2, and 3. Those three lines of products are then shipped to the different affiliates. As the below illustration demonstrates, the supply chain can become very complex, very quickly. The simplified illustration utilizes one manufacturing facility and four affiliates.

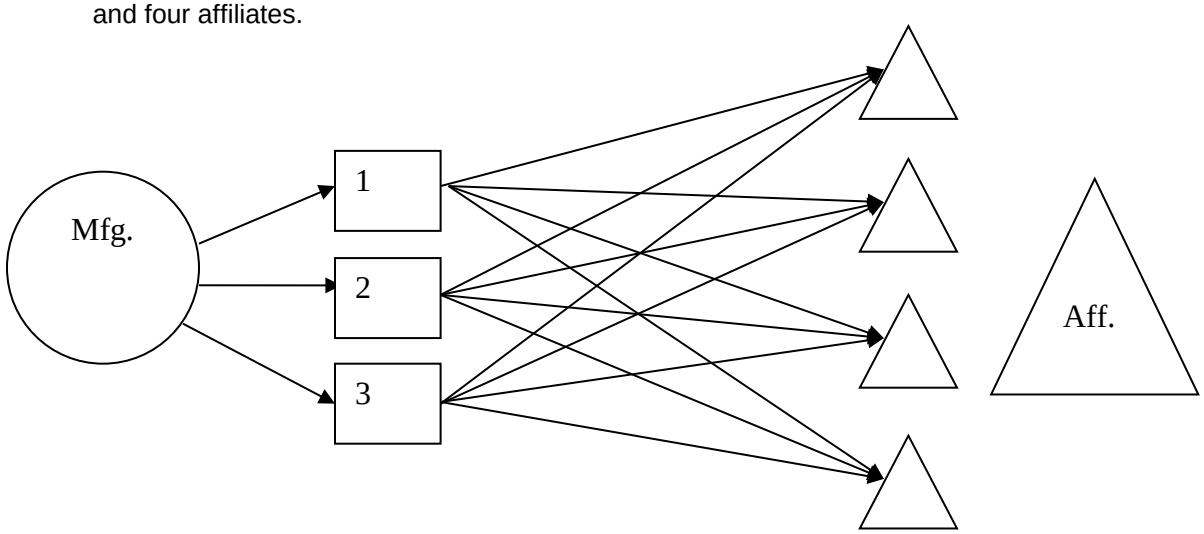

Figure 5-1 Supply chain example of different Nodes

The reality of the situation has several manufacturing facilities and a rather large number of affiliates (approximately 52). Trying to “allocate” costs by different products is very difficult and changes to the accounting system to allow such costing would be cost prohibitive, to say the least.

Therefore, existing studies and literature focusing on costing theories, various models, and structuring of Supply chain costs have proved promising, and provide a needed base for the current endeavor. However, as stated with many of the costing

methods/models, there is little ability to make changes to the accounting system used globally. Thus, any Supply Chain Costing System will utilize the existing cost buckets that are already in place.

Chapter 6

Model Development

6.1 Data Gathering

What are the components of a costing model?

In brainstorm meetings with Global Supply Chain executives, the layout of the supply chain was written on a white board. After discussing how to develop activities within each node, a simple equation for calculating the total Supply Chain Cost was proposed:

[2] Total SC Cost = 1) Mfg. Std Cost + 2) Cost to Operate ICDC (inter-company distribution center) + 3)Cost to Operate RDC (Regional Distribution Center)+ 4) Cost to Operate Affiliate Distribution Center (DC) + 5) Any Redress Cost at applicable DC.

When broken down into affiliates within the supply chain, it is theorized that different components of the cost model can be estimated. If the five components of the model can be reasonably estimated, then the total supply chain cost equation can be manipulated to solve for the unknown. The estimated total supply chain cost can then be compared to the actual total accounting costs for each affiliate, to assure the model exhibits sufficient accuracy.

As with any model, there are assumptions made to allow for an optimal solution to be returned. The model assumptions are as follows:

1. It is believed that virtually every cost above is already known and is a constant, or can be estimated and validated to be a constant.
2. Manufacturing Standard Cost is well-characterized and known. As manufacturing costs are older and more established cost centers, the estimated cost from raw material to dock are already know with a reasonable level of accuracy.
3. Given 1, if all the costs above can be estimated and validated, a simple method for quickly measuring Total Supply Chain Costs can be ascertained.

4. The key cost differentiator between supply chains, all things being equal, is Redress Cost. Redress cost is simply what cost is expended to re-package, provide literature, re-label, etc. the product to comply with requirements.
5. Cost to Operate RDC, ICDC, or Affiliate: based on discussions with Finance and Operations, the following is proposed:
    a. Ratio of 'DC Operational Cost / Units Sold via DC' may be very similar across similar facilities. If true, then each of these costs would become a 'plugged' value in the total cost model.
        - This may be true, as management reviews these types of ratios and forces the operational results towards central tendencies.
    b. By using tiers, groups, and other mechanisms, costs can be further refined and forced into a "plugged" value (for instance, small affiliates may have a slightly different ratio than large affiliates, etc.)
    c. These costs for each affiliate have been estimated as $2.25 per unit by management. This is the assumption that management has been working from in their decision-making process.
6. Redress costs: based on GSC experience, it is theorized that redress costs are tiered and probably constant across sites, for a given tier.
    a. Example: simple redress (adding one label with fixed text) is about $1.05 labor and $1.05 label.
    b. Tiers might include: simple redress; variable text redress; serialized variable redress; others.
    c. By using tiers, groups, and other mechanisms, costs can be further refined and forced into a plugged value (for instance, all facilities may have similar costs for simple redress, etc.)

