

**THE SUPPLY CHAIN
AS A WHOLISTIC SYSTEM:
A CASE STUDY**

Abstract. *This article describes new concepts and methods that have successfully been applied to manage quality in a complex medical supply system. It introduces and integrates the concept of wholism, a method called Dialogue, and nonlinear techniques and describes how these approaches are used in combination to improve management of the supply chain. The research problem focused on a continuing inability to increase product availability from a moderately high 95 percent toward an exceptional 100 percent. The research design involved implementing a performance feedback tool for members of the supply chain. The tool revealed the difference between changes in actual and perceived performance and was used to drive discussions on supply chain improvement. The results of this intervention include improvement of product availability, cost reductions in rework, waste and expedited freight charges and important changes in culture from a part-centric view to a collaborative, wholistic view of the supply system.*

Keywords: supply chain management, wholism, dialogue, nonlinear, culture.

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*Management & Marketing
Challenges for the Knowledge Society
(2012) Vol. 7, No. 4, pp. 551-564*

1. Introduction

Supply chains are said to encompass “all activities associated with the flow and transformation of goods from the raw materials stage (extraction), through to the end user, as well as the associated information flows” (Handfield and Nichols, 1999). Supply chain management (SCM) has been defined as “the integration of these activities through improved supply chain relationships, to achieve a sustainable competitive advantage” (Handfield and Nichols, 1999). According to the Board of the Institute of Supply Management, supply management is “the identification, acquisition, access, positioning, and management of resources the organization needs or potentially needs in the attainment of its strategic objectives” (Cavinato, 2001).

1.1. Materials management models

Over the past 40 years supply chain management has evolved from a narrow focus on materials handling within an organization to a broader perspective that is concerned with managing the entire supply chain inter-organizationally (Briscoe, 2001). Figure 1 illustrates this evolution of approaches. It cites methods ranging from simple reorder point management (ROP) to progressively more complex approaches such as material requirements planning (MRP), manufacture resource planning (MRPII) and Just in Time systems (JIT). The 1990’s saw a continuation of this evolution to include comprehensive systems such as manufacturing execution systems (MES) and enterprise resource planning (ERP) (Rondeau and Litteral, 2001). Currently, attempts to create efficiencies in material supply centre on efforts to integrate the entire supply chain. Integration, which can rarely be done by any single firm, pools the resources and knowledge of supply chain members into a network that creates competitive advantage (Halley et al., 2010). Integration can result in a lean supply chain that saves costs by aligning management strategies, sharing information, integrating operations and increasing the capacity to deal with uncertainties (Sharma et al., 2011).

In recent years business environments have dramatically increased in dynamic complexity requiring organizations to adapt more quickly and frequently. An integrated supply chain “can coordinate and facilitate relations between suppliers and customers through information sharing” (Toloie-Eshlaghi, 2011).

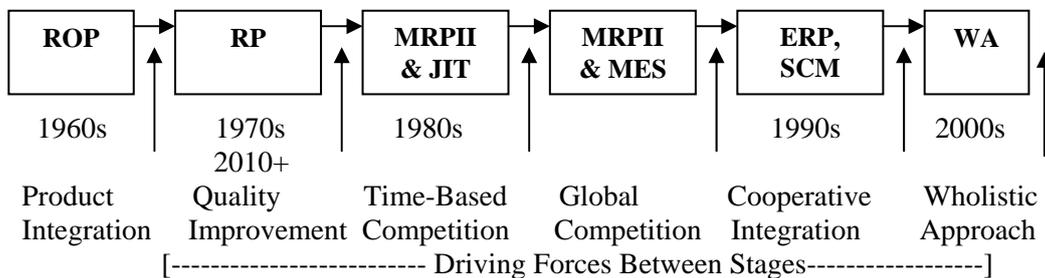


Figure 1. Sequence of significant material management systems and driving forces

Supply chain management (SCM) began as an attempt to create strategic partnerships with immediate suppliers. The idea was then expanded beyond purchasing activities to include physical distribution, transportation, and warehousing (Tan, 2002). The idea of a customer-oriented supply chain is a recent variation in SCM. It calls for designs that can cater to individual customer relationships. The Wholistic Approach (WA) calls for a new way of thinking about the order of the entire supply process. Throughout this evolution there has been an ever-increasing reliance on information systems. Information processing requirements related to managing the supply chain have become so great that the task is often handed off to business partners who specialize in managing customer information (Randeau and Litteral, 2001).

