An examination of quality performance at different levels in a connected supply chain: a preliminary case study

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Introduction

Many firms are using total quality management (TQM) methods and supplier partnerships as methods of obtaining strategic advantages against their competition. Open communications, sharing of trade secrets and commitment to long-term supplier contracts have increased quality levels, decreased component costs and decreased product inventory levels (Adam, 1994; Benson et al., 1991; Choi and Hartley, 1996; Dean and Bowen, 1994). A common thread in such studies is the successful implementation of TQM-style principles. One of the main precepts of TQM is continuous improvement. Continuous improvement seeks continual improvement of machinery, materials, labor utilization, and production methods through application of suggestions and ideas of team members (Chase and Aquilano, 1995). Using continuous improvement as a method to constantly drive toward ever-increasing quality levels is a very effective tool for increasing a firm’s competitiveness (Deming, 1986).

Quality is often a subjective goal that has indefinable characteristics. Quality within a supply chain may have different standards at different levels within the chain. In this study, we will use specific labels to identify different levels of the supply chain. The highest level will be termed the “customer”. The immediate supplier to the customer will be labeled the “supplier”. The party supplying to the “supplier” will be labeled the “sub-supplier”. The “sub-supplier” is the lowest level in the supply chain. These concepts are further defined and shown in the following section in Figure 1. In many instances, the entity paying for the product defines the quality requirements. The lower levels within the chain may not understand the need for certain quality requirements. These quality requirements are accepted as requirements to aspire to but are often not surpassed. Lower level suppliers and sub-suppliers also accept these requirements because they have been conditioned to accept the requirements of the higher level suppliers. The power of decisions involving quality rests with the higher level suppliers because they are paying for the product supplied by the lower levels. The lower levels of the supply chain do not question the customer’s ability to make and judge quality requirements, they simply want to get paid for their efforts to supply a product or service. In an effort to understand how quality requirements are developed in a supply chain, the following research questions are proposed for this paper:

- Are there differences in quality definitions between levels of a supply chain?
- Does the higher level entity in the supply chain understand the quality requirements imposed on their suppliers?

The next section of this paper defines the structure of a particular supply chain and the four entities that are involved. The particular supply chain that is discussed consists of three manufacturing firms in the appliance industry (Whirlpool, Stanley Engineered Components (SEC) and SEC’s sub-suppliers) and the end users, the homeowners. The following section defines the research method while the section after this describes the interrelationships between the four entities. An analysis of their interrelationships is in the penultimate section with a summary of the research findings in the final section.

The structure of the supply chain

The chain studied in this paper consists of three manufacturing firms in the household cooking range industry and the final household customer, or the end user. This
Supply chain was chosen because it represents many of the connected supply chains within the USA. The end users, homeowners, are at the top of the chain. It is at this level that the ultimate sense of customer satisfaction is realized through the purchase and use of a range for the home. All levels of the supply chain below the end user, the manufacturing supply chain, must work toward the goal of satisfying the end user. The top of the manufacturing supply chain is called the customer. In this case, the customer is the range division of the Whirlpool Corporation. The customer sells ranges to the end user, the homeowner. The middle of the manufacturing supply chain is SEC, a supplier to Whirlpool. SEC provides stamped metal assemblies to their customer, Whirlpool. The bottom of the chain consists of sub-suppliers to SEC. Sub-suppliers provide raw materials and components to the supplier, SEC. The relationships between these four entities are shown in Figure 1. The relationships shown are not unique to these four entities. Relationships similar to the Whirlpool supply chain are formed during the manufacturing of other products.

**Customer – Whirlpool**

In 1997, Whirlpool Corporation was an $8.35 billion company and the world’s leading manufacturer and marketer of appliances. Whirlpool manufactures in 12 countries and markets products in over 140 countries. The range appliance division of Whirlpool, located in Tulsa, Oklahoma, manufactures freestanding gas and electric ranges. A range has four cooking elements on top and one oven cavity below. The freestanding ranges are marketed under the Whirlpool, KitchenAid and Roper brand names. The Tulsa manufactured ranges are Whirlpool’s latest effort to introduce a product line that exceeds customer expectations. Whirlpool has been a customer of SEC for over 20 years and it is SEC’s largest customer, representing 40 per cent of SEC’s total sales. As of 1996, Whirlpool and SEC became partners in a long-term agreement.