Given the estimations and management's costs assumptions, the final model breaks down as follows:

[3] Total Supply chain costs (per unit) = Mfg COGS+$5.00 + redress ($.40-$.90 per unit)

These cost estimates currently have little empirical basis. Therefore, the simplified costing model needs to be tested against empirical data. This can be accomplished by comparing estimates from formula [3] above to the total accounting costs for the affiliates. For all the affiliates, the total cost for the affiliates are available. The redress costs need to be operationalized for each affiliate. Given the prior model of redress costs, the estimated redress costs for each affiliate is estimated.

Given actual costs and inventory, and estimated redress costs and apportioned costs for each affiliate, the estimation model can be validated. Thus, redress costs need

to be estimated to progress with the Supply chain Costing Model. Once Redress costs are obtained, [3] can be tested.

The goal of the model is to estimate 80% of the supply chain costs.

6.2 Survey Development

In progressing with the thesis, it was necessary to develop more objective information regarding the redress costs incurred at each distribution facility within the Supply chain. It was determined by the representatives of the Supply chain that the best way to derive the information is by using a survey. A spreadsheet was sent to each of the distribution facilities. The purpose of the spreadsheet was to gain more information concerning redress at the affiliate level. There were several purposes for asking about redress.

First, as seen by the methodology of coding the different costs, each affiliate has a level of autonomy/ independence in managing their operations. Addressing product redress is no different. Each affiliate “responds” (or possibly, “reacts”) to cues from their local environment as to what level of redress is imposed on the products. These cues may comprise of various sources, some of them more salient than others. Consider affiliate A in country AA, shipping product within AA. They may be performing a much more involved level of redress than those conducting “simple” redress. Is this level of redress truly required? Was it required at one time, but may not be anymore? Or could it be that affiliate A are fulfilling redress requirements for country BB, but not AA?

It’s possible that the level of redress activity at the different affiliates is a combination of activities: Requirements (must be done), and niceties (they are helpful, but not required). The issue is that the particular affiliates are concerned with “local” goals of accurate shipment, appropriate inventory, completing all redress activities, etc.; and

have little time to consider “strategic” goals of determining the required redress, the possibility of centralizing redress activities, etc. The redress survey serves the following goals:

- Determine exactly what redress is being implemented in each facility
- Each facility “estimates” what redress costs are incurred
- Compile the information to make strategic decisions regarding redress costs, including the level of redress, centralization of activities, and redress cost estimations to be utilized in the Total Supply chain Cost Model.

In summary, this redress survey will provide better information about redress activity among the different affiliates. This information is gathered using an Excel survey tool, which is discussed next.

The survey tool was designed by a Global Supply Chain (GSC) representative, with input from other members of the GSC group. The survey initially served to capture redress activity only. Given input from an GSC executive regarding the need to capture redress costs, a sheet was added to the redress spreadsheet to capture estimates for redress costs. The redress cost information was fairly simple and objective. Given that there were no perceptual type questions, there was no need for extensive survey validation. Too, given the time constraints and the collaborative nature of the survey, extensive validation efforts were not possible (although in the opinion of the author, not required). There was a week to create an Excel cost tab, check it, and get it in the survey being distributed to the affiliates.

6.3 Pre-Test

The survey questions and the template were sent to 3 participants prior to issuing to the larger audience. Feedback from those sessions was utilized to modify the document appropriately. The first workbook survey was based exactly on the verbiage of a Quality Assurance (QA) Guideline.

As demonstrated in Appendix B, the redress cost questions were fairly straightforward. The survey went on the assumption that the redress costs fit a fairly typical pattern with typical activities. Using the Delphi Method, assumptions were made about what the particular levels of redress should cost. A GSC executive consulted with several other key personnel within the supply chain regarding the cost estimation. The physical costs of the different tags/labels were fairly well-known; a little more subjective was the estimation of labor. However, given the amount of labor required to redress products coming in at reasonably predictable flow rates allowed a per unit estimation of the labor costs. So these category estimates provided a reasonable basis for evaluation.

Thus, each affiliate was asked to report if their experience/actual costs significantly deviated from the assumptions set forth by the questions. The construction of the questions allows for a tiered-cost approach. So in general, those with simple redress activity will only be doing 1-2 simple activities at a fairly predictable cost (tier 1). Those with tier 3 activities will most likely be performing the simple tier 1 and tier 2 redress activities also. This allows for more accurate cost estimation for each facility, given their current level of redress activity. Too, it will allow the GSC to review all the activities at each affiliate to determine the required redress activities, and identify those that can be removed from the process, saving time and money.

The GSC purpose for distributing the survey was two-fold. First, there was a QA Guideline that was sent to all Affiliates May 2009. This guideline was developed in response to audit findings at various affiliates. In short, the findings suggested that the GSC is in need of better control in redress operations. This survey will help determine current gaps so that appropriate prioritization and remediation plan can be planned for the future.

The second purpose of the survey was to get a better understanding of the current redress activities being performed throughout the supply chain. There is currently little/no visibility to the packaging activities that are occurring outside of the manufacturing and Intercompany Distribution Center (ICDC) locations.