1.2. Relationships in the supply chain

According to Belshaw, Citrin and Stewart (2001) understanding supply chains begins with understanding the interrelationships of supply chain partners. It is becoming clear that individual channel members cannot make substantive and sustained improvements to the chain. Instead, the supply chain must be evaluated as a whole system. Briscoe (2001) emphasizes the importance of managing the relationships of channel members and believes companies too often use a piecemeal approach to making improvements in the supply chain.

Recently, channel relationship factors such as trust, commitment, and communication have found their way into supplier evaluations (Simpson et al., 2002). Supplier characteristics such as customer focus, timely communication of supply chain issues, sharing of information and a willingness to be open, receptive, and responsive have been identified as essential to maintaining trust and good communication in the supply chain (Simpson et al., 2002).

While numerous technical systems such as Oracle and SAP have been developed and successfully implemented to track the flow of materials and payments these systems only increase the level of complexity that must be managed. What has become apparent is that relationship management, a primary activity of SCM, is an even more important aspect of supply chain management than these systems address. Ultimately, the performance of the entire channel depends upon the quality of the relationships established among channel members and these relationships can be fragile and even competitive (Handfield and Nichols, 1999; Tan, 2002). Glaser-Segura (2010) states the supply chain management should be viewed as *“a more inclusive systems view that incorporate suppliers and customers into a unified structure that is often referred to as a virtual organization.”* This *“virtual organization is composed of several organizations that operate under the same general goals, communicate and share resources, and are interdependent of each other to the point that they act as a single firm or organization”* (Glaser-Segura, 2010).

Tan (2002) states that a lack of trust and cooperation among supply chain members adversely affects product quality and competitive position. One of the greatest challenges facing supply chain managers, therefore, is establishing and maintaining trust among the channel members.

Toward this end, our effort to create a more cooperative culture within a complex supply chain has resulted in the development and application of methods that will be unfamiliar to most material management professionals. We have applied the concept of wholeness, the practice of dialogue and nonlinear methods to improve the performance of a complex supply chain that supports a major hospital in the Northeast. Specifically, we sought to reduce the number of stock-outs of products without increasing costs associated with the supply chain. We called our intervention "Patient Product Availability" (PPA) and stated our objective to be 100 percent availability of products at the nursing stations.

To implement our PPA initiative we created a team that could represent the entire supply effort for the hospital. We sought representation from four major manufacturing companies and included operations and customer service personnel from the primary distributor and staff and management from the hospital's purchasing and material management departments. We also included senior hospital staff and management, nurses, and representatives from the nursing education department. An effort was made to select individuals who were both involved in the daily operations of their respective functions and sufficiently empowered to act with authority when needed. The size of this group, including the facilitators, totaled twenty-two members. We presented the concept of wholeness to this group and began a series of monthly discussions to relate wholeness to our supply chain management effort.

2. The concept of wholeness

The term "supply chain" evokes a particular view of supply management. It suggests a sequential set of relationships between channel members with product flowing from manufacturer to distributor to final purveyor and end user. It is a parts-oriented perspective and one that fails to capture the complexity of the relationship on the scale of the whole supply system itself. The term "wholeness" has emerged to describe a new view of complex systems beyond that offered by traditional systems theory. Rather than focusing on the parts of a system, a wholeness view defines parts as only artifacts of a larger whole. The whole is considered primary and the parts secondary with emphasis on understanding the whole. Unlike a systems view, wholeness recognizes that the relationships among channel members change and the channel members themselves change as a result of their collective activity. The whole emerges and dynamically evolves over time. The wholeness approach recognizes the existence of a system-wide culture that ultimately relies on individual members to organize their behavior. This observation was also identified by Schein (1999) when he stated, "*culture exists at the level of the whole organization if there is sufficient shared history. It is even found at the level of a whole industry because of the shared occupational backgrounds of the people industry-wide*".