**Supplier – Stanley Engineered Components**

In 1997, SEC was the smallest division of the Stanley Works, a $3.5 billion worldwide supplier of hand tools, hardware and hardware products. SEC had approximate sales of $20 million and they have been a domestic supplier of products to the appliance industry for the last 30 years. SEC’s main products are oven door latching mechanisms and oven door hinges. The oven door latching mechanism is an integral part of the oven assembly that locks an oven door during the self-cleaning cycle in both the gas and electric ranges. SEC manufactures three types of latching mechanisms for US consumers: bi-metal, motorized and solenoid. In the USA, SEC controls all of the bi-metal latch business, 20 per cent of the motorized latch business and 30 per cent of the solenoid latch business. SEC controls 20 per cent of the oven door hinge business. SEC’s customers include Whirlpool, General Electric, Frigidaire, Amana and Maytag.

**Sub-suppliers – a wide array of 60**

SEC uses approximately 60 sub-suppliers in this particular supply chain. These suppliers cover a wide range of capabilities and expertise. Component suppliers provide products that include rolls of steel, springs and electric motors while tooling suppliers provide stamping dies and assemblies that enable production on the manufacturing line. Some of the sub-suppliers are well versed and willing to comply with the methods of quality while others are less knowledgeable and more hesitant to comply with SEC’s quality requirements. Some of the sub-suppliers have worked with SEC for over 30 years, while others are just starting relationships. Although a few of SEC’s sub-suppliers have total sales that are higher than SEC, most of these sub-suppliers are much smaller than SEC.

The manufacturing supply chain in Figure 1 will primarily be used to show how the three levels (customer, supplier and sub-suppliers) interact with each other on quality issues. We will ascertain whether or not differences exist in quality definitions between each of these levels. We will also...
determine if the customer level of the supply chain truly understands the quality requirements that they impose on the suppliers and sub-suppliers.

Research method

The research method used in this paper involved on-site interviews with the plant manager and design engineers from SEC. A single interview session is not enough to document all of the issues involved with this supply chain. This paper is the pilot study of a multistage process that will be used to uncover underlying relationships and perceptions of quality within a connected supply chain. Interviews were conducted to ascertain how SEC determines the level of quality necessary to satisfy their customers. Questions were asked concerning SEC’s perceptions of defining and monitoring quality within the different levels of the supply chain. Interviews were used to elicit candid discussions.

An interview with the plant manager of SEC, Joe Perez, was conducted in his office on April 6, 1998. Joe has been the plant manager for over two years and served as quality assurance manager for the previous nine years. This on-site interview also included a plant tour and discussions with members of the design-engineering group. The interview was recorded and notes were taken during the plant tour and subsequent discussions. Permission was obtained to use all information for classroom use, but review and approval was needed if the write up was to go out for publication.

The interview involved questions relating to quality leadership, perceptions of quality and quality effort, strengths and weaknesses of links in the supply chain and partnership. Transcriptions as well as field notes are available as line-numbered qualitative data for the first 45 minutes of the hour-long interview. These line numbers are used to reference specific quotes during the interview. The final 15 minutes of the conversation were not transcribed, but field notes were made. Follow-up phone calls were made to clarify certain points during the write-up process.

Interrelationships

The interrelationships between the four entities are complex and sometimes implicit. One of the relationships studied is that of passing on quality requirements through formal methods. These requirements are typically passed on through a top-down management philosophy. The entities paying for the product generally set the quality requirements. The second relationship studied is the method of receiving feedback to increase product quality. Through a partnership agreement, one would assume that communication would be open and free flowing from all entities with increased quality levels for the final product being the only concern. This will be investigated further to see if this is the actual case. The two relationships studied are diagrammed in Figure 2.