6.4 Data Compilation

The surveys were sent to all Venture, Inc. 52 Affiliates. Primary contact was Materials Management. They have since included Regulatory, QA, Finance, etc. as needed. The response rate was 84%. The surveys in raw data form were distributed to the groups for analysis. A presentation was given by the groups that presented the data analysis they had performed. The data was then summarized to be used in the next costing phase.

Given that estimations from each affiliate regarding Redress Costs were available, all the essential components were in place for the model. Given the previous listed model assumptions, the model inputs were as follows:

2008-10 Profit and Distribution Costs estimates from each affiliate.

2008-10 volume and Redress Costs from each affiliate.

2008-10 COGS for each affiliate by Stock Keeping Unit (SKU; ranked by relevance).

List of various SKU's used by an affiliate. This is determined by expert opinion, and the location of origin listed on the master SKU list.

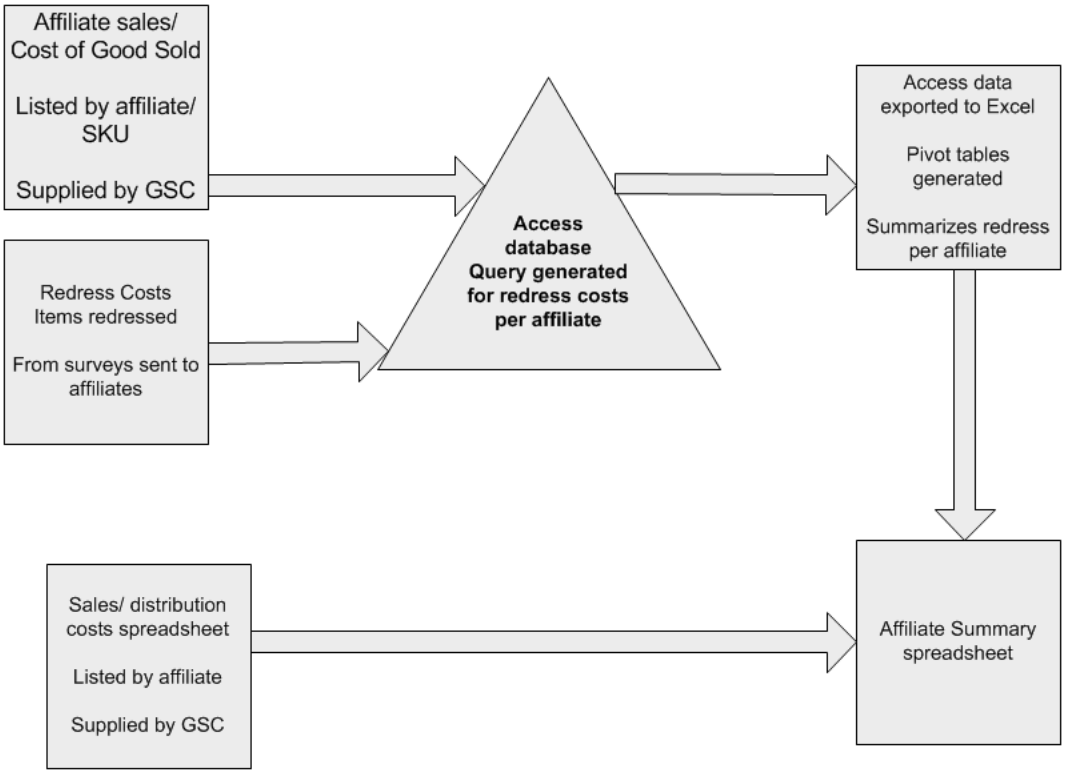

Figure 6-1 Data Compilation: Overview Model

6.5 Data Analysis

A spreadsheet was maintained in regards to reporting redress costs. The non-responses, zero reported costs, contacts, and other relevant information were filed in an Affiliate Survey spreadsheet.

The data first had to be compiled into a meaningful manner. The affiliate sales/ Cost of Goods sold (COGS) was a fairly large spreadsheet. A query was used (with a summary tab) to determine how much total COGS is apportioned to each affiliate.

For the purpose of determining redress costs, the affiliate sales/ Cost of Goods Sold spreadsheet was imported into Microsoft Access. Additionally, the Access database of redress costs was also imported into Access. A query was then used to display the units that were redressed. The query was then exported back into Microsoft Excel. A pivot table was constructed to display the total redress cost per affiliate.

The sales/distribution costs (for each affiliate) spreadsheet was revised. The COGS for each affiliate was added, and the redress costs for each affiliate were also added. This allowed for simple evaluation comparison of the various costs associated with each affiliate. If no redress costs were reported from the affiliate, or if they reported 0 affiliate costs, the value of zero was added in the spreadsheet. This spreadsheet becomes known as the affiliate summary worksheet.

6.6 Data Modeling

Neural networks (NN) have been increasing in use as a viable forecasting tool. Of the multiple advantages, they are being used for prediction scenarios where traditionally regression and other statistical tools have been employed (Paliwal and Kumar 2009). Two reasons for the popularity in using NN are due to the non-parametric and linear/ non-linear flexibility (Paliwal and Kumar 2009; Crone, Hibon et al. 2011). While the tool employs several of the listed advantages, one concern is how robust the tool is in comparison with the traditional tools like discriminant analysis and logistic/multiple regression (Paliwal and Kumar 2009).

There have been several studies performing comparison analyses between Neural Networks (NN) and more common statistical analysis methods commonly utilized. In performing various analyses using various statistical methods during the NN3 competition, NN performed well when using complex data (Crone, Hibon

et al. 2011). The results suggest that NN can perform as competitive as many of the common statistical methods, but did not demonstrate that the results were superior. Conversely, there was no evidence that they were inferior either (Crone, Hibon et al. 2011).