Table 1

Traditional and wholeness views

	Traditional view	Wholeness view
Perspective	Independent and part-centric	Interdependent and whole-centric
Problem Solving and Decision-Making	Autonomous benefits to self or a single member	Shared benefits to the whole
Space and Time	Local and immediate	Totality and continuous
Leadership	Command and control	Facilitate, teach, and create together
Communications	Linear exchange	Creativity through Dialogue
Measurement	Single variables over time	Multiple, dynamic and interactive
Effectiveness	Organization specific	Distributed throughout the whole
Learning	Limited and skill based	Continuous and relationship based

Compared to more traditional views, wholeness suggests changes in how one should manage the supply system. Rather than viewing the supply system as “independent parts” the wholeness view calls for it to be managed as one “interdependent whole”. The responsibilities for problem solving and decision-making shift from individual system members to all system members collectively. Table 1 compares the traditional view to the wholeness view with respect to these and other important characteristics of supply chain management.

The wholeness view draws attention to the interdependencies among the parts and thereby changes the focus of decision-making. Problems are viewed as problems of the whole rather than associated with any single part. Solutions, likewise, emerge from a better understanding of the whole. The supply system is managed in its totality rather than as autonomous parts with immediate concerns. Those responsible for managing activities in the supply system assume new roles. Managers facilitate dialogue, teach, and seek creative solutions rather than attempt to control the system by authority or policy. Communication among channel members takes on an entirely new form. Rather than merely an exchange between individual members, communication takes place in “dialogue” sessions that foster greater understanding of supply system issues. Likewise, new techniques for measurement are used to capture the interactive and dynamic behavior of the system. The wholeness view and the methods that support it produce improved efficiencies throughout the supply system and, because participants continuously learn more about the changing behavior of the system, a new culture of cooperation and mutual benefit emerges. This change in culture causes improvements to be sustained without repeated initiatives and renewed efforts.

To apply wholeness to our PPA initiative we created a team that could represent the entire supply effort for the hospital. We sought representation from four major manufacturing companies and included operations and customer service personnel from the primary distributor and staff and management from the hospital’s purchasing and materiel management departments. We also included senior hospital staff and

management, nurses, and representatives from the nursing education department. An effort was made to select individuals who were both involved in the daily operations of their respective functions and sufficiently empowered to act with authority when needed. The size of this group, including the facilitators, totaled twenty-two members. We presented the concept of wholeness to this group and began a series of monthly discussions to relate wholeness to our supply chain management effort.

3. The practice of dialogue

The term “dialogue” is typically taken to mean a useful discussion. However, we use the term to refer to a very specific way of communicating (Bohm, 1996). The purpose of a dialogue session is different from that of a traditional business meeting. Most notably, while the purpose of most meetings is to resolve problems or issues, the purpose of a dialogue session is simply to provide all participants with a more thorough understanding of an issue or process. This improved insight will subsequently lead to creative ideas and better solutions than those derived from most traditional meetings. Because the purpose is different, merely to understand better, the conduct of individuals in a dialogue session differs significantly from common practice in a business meeting. Participants are expected to present their unique perspectives with the purpose of sharing and learning from each other. By listening closely to others and questioning each other for clarification members of a dialogue session foster a greater understanding by all. In a dialogue session participants do not advocate a particular view or criticize the views of others. All views are considered equally valid as each view contributes to a greater understanding of the whole. All of the views, whether they are consistent with each other or not, constitute a “Shared Common Content” that represent the collective view of the participants. Examining this “Shared Common Content” leads to a better understanding of the assumptions each person holds and, ultimately, a better understanding of the topic being addressed. Table 2 compares a traditional discussion to a dialogue session with regard to the differences in focus, process, purpose and outcome.