Passing on quality requirements through formal methods

End users determine the amount of production in a supply chain by their purchasing power. It is through purchasing power that end users are able to show their approval or displeasure with a product. In this chain, this is the only form of feedback for measuring end user satisfaction. The end user does not have a formal method to make specific demands or to list requirements. It is true that market analysis and surveys provided through Whirlpool can identify and probably predict end user needs, but a constant method of evaluating end user requirements is not in place. The method used is one of recording product sales and determining market share. Capturing greater market share is indicative of measuring increasing levels of end user satisfaction.

Whirlpool realized that their old products had a high service incidence rate (SIR). A service incidence, as defined by Whirlpool, is

Figure 2

Interrelationship between entities of a supply chain
when a representative of the Whirlpool repair team is called to a homeowner’s kitchen to repair a defective range. Whirlpool incurs the cost of the visit if it is within the one-year warranty period. These warranty visits are expensive to Whirlpool and dissatisfying to the homeowners. By decreasing the service incidence rate, Whirlpool could increase their profits and increase the end user satisfaction. In 1993, the SIR was 20 per cent (20 home repair calls per 100 purchases). This rate was slightly higher than the competitors’ service incidence rates. The goal of Whirlpool’s new product line was to decrease the service incidence rate to 2 per cent (two home repair calls per 100 purchases).

Whirlpool formally passed on their requirements to SEC through a documented purchased material quality system and training on process analysis using statistics. These requests included mandatory quality requirements, mandatory yearly price reductions and mandatory proactive initiatives. Whirlpool expected SEC to completely understand Whirlpool’s quality requirements and to have the ability to meet all of the requirements with little help from Whirlpool. Whirlpool expected SEC to act as free consultants that would continually provide ideas that would decrease cost and increase quality of Whirlpool’s entire final product, not just the components that SEC produced. SEC was expected to help with these initiatives for the final product because they were considered to be business partners with Whirlpool. In a partnership, the concern is for promoting both sides of the partnership, not just one entity’s interests. Although in theory support for both sides is the way of a true partnership, this was not the case with SEC and Whirlpool. When asked to comment on whether SEC feels like a true partner with Whirlpool, SEC plant manager Joe Perez stated (transcription from taped interview on April 7, 1998):

There is no such thing. There are better relationships and worse relationships, but there is no such thing as a true partnership. The illusion we had did not pan out in the end because they were perfectly willing to send products out (to other potential suppliers) that we thought we had a claim to manufacture for a few years and they went out to bid on them. They just put them out on the market. We protested, and there was a lot of people inside their organization that felt that it wasn’t right, but nonetheless, they still did it. And so after that, my view on partnerships is not what it used to be. They’re (Whirlpool) better than anyone in terms of working with you, but I’m not so sure that partnerships exist. You’re at the whim of your customer.

Joe Perez is giving Whirlpool credit for methods that they used to help SEC improve the quality on their products supplied to Whirlpool. With Whirlpool assistance, and because of Whirlpool’s requirements, SEC did achieve Whirlpool’s quality goals. Joe is also recognizing that Whirlpool looks at relationships that involve supplier partnerships as a short-term agreement with Whirlpool rather than a long-term agreement. Technologies developed and worked on as partners for new products are then passed out to competitors for further price reduction and quality improvements once they are into production. SEC, because of their size and subservient location in the supply chain, is forced to accept these conditions from the much larger supplier.

SEC formally passed on their requirements to their sub-suppliers through formalized procedures and drawings depicting critical quality characteristics and processes that needed to be monitored. The big difference with this connection in the chain was that Whirlpool did very little to help SEC achieve the goals of the requirements. Whirlpool assumed that SEC could independently develop the necessary programs needed to satisfy the requirements. SEC recognized that their sub-suppliers needed the guidance and support of SEC to implement these requirements.

SEC was required to develop many of the programs for their sub-suppliers. SEC was required to get very involved with their sub-suppliers to help them understand SEC’s quality expectations. When asked how SEC’s sub-suppliers perceived SEC’s quality requirements, Joe Perez stated (Lines 107-110 from the transcription of the taped interview on April 7, 1998):

There is a whole different array of sub-suppliers out there and some are more accustomed to these type of requirements than others. Some are more willing to comply but they don’t have the knowledge either and it is up to us to try to help them to fulfill these requirements, to get them trained equally well.