A review of 73 papers comparing NN with other common statistical techniques was performed (Paliwal and Kumar 2009). These techniques included Discriminant Analysis, Logistic Regression, classification and regression trees. In 58% of the cases, NN outperformed the “traditional methods, in 24% were equal, and in 18% NN were inferior to “traditional” methods (Paliwal and Kumar 2009). One interesting note in the article stressed how important basic assumptions are in using many of the “traditional” methods; yet less than 1/3 of the articles reviewed demonstrated that the assumptions had even been considered. Additionally, no advantage was observed within any method when the data was broadly classified between small and large data sets (Paliwal and Kumar 2009).

Chapter 7

Results and Discussion

7.1 Neural Network model

The general structure of the Neural Network model is as follows:

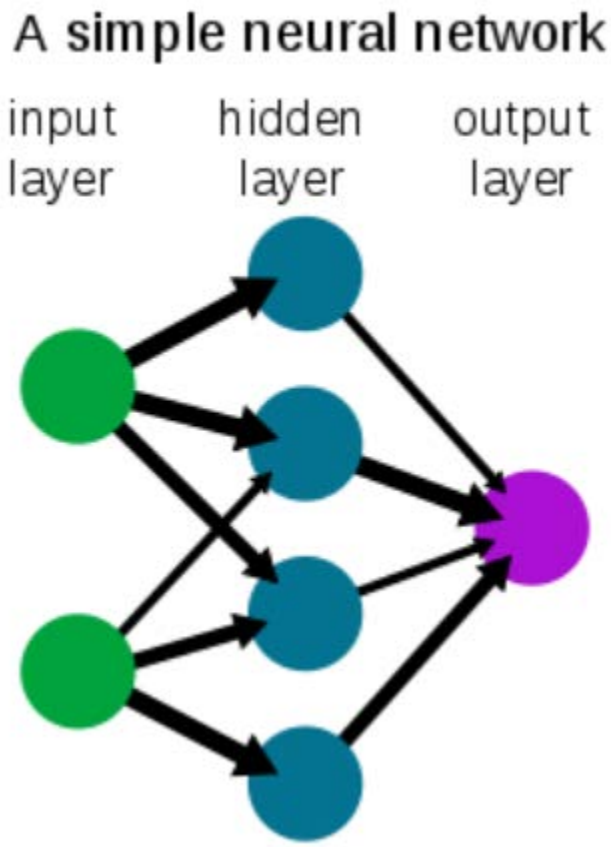

Figure 7-1 Neural Network-General Example

The input layers are the input variables to the model. These are the "estimators" that provide "predictive capability" for the output variable. The output layer represents the estimation of the Supply Chain Costs. The hidden layers represents the

model's generalizability (Kaastra and Boyd 1996), and enable the model to handle non-linear problems in classification (Berrueta, Alonso-Salces et al. 2007). Typically, one hidden layer with the appropriate number of estimated hidden neurons should be acceptable for function approximation (Kaastra and Boyd 1996).

Thus using one input layer, the next objective is to identify the appropriate hidden layers. The recommended approach is to start with two hidden nodes to minimize the opportunity for over-fitting (Kaastra and Boyd 1996). The number of hidden nodes is then increased by two until the power of the forecast reaches a level of insignificance; suggesting the model is "trained" (Gorman and Sejnowski 1988; Hill, O'Connor et al. 1996; Berrueta, Alonso-Salces et al. 2007).

The statistical program JMP is used for the analysis. The relevant data for the analysis is loaded into JMP in spreadsheet format. Using the modeling function, a Neural Network model is developed. The input (Predictor) variables are selected (see Table 7-1), and the Distribution cost is chosen as the output (Y) variable.

Table 7-1 Neural Network- Input Variables

Long Data Description:	Short description:
Member of EU community (Y/N)	EU
Total Volume	V
Total Redress volume	RV
Redressed Performed? Y/N/n/a	RP
Redressed Reported? Y/N/n/a	RR
Redress costs	RC
Redress cost group (self-report from affiliates-(Low/ medium/ high)	RCG
Cost of Material (for each affiliate)	COM
Dec YTD ActUS Net Sales	SALS
Affiliate Throughput? Y/N	TPT
Redress part of distribution costs? Y/N/ n/a	RDIST

7.1.1 Model Validation

The model validation is performed using K fold validation within the JMP application. K fold validation is a cross validation model where the data is split; part of the data is used to “train” the model, and the other part is used to “validate” the trained model (Berrueta, Alonso-Salces et al. 2007; Arlot 2010). Earlier Neural Network literature typically use a K fold value of 5 and 10, primarily citing the main reason being the computational cost of using a larger K fold value. However, several authors suggest using different K fold values due to the increased value gained (Kohavi 1995; Amin and Singh 1998; Arlot 2010; Rodriguez, Perez et al. 2010). It is suggested that multiple cross validation be executed, given appropriate computational feasibility (Berrueta, Alonso-Salces et al. 2007; Rodriguez, Perez et al. 2010). While the literature suggests that large K fold is reasonable, K fold iterations of 5 and 10 are used for this thesis as suggested in the body of Neural Network literature.