Considerable interest in dialogue has recently emerged as a way to better understand and manage complex systems. While the original concept of dialogue is credited to Bohm (1996) and discussed thoroughly in his work, practical application of these ideas required considerable thought and interpretation. In monthly meetings with our PPA team we practiced dialogue and used it to understand the supply system better. From these sessions emerged ten basic requirements that team members considered essential to supporting product availability. The requirements apply at all levels throughout the supply system in keeping with the concept of wholeness. In order to periodically measure how well the team was meeting these requirements we constructed a series of questions to collect team members’ opinions of the system chain management effort. The requirements and the questions used to measure each one are provided in Table 3.

Table 2

Comparison of discussion and dialogue sessions

	Discussion	Dialogue session
Focus	The focus is on advocating a point of view through competing, convincing and using authority.	The focus is on understanding the system better.
Process	The process calls for competition of ideas advocated by individual or subgroups of participants.	The process calls for presenting one's own view honestly then suspending assumptions, listening and asking questions in order to learn.
Purpose	The purpose is to gain support for a particular point of view through the use of negotiation, compromise, majority rule, or authoritative demand.	The purpose is to develop improved insight into an issue or process and "Shared Common Content."
Outcome	The outcome is a plan of action that may or may not have full support of all participants.	The outcome is a better understanding of the issue and creative insights that may subsequently produce innovative solutions.

The dialogue sessions allowed team members to better understand their interdependencies and interactions and become aware of their individual responsibilities to the supply system requirements. Subsequent dialogue sessions were held each month to review measures of performance and discuss management of the system.

Table 3

The patient product availability questionnaire

Requirement	Evaluation Questions To what extent do you agree with each of the following:
Efficient Communication:	Information is received in a timely manner. Information is frequently received from customer-users. Information is adequate to support action-intervention.
Effective Communication:	Information provided by members is accurate and reliable. Information received is organized and easy to use. Information received is free of unnecessary data.
Quality:	Product designs are efficient and/or effective. Products are free of defects. Products are safe for distribution and use.
Quantity:	Packaged quantities are best value. Supply is free from stock-outs or delays. Availability supports critical needs.
System Satisfaction:	Channel members actively work together. Channel members cooperate as necessary. Your contacts in the channel are professional and effective.

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Requirement	Evaluation Questions To what extent do you agree with each of the following:
Service:	Technical support service is excellent. Service recovery procedure is clear and effective. Individuals take responsibility and follow through.
Correct Product:	Products supplied match requisitions. Products are optimal in design. Products are best value available.
Proper Identification:	Products are properly packaged, labeled and named. Identification prevents frustration and wasted time. Labeling eliminates risk to patient.
Organization/Location:	Products are available where and when they are needed. No time is wasted locating products within the supply channel. Product organization/location provides ease of use.
Timing:	Timing of supply supports efficient patient care. Product flow eliminates confusion and frustration. Timing of deliveries is most efficient for stock management.

4. Nonlinear measures of performance

A wholistic view provides a more realistic representation of modern supply system and Dialogue offers a new way of understanding and intervening to manage the complexities of such systems. Still needed, though, was a way of measuring the system's performance in a manner consistent with these new views and methods. Specifically, we needed a way to compare the team's perception of its effectiveness to the actual performance of the system. Because team members tend to focus on part-centered solutions, which produce only local improvements, the relationships between beliefs and reality needed to be revealed so team members could see both their individual actions and the resulting performance of the entire supply system. Further, they needed this information to be timely and sensitive to subtle changes in the system.