Joe Perez is stating that some suppliers understood SEC’s higher level quality requirements because they are already producing at higher levels of quality for other customers. Some suppliers want to comply but they do not have the ability. This is due to their lack of experience, qualified personnel and company culture. As a supplier that expects higher levels of quality from their sub-suppliers, SEC is responsible to show these sub-suppliers how to comply with the higher quality requirements.
When asked how SEC trains their sub-suppliers, Joe responded (Lines 114-120 from the transcription of the taped interview on April 7, 1998):

They come into our facility or we go out to their facility. If it is a new supplier, obviously you give them a supplier quality audit. Beyond that, I mean you can talk very specifically about what component they were going to make for us and what characteristics are important and why they are important to us, so that they can understand why, not just the what. I want them to understand the whys of these things. Once you get that understanding, then you can depend more on them for executing because they know why it is going to work.

Joe Perez is stating that simply showing a sub-supplier what to comply to is not nearly enough when complying with SEC’s quality requirements. Sub-suppliers need to understand why they are being asked to increase quality levels. Sub-suppliers need to understand that their level of involvement is integral to the total quality system. The sub-suppliers are the expert for their particular component and they are in the most informed position to make quality improvements. If the sub-suppliers can understand the process and methodologies involved in increasing quality, a never-ending cycle of continuous improvement will exist between SEC and their sub-suppliers. This ever-increasing quality for supplied components contributes to ever-increasing quality for the final entire product sold by Whirlpool.

When asked if SEC’s sub-suppliers are doing enough to support and encourage quality improvements, Joe responded (Lines 167-172 from the transcription of the taped interview on April 7, 1998):

No. There are some fine sub-suppliers out there that seem to be on the forefront of their technology and know what they’re doing from a quality aspect. There are others out there that are waiting for you to tell them what you want them to do. They are going to do it but it’s not like they can think about it if I wasn’t asking for it.

Joe Perez is stating that some sub-suppliers need to be encouraged and directed into making quality improvements. Some do not think to make quality improvements because they are not in the habit of doing more than simply supplying a part to the customer’s specifications. Another possible reason for their lack of initiative could be due to the expense and effort involved in making the quality improvements.

Whirlpool was able to have their supplier, SEC, comply with their requirements without much involvement or leadership. SEC was able to have their imposed requirements met with their sub-suppliers only after much guidance and leadership. SEC provided the leadership and training to have their sub-suppliers meet SEC’s goals.

Receiving feedback to increase product quality

Whirlpool distributes and promotes quality requirements yet they have few channels to receive feedback regarding the ways in which they determine and measure their quality requirements. The only method that Whirlpool has for receiving feedback is when consumers purchase their products. Each product represents a different level of quality requirements and end user satisfaction. The types and quantities of the models purchased are methods of determining end user satisfaction with quality requirements.

SEC is able to offer suggestions to Whirlpool for changes, but it is up to Whirlpool to accept or reject these; SEC’s suggestions are basically in the form of asking permission to change and Whirlpool can either grant or deny these requests. This type of relationship demonstrates very little partnering or negotiating. Whirlpool has asked SEC to be proactive to change. SEC has tried, but is often frustrated. When Joe Perez was asked about Whirlpool believing whether SEC is doing enough or not to support and encourage quality improvements, Joe said (Lines 129-136 from the transcription of the taped interview on April 7, 1998):

They never mentioned to us that we were behind anybody in term of fulfilling their requirements or doing what needed to be done. From time to time, they have come back to us and told us that we needed to be more proactive. We’ve always had to struggle with trying to understand what proactive meant because we had to come up with a lot of ideas for them. They’ve looked at them very casually and they never ever really thought too much about it. So we have a tough time, we’re struggling with being proactive because we’ve been doing a lot and yet they still criticize us for that, so it’s a tough thing.