7.1.2 Neural Network analysis-Results

The Neural Network analysis was performed while varying the # of K folds and # of hidden nodes. The results are presented below. Given the listed R^2 for each of the parameters, the K fold of 10 and the 4 hidden nodes are chosen for the model. One of the concerns in Neural Network modeling is with over-fitting by selecting too many hidden nodes. This over-fitting is observed when the R^2 for the training set is high; but the R^2 for the validation set is significantly smaller. In the current model, the R^2 for the validation instance shows very little difference compared to the R^2 for training, suggesting that over-fitting concern is minimized (see Table 7-2).

Table 7-2 Supply Chain Costing Model-Neural Network Model parameters

# of K Folds	# of Hidden Nodes	R2 Training	R2 Validation
5	2	.97	.96
5	3	.97	.98
5	4	.98	.98
5	5	.96	.99
10	2	.96	.83
10	3	.98	.89
10	4	.98	.99
10	5	.98	.98
10	6	.99	.90

Figure 7-2 shows a graphical presentation of the Neural Network model:

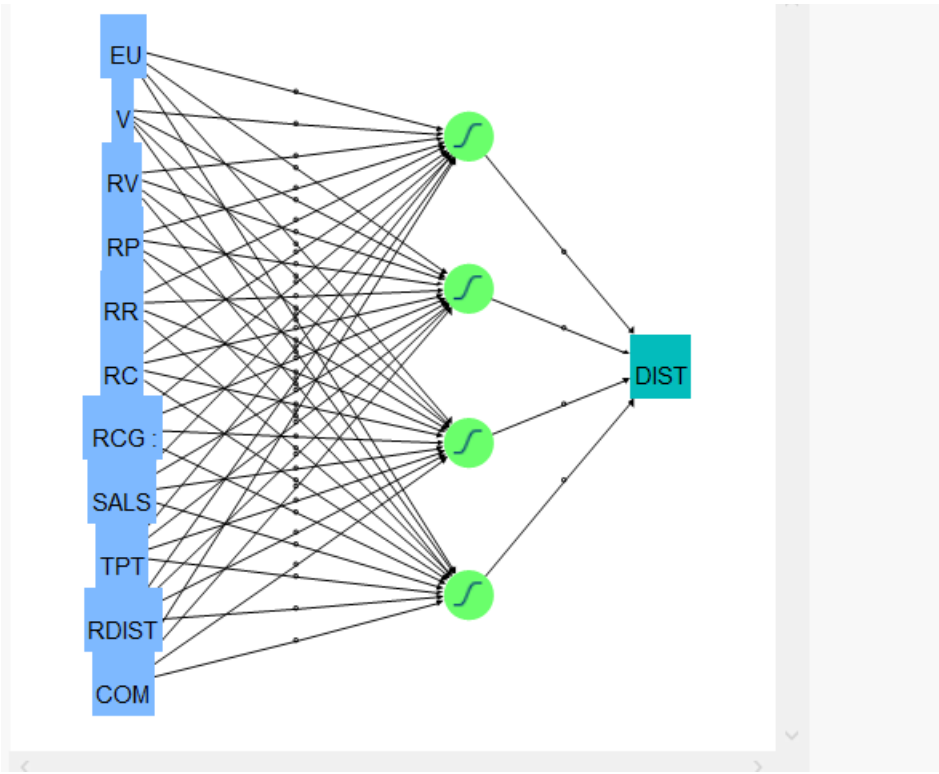

Figure 7-2 Neural Network-Output Model

Given the strong R^2 for the training and validation instances, a satisfactory management-dashboard Neural Network model can be offered, using a small set of input variables. This satisfies management's requirements for accuracy, and given the limited number of inputs, also satisfies the requested simplicity.

The Neural Network model is chosen over other traditional statistical tools used with the data. Standard regression analysis was performed using Log transformed data

and yielded R^2 of. 76 (best case). CART (categorical and Regression Trees) were also used. However, the regression trees appeared to yield inconsistent results when comparing the three years of data. In addition, CART is a more sophisticated statistical tool, and as such, would require more explanation for the practitioner and would distract from the goal of simplicity. Thus, given the ability to handle non-normal/ non-linear data, and the high R^2 results, Neural Network model is superior to other model choices available.

This model can be used to empirically verify assumptions regarding the Supply Chain Costs among various affiliates. Using the various Profile Functions within JMP, particular costing estimates can be estimated by varying one variable, while holding other variables constant. For example, given a particular sales volume, the discrete variable "Member of EU community (Y/N)" can be varied, yielding an estimation of the effect to the distribution cost.

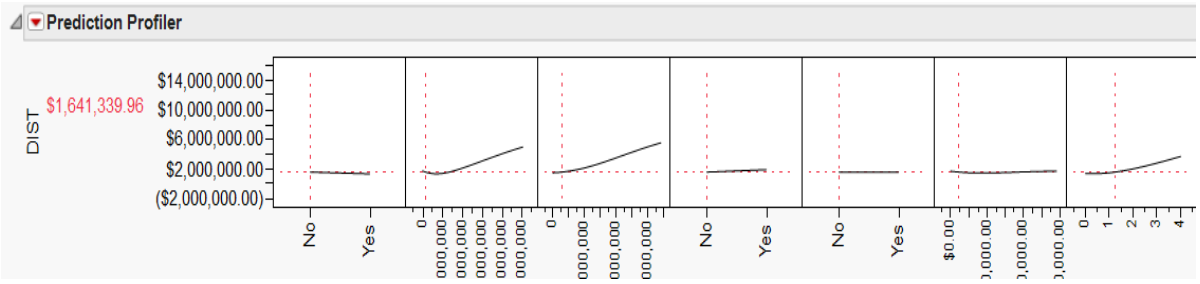

Figure 7-3 Neural Network-Prediction Profiler

By placing the cursor over one of the graphs in Figure 7-3, one can move to a particular criteria and determine how a change in the value affects the other variables. By allowing the user to visually determine the effect of a change in a variable, the prediction profiler provides a dashboard indicator for change in inputs to distribution costs.