Nonlinear science provides methods suitable for examining the dynamic relationships of complex systems (Sharp and Priesmeyer, 1995). The science makes use of phase planes that reveal the evolving dynamic state of a system over time. We measured actual performance as product availability at the nurses' station and called this measure PPA-1. To measure the team's perception of performance we had team members evaluate their efforts using the questionnaire in Table 3. Team members related their own primary supply system responsibilities to the ten requirements. Each member used a five-point Likert type scale which ranged from "(5) Fully Agree" to "(1) Fully Disagree" with a score of three representing "Neither Agree or Disagree".

These assessments, taken collectively for all team members on all requirements prior to each meeting, constituted an overall measure of performance called the PPA Qualitative score. The phase plane in Figure 2 depicts the relationship

of these two measures and provided a visual tool that allowed team members to see the association between their beliefs and actual performance.

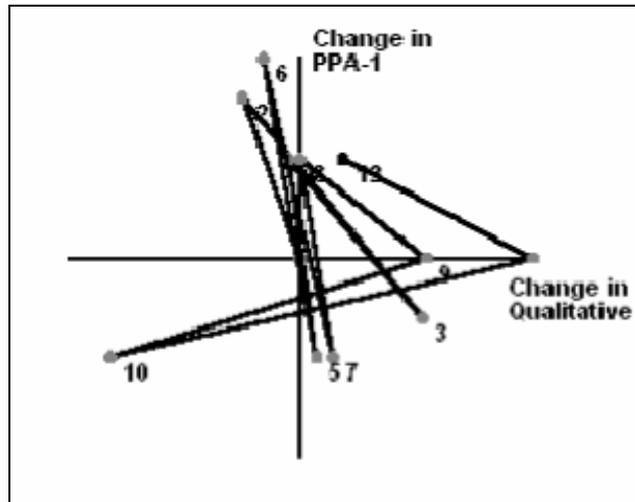


Figure 2. A phase plane depicting the interaction of qualitative and quantitative measures

Figure 2 reveals the difficult history of the team as it sought to gain wholistic control of the supply chain. The first eight months were marked by visitations to the upper left and lower right quadrants representing misunderstandings of the relationship between management efforts and overall performance of the supply system. Only in the tenth month did the qualitative and quantitative scores agree- in that month both measures declined. In the 12th month, however, the team showed improvements in both measures indicated by a movement into the upper right quadrant and signaling a new level of control over the entire system and that performance was sustained.

In nonlinear science, the transitions through state space are viewed as driven by underlying causes, whether they are apparent or unknown. This deterministic approach, which differs markedly from statistical approaches, allows one to interpret the changes as meaningful and actionable. What might be seen as a random variation in statistics becomes a change in states on the phase plane thereby allowing one to interpret and respond to subtle changes that would otherwise be ignored. In practice, the immediacy and clarity of this feedback empowers the team to respond quickly to either mitigate degradations in performance or identify and sustain recent actions that have improved performance. Table 4 provides descriptions and interpretations for each of the four quadrants on the phase plane.

The phase plane in Figure 2 and others depicting changes in the ten supply system requirements were provided to the team each month. Monthly Dialogue

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sessions centered on these materials and allowed the team to relate their efforts to performance. Further, the wholistic and interdependent nature of the system members became evident as issues were discussed. At the end of each meeting, there was inevitably a greater awareness of the collective interdependencies and a greater understanding of the overall supply system. Because the phase planes reveal the most recent changes in the system, they readily confirm any successes and failures and effectively reinforce the teams' efforts.

Table 4

Descriptions and interpretations of the PPA qualitative PPA-1 phase plane

Quadrant	Position	Descriptive behavior	Interpretation
1	Upper Right	Both the qualitative score and actual performance improved.	The team believes they made improvement and actual performance did improve. This implies the team understands how to manage the system. Dialogue identifies and confirms effective actions and behaviors.
2	Upper Left	Qualitative score declined while actual performance improved.	The team believes performance was worse when it was actually better. This implies the team made meaningful improvements but does not know what actions produced improvement. Dialogue will identify actions taken so they can be recognized and sustained.
3	Lower Left	Both the qualitative score and actual performance declined.	The team believes performance was worse and it did decline. This implies the team knows what actions should have been taken but did not act. Dialogue will identify sources of resistance and address compliance problems.
4	Lower Right	Qualitative score improved while actual performance declined.	The team believes performance was better when it actually declined. This implies the team does not understand the actions necessary for improvement. Dialogue will focus on discovering actions and behaviors that drive system performance.