One of the requirements of being a supplier to Whirlpool is that you exhibit and actively participate in quality improvements. SEC has been criticized by Whirlpool for not being proactive toward quality improvements. Even though SEC has made viable suggestions to Whirlpool for quality improvements, Whirlpool has not taken them seriously. One possible reason for this may be that these changes may involve Whirlpool making some changes to their system. Whirlpool possibly wants quality improvements to occur with supplied items.
that involve no modifications to the design at the Tulsa manufacturing plant.

SEC receives and actively encourages suggestions from their sub-suppliers because SEC often develops and works very closely with these sub-suppliers. This relationship differs from the higher connections in the chain because SEC truly needs the support and expertise of its sub-suppliers. The chosen sub-suppliers are willing to help decrease component cost and increase quality levels because they realize that a sale cannot be made unless these goals have been accomplished. While this relationship is a lot more consultative than the Whirlpool-SEC relationship, the connection between SEC and their sub-suppliers is still one where SEC is the obvious leader: there is no partnership.

SEC is held accountable, immediately, for less than perfect parts because they are being monitored by Whirlpool. This is not the case with Whirlpool selling to their end users. Whirlpool is only held accountable to itself. Although obvious flaws or unsafe designs would not be allowed, Whirlpool does not have to report to anyone immediately for their less than perfect designs. When asked about Whirlpool’s ability to define and monitor quality requirements Joe Perez responded (Transcription of the taped interview on April 7, 1998):

I think people need to be well rounded. If you focus too much in one area, you lose your perspective. If you are talking about quality, you need to be on the receiving end of the problem as well as the giving end of it. The more you do that, the better your awareness for quality becomes and the more sensitive you are to issues of quality. If you are only sitting on one perspective, you can make life miserable on the supplier. You really can. You have no understanding what that supplier is going through.

Joe Perez is of the opinion that Whirlpool does not truly understand the definition and purpose of increased quality levels. Whirlpool does not actively seek methods of continually increasing quality levels. They merely seek levels of quality necessary to obtain sales of their ranges. This goal quite often involves a higher importance put on decreased component cost instead of increased quality levels. Whirlpool does not actively seek quality requirements from their customers, the homeowners. Whirlpool is paying for the supplied products, therefore they are the dictators of the quality requirements. In a system composed of members who truly promote and accept change, all levels are of equal importance. In the supply chain of Figure 1, Whirlpool has made the point of being the most important link. Because Whirlpool is not truly receptive to change, they do not understand the importance and necessity of shared definitions of quality goals through open communication.

**Analysis**

The three companies depicted in this manufacturing supply chain are structurally independent of one another. Despite this independence, the three companies clearly interact with each other in ways that blur their organizational boundaries (Cooper and Yoshikawa, 1994). Whirlpool has radically changed the way that SEC does business by imposing TQM procedures. Prior to the start of Whirlpool’s new program, SEC was not using TQM methods. The sub-suppliers to SEC are now performing certain quality related functions that were previously not required or necessary to fulfill order obligations. SEC has taken on the role as a mentor and leader to their sub-suppliers to help raise them up to a quality level that is acceptable to both SEC and Whirlpool. No longer are the suppliers and sub-suppliers to a customer like Whirlpool focused only on price. To compete effectively, a supplier must be an optimal provider of quality, delivery and price.

In SEC’s opinions concerning Whirlpool’s ability to define and monitor their quality requirements, there was an implicit view that Whirlpool focuses too much on imposing quality requirements. Joe earlier defined this as the “whats of quality”, or what is important to Whirlpool. Joe implied that Whirlpool needed to be more informed on the receiving end of a quality program to make better decisions for their suppliers. Whirlpool needs to be more receptive to the suggestions for change from the lower levels of the supply chain to promote change effectively. Whirlpool’s level of quality needs to be better explained to the suppliers. Joe defined this as the “whys of quality”, or why is this requirement important to Whirlpool.