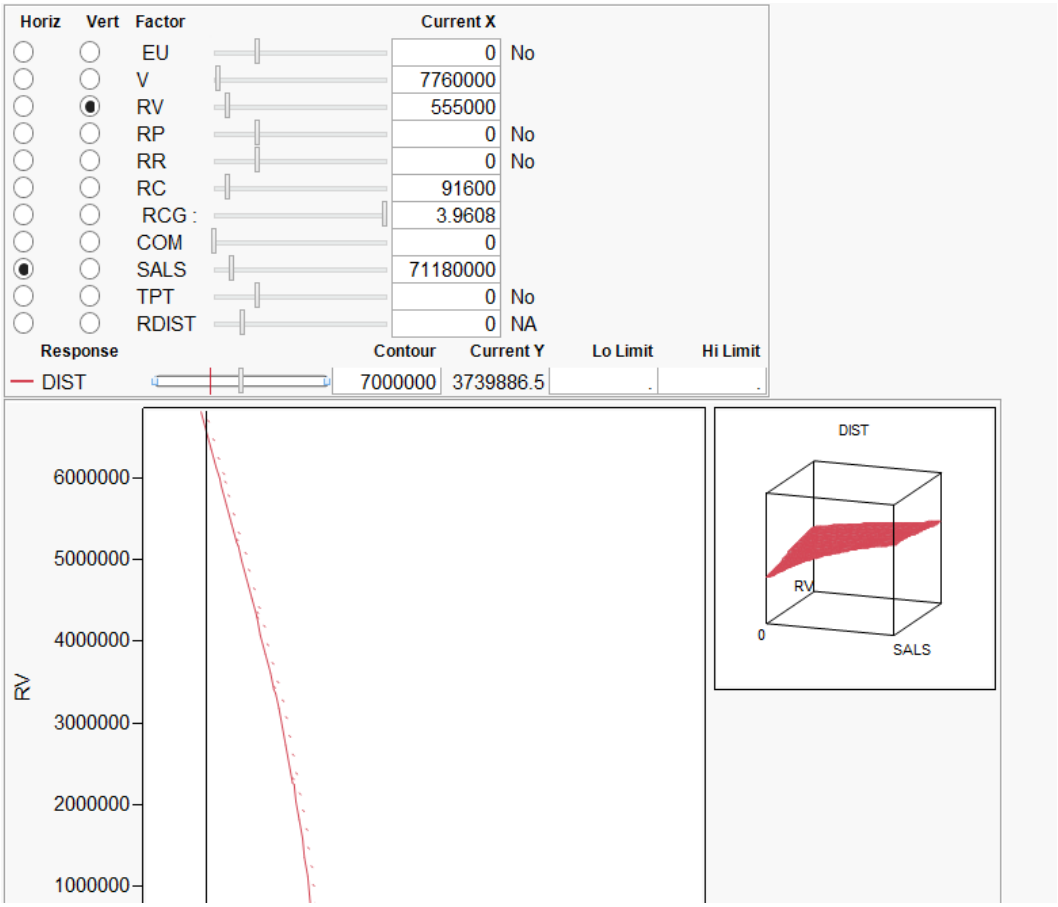

Figure 7-4 Neural Network-Contour Profiler

The contour profiler shown in Figure 7-4 further provides for a dashboard model. It allows the user to “slide” along the horizontal bars next to the factor listings. By selecting/de-selecting a particular variable, the user can view 3 dimensional changes to a choice of up to 3 variables. This will demonstrate the effect on particular variables.

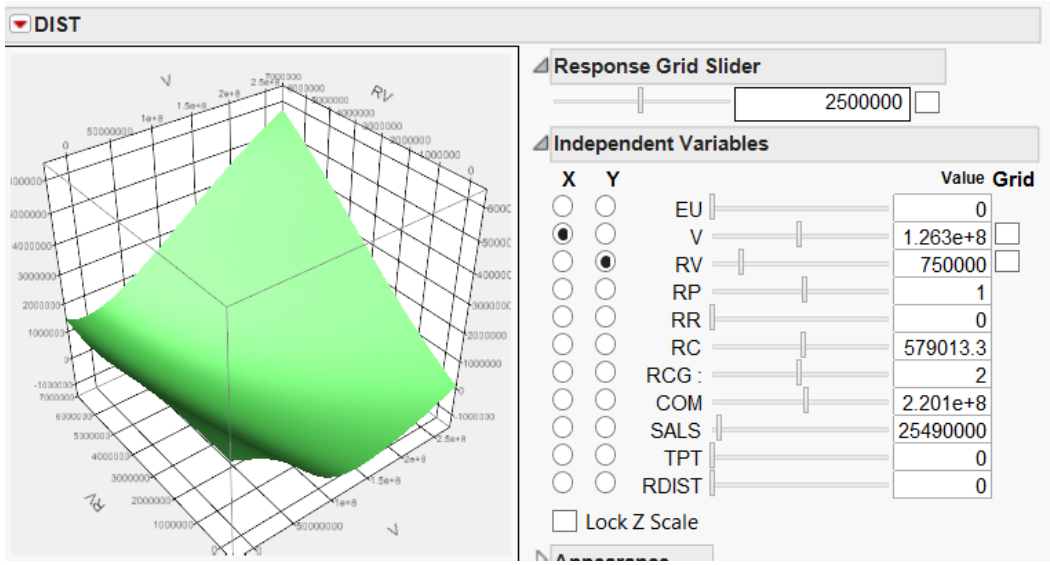

Figure 7-5 Neural Network-Surface Profiler

Similar to the contour profiler, the surface profiler in Figure 7-5 gives additional dashboard decision-making ability by providing a more graphical representation of a chosen change in a particular variable.

Chapter 8

Limitations and Conclusions

8.1. Limitations/Future Research Opportunities

There are limitations with the methodology. First, Neural Network analysis can be seen as a “Black Box” modeling concept. As opposed to more linear models (such as Regression), It is difficult to explain what occurs within the modeling process. Too, given this is a tool that can be used by management, can provide hurdles in gaining acceptance among management. Secondly, the model does not yield the typical deliverables of a modeling activity (weights; parameters; sensitivity analysis). Thirdly, given the specific source of data derived from one industry, the generalizability of the model’s results are limited. The generalizability can be improved through replication using additional data from other industries.

There are a number of future research opportunities. First, more research is needed to expand Supply Chain Costing Theory. Transaction Cost Economics has provided a suitable framework for supporting the current costing model, and for explaining why some costs may be higher than other similar costs (why distribution costs differ significantly among affiliates). However, there may be strategic imperatives present in management decision-making that would explain why costs may vary significantly among affiliates; other than just efficiency in transaction costs. Tax laws, for example, vary drastically from country to country, and do influence how costs are allocated in a traditional accounting system. Expanded theory is needed to explain how additional strategic imperatives influence costing estimates among global affiliates; that may conflict with the need to simply report the lowest transaction cost for distribution.

Secondly, the choices of input variables can be revised, expanded, and/or reduced. The current model uses eleven variables. The model may yield acceptable results using a smaller set of input variables, and needs to be validated using other datasets. More research is needed to verify if there are other easily-obtained input variables that can provide predictive ability for distribution costs. Alternatively, it may be decided that adding a few more input variables yields higher validation fit when using other datasets. As the results of the model are tested using data from other sources/industries, the model may be improved to yield more generalizable results.

Next, the model should be tested every 3 years, to assure the model still yields acceptable results. If it is observed that the R^2 model estimations begin to decrease using different datasets, the # of hidden nodes may need to be re-evaluated. Also, the # of K fold validations can be increased.

Finally, additional modeling techniques should be explored in addition to Neural Network analysis. Other modeling techniques that do not assume normality/ linearity should be developed and tested. If additional models are identified, the results can be compared to the current thesis, increasing the value of the findings.

8.2 Conclusion

The purpose of the thesis was to seek out an understanding of the various costing approaches that an organization may implement to better estimate the supply chain costs. Most organizations record costs using standard Traditional Accounting methods; thus, it is very difficult to “track” costs that would represent Supply Chain Costs. This thesis was conducted to promote a baseline understanding of the purpose/scope of the model necessity, propose various solutions, identify relationships among the

input/output costs, and then further improve/modify the modeling approach to improve the accuracy/usefulness of the model. A neural network model was developed to estimate distribution costs and demonstrating suitable R^2, while minimizing the number of required input variables.

Gerd Gigerenzer argued extensively that advancing such research is entirely possible by using Heuristics. More accurate judgments are possible by ignoring part of the information/ weighting/ trying to add information: "Heuristics are efficient cognitive processes, conscious or unconscious, that ignore part of the information"(Gigerenzer 2011). In reviewing the literature and data on decision making, the author asserts that "less-is-more". A U-shaped relationship is proposed in regards to the value of additional information; too much information can degrade the quality of the decision (Gigerenzer 2011). The author concludes the literature review section by offering this definition of a Heuristic: "A heuristic is a strategy that ignores part of the information, with the goal of making decisions more quickly, frugally, and/or accurately than more complex methods."(Gigerenzer 2011).

The Heuristic proposition expands past the literature review section. In a review of organizations reviewing customer status (active/ inactive), a comparison was made of modeling previous customer purchase data and particular benchmark values used by particular industries. These benchmarks would "ignore" additional data in regards to the customer; and demonstrated higher accuracy predictions than those results generated from data modeling (Gigerenzer 2011). Further, in reviewing election predictions, the estimations based on name recognition only had similar accuracy than those based on polling the voters. As large samples are required to yield valid inferences based on voter intention, "recognition-based forecasts can be computed from small, "lousy" samples"(Gigerenzer 2011).

There is a “trade-off”, between the additional effort/ cost expended for further data, and the value of that additional effort. This theory is in direct opposition with the generally accepted notion that more is better- the more data used in a model, the better. The author does stress that the general intent is not to suggest that a Heuristic is more accurate than linear regression. Rather, the more accurate goal is to determine in which environment the Heuristic is more accurate than a linear regression model, and which environment it is less accurate.(Gigerenzer 2009).