By referring back to Figure 2, it can be seen that SEC suggests quality changes to Whirlpool and promotes quality changes to their sub-suppliers. Whirlpool promotes quality change to SEC and SEC’s sub-suppliers suggest quality change to SEC. SEC is positioned to both receive and specify quality requirements. SEC is aware of the struggle to meet the requirements of a customer that is a much larger company. SEC is also aware of the need to work with usually smaller sub-suppliers to bring them along and help them reach quality levels that were previously unattainable. SEC is capable
and willing to understand what quality requirements are important and explain why they are important to their employees and sub-suppliers. Through this level of detail and exposure, SEC has established a level of quality awareness for the entire supply chain. By referring to Whirlpool in Figure 2, it can be seen that Whirlpool is promoting quality changes to SEC while they have SEC suggesting quality changes to them. As discussed by Joe, even though Whirlpool talks about partnerships, their manifest behavior is different. They are usually not willing to listen to new ideas from their suppliers. In most cases, Whirlpool is not willing to receive changes from their suppliers. Requirements from homeowners are delivered through surveys of focus groups and competitors’ models. Issues involving quality are made as general requirements without definition and guidance. Although very necessary for identifying consumer needs, end users do not provide direction for quality initiatives. The initiative to decrease the SIR could have been triggered by consumers’ dissatisfaction with the high incidence of service calls. Homeowners could have requested higher levels of quality because they were dissatisfied with the frequent repair visits to their older ranges. This may be unlikely because Whirlpool incurred the cost of the visit if it is within the first year. Homeowners might not be dissatisfied if the repair team incurred the cost of the failure instead of the homeowner. The effort to reduce the service incidence rate could have also been a directive from Whirlpool to decrease their service calls to increase Whirlpool’s profit margin. Another reason to question whether or not a reduced service incidence rate would increase sales arises when it is realized that most consumers purchase their ranges through two actions. The first is appearance. If the range is attractive to the homeowner, this increases their level of satisfaction. The second method that a consumer uses to evaluate a new range is through the feel of the oven door as it opens and closes in the showroom. These two actions are the only two actions that a consumer can perform when buying a range from a showroom. The purpose for bringing up this point is to realize that through decisions like these, a range is purchased. These types of actions do not provide adequate information toward quality requirements.

The sub-suppliers receive inputs from SEC to promote change and SEC receives inputs from the sub-suppliers to suggest change. SEC needs and accepts the input from the sub-suppliers just as much as the sub-suppliers need and accept the quality input from SEC. The sub-suppliers are encouraged to improve the quality in their components to not only help themselves, but to help SEC’s products obtain ever increasing quality levels. Improvements in designs are incorporated in SEC’s products when possible. Whirlpool, as evidenced by SEC’s experiences, is less receptive to quality improvements that would require a manufacturing change in the Tulsa production plant.

Summary and conclusion

This paper documents how four different entities impose quality requirements on each link of a connected supply chain. The middle of the supply chain, SEC, struggles to both accommodate the larger customer, Whirlpool, and educate the mostly smaller sub-suppliers. By being on both the receiving and giving end of proposed quality changes, SEC is the link most able to understand what the quality requirement is important for and why it is important. Creating a quality awareness needs to be multidirectional, not unidirectional. This can only be accomplished if improvements are sought out through open communication within all levels of the supply chain. Quality awareness for all levels of a supply chain can be used effectively as a competitive advantage. This requires similar definitions of quality and education toward methods of incorporating quality and improving quality.

Future work

To justify this paper’s research question of identifying the differences in quality definitions between levels of a supply chain, a more thorough analysis needs to be performed. To finish the effort started with this supply chain, long interviews and on-site visits with key personnel from both Whirlpool and some of the sub-suppliers would need to be performed. Additional long interviews would also need to be performed with other members of SEC. These interviews would be taped, transcribed, and notes would be taken. Individual case studies could be written up as a method of reducing and analyzing the data. As a method to initially review the data, each respective link (customer, supplier and sub-suppliers) would be given a chance to review and suggest changes to their individual cases. These rewritten cases could then be compiled to get a more comprehensive and thorough qualitative analysis of this connected supply chain.
chain. From this collection of case studies, a survey could then be developed so that a quantitative analysis could be compared to this qualitative analysis. The combination of qualitative and quantitative analyses would enable a comprehensive and complete analysis of the research questions presented in this pilot study.

References