The Heuristic suggested by Gigerenzer is reinforced in this thesis. While more accurate costing models may be possible using large amounts of data, transformations, and sophisticated statistical methods, the current model uses one approach with a small set of variables. This modeling approach allows managers to identify variables considered theoretical predictors of distribution costs, and then to test their relationship to distribution costs. And using Neural Network modeling, tests/ assumptions regarding linearity/ and normality are not required. The proposed model provides a contribution to research in estimating the Supply Chain Costs from a total cost perspective (Melnyk, Sandor et al. 2007).

Appendix A

Redress survey Cover Sheet

Appendix A: Redress survey Cover Sheet

The cover letters were included in the email. This is what was sent:

FIRST WORKBOOK ISSUANCE:

In May you received notification of the issuance of a new QA Guideline which covers "Value Added Product Configuration and Kitting in Distribution (CORP-XXXX)". At that time, you were informed that there would be following up with a Gap Analysis to determine your current situation regarding these activities.

Please find attached an Excel workbook which contains that Gap Analysis.

It is recommended that you ask the appropriate stakeholders to work together to complete the workbook.

Please complete and email back to us ***no later than September 1, 20xx***. It is understandable that you and your organization may need clarification or have questions related to the document. If that occurs, please contact the researcher so that we may set up a conference call and WebEx to assist you (XXXXX, or YYYYY)

Please note that you will be receiving within a separate e-mail an additional workbook which encompasses "Product Item" information.

Thank you in advance for your input and for ensuring appropriate information in order to take a consistent approach to evaluating our current processes.

SECOND WORKBOOK ISSUANCE:

Please find attached the second Excel workbook which encompasses product level redress activities occurring on all of your products. This will provide an in-depth view of current redress activities occurring under your control. (Please note that data was included with regards to product being redressed in Redress Central and request that you verify this information and also complete the "Reasons" and "Attributes" portion of that spreadsheet.)

Please complete this workbook and email back ***no later than September 1, 20xx***.

We understand that you and your organization may need clarification or have questions related to the document. If that occurs, please contact us so that we may set up a conference call and WebEx to assist you (XXXXX, or YYYYY).

Thank you in advance for your input and for ensuring the appropriate information in order to have full visibility to the current processes regarding redress activities

Since the issuance of these requests, the individual parties have been contacted to answer questions and adjust timelines.

Appendix B

Introduction tab on survey spreadsheet

Appendix B: Introduction tab on survey spreadsheet

Name of Location: _____

Please enter your name

Name: ___

Welcome to the Packaging Configuration and Kitting Gap Analysis!
On May 21st, you received the Guideline for Value Added Product Configuration and Kitting in Distribution (CORP-00XXX)

In conjunction with this guideline, please complete this workbook.
The purpose of this exercise is to assess your current situation regarding packaging configuration and kitting activities.

This workbook is divided into three sections for completion:
1. A series of questions (Gap Analysis) to gain understanding of your current situation regarding packaging configuration and kitting activities.

2. Product line data sheets to identify current product configuration activities.

The data compiled is based on 20xx sales data.

3. A series of questions regarding costs associated with packaging configuration and kitting activities.

Workbook Contents

- Welcome Page

- Instructions Page

- Definitions Page

- Gap Analysis Page

- Product Line Redress Pages (Labeled with the product line names)

- Cost Page

- Final Page (Email submission page)

Appendix B: Introduction tab on survey spreadsheet

Before you begin, please answer the questions below. Place an "X" in the Yes or No box where indicated.

1. Does your affiliate perform redress (any kind of change to packaging or labeling) for any products ? Yes/No

2. If you do not perform redress currently, have you ever done any redress in the past ? Yes/No

If yes, why did you stop?

3. If you do not currently perform redress, do you anticipate doing redress in the future?

Yes/No

Appendix B: Introduction tab on survey spreadsheet

If yes, what products do you anticipate redressing?

5. Do you redress Custom Paks? Yes/No

Appendix B: Introduction tab on survey spreadsheet

Please complete this workbook and email back no later than September 1, 20xx.
On the last tab labeled "Final Sheet", there is a button

that will automatically email this workbook to us.

Email reminders will be sent along the way to see how you are progressing.
If you have any questions, a conference call and
WebEx can be initiated to assist you in completing this workbook.

Contact XXXXX, or YYYYY for help.

Thank you in advance for your input!

Appendix C

Redress Cost Survey questions

Appendix C: Redress Cost Survey questions

Please help estimate the costs of redress in your facility. To simplify this process, 4 categories of redress below have been defined. Please review the category and the estimated costs for each category and provide your feedback.

Cat.:	Description of Redress Activity	Typical Cost per Unit to Redress (materials and direct labor)	Do you currently conduct redress operations in this Category? (Yes or No)	If you have a substantially different cost per unit (plus/minus 25% or more difference), please record it here (in USD per unit)
	Attach a sticker, vignette, other label to the carton. Minimal change to product; no re-cartoning.	$0.40 USD		
	Any of the following: -Attach multiple stickers, vignettes, labels to carton. -Add DFU / IFU to outside of carton and shrinkwrap.	$0.65 - $0.80 USD		
	Any of the following: -New carton / re-carton / new secondary packaging. -Add new DFU / IFU / Insert / Patient Reply Card inside carton. -Over-label primary and secondary packaging with country-specific labels. -Re-configure product in any other way (e.g., convert 12-pack into 3-packs).	$0.80 - 0.90 USD		
	Any of the following: -Serialize every unit (generate serial numbers, print serialized labels, apply serialized labels). -Other substantial product repackaging activities.	Greater than $0.90 USD		

Any comments or thoughts would be appreciated.

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