Copious notes were taken during each of these Dialogue session recording observations and specific actions to be taken by any of the supply chain members. The types of actions varied widely. There were agreements by the distributor to notify hospital purchasing immediately of back orders or if orders could not be filled completely. On numerous occasions there were exchanges in phone numbers no information could be exchanged between members who were quite separated from each other if viewed from a traditional supply chain perspective. On one notable occasion a nurse called out a manufacturer (each representing one end of the entire supply chain) for eliminating the color of ink on a product's packaging without notice.

The color had been used to delineate between adult and infant respirators and the resulting confusion created a life-threatening event in a patient's room.

Such were the type of issues discussed as the team sought to understand the difference between their belief that they were providing improved performance and the reality of decreases in the PPA-1 score. Note again the many visits to quadrant 4 (lower-right) in Figure 2 and the description of this quadrant in table 4. The phase plane provided a vivid illustration of the monthly performance and prompted the PPA team to look beyond general performance initiative and to engage in discussion of specific events that revealed inefficiencies at a finer scale.

5. Results

When we started this initiative the product availability percentage at the hospital was a respectable 95 percent availability measured at the nursing stations. Within six months of this intervention the supply system members were able to increase that availability percentage to 98 percent. The team has managed to maintain the availability percentage at 98 percent each month over the two years of this effort. Although this increase in performance may appear modest, one must recognize that this improvement represents the elimination of over 250 product availability failures for patients each month. In a healthcare setting this is a significant improvement. A further benefit is the continued duration of improved results for well over two years consecutively which is quite unlike most total quality management projects which seem to run out after a year or more.

Of equal importance is the fact that this initiative resulted in cost savings by reducing re-work, waste and costs associated with expedited freight. The relationship between the hospital, the distributor and manufacturers improved resulting in better communication regarding substitute products, fewer backorders and reductions in the amount of time and money spent correcting invoice discrepancies.

Our ability to sustain these improvements for more than two years is the result of new individual and group-level competencies. These changes were identified through a series of in-depth interviews with the individuals involved in the project (Table 5). Those you participated now understand the concept of wholeness. They also are practiced in the Dialogue technique that has substantially improved communications among the members. They report that this effort has given them a new perspective on their individual responsibilities to each other and has led to creative ideas and innovative approaches.

The group collectively has acquired new competencies that appear to be the result of a more collaborative culture. Problem solving is a shared activity now and the Dialogue sessions facilitate collective understanding, learning and problem solving.

Table 5

Behavioral benefits

New Individual Competencies	New Group Competencies
An understanding of wholeness	Collaborative culture
Improved communication	Collective understanding
New perception of responsibility	Collective learning
More creative insight	Shared problem solving

These were significant group dynamic behaviors that are typically difficult to produce and they indicate that the team has evolved to address supply system issues in a far more efficient and cohesive manner. These successes are particularly notable when one realizes that these team members do not answer to a single leadership that can drive this initiative but, instead, represent separate companies with different management styles and cultures.

6. Discussion

The history of supply system management reflects a continuing evolution of methods designed to match increasing levels of complexity. Modern supply systems require a level of integration between participants beyond that offered by technological solutions. The most fertile ground for improvement may now be behavioral integration of the supply system members. Our effort to improve the performance of a complex medical supply chain centered on advocating an approach that sought to change the culture of those involved. Viewing the supply system as a whole rather than a collection of parts allowed manufacturers, distributors, materiel management personnel and nurses to see a new level of collective interdependency. Dialogue provided a way to improve our understanding of the management effort and fostered creative ideas for improvement. Rather than relying on statistical measures of performance we took advantage of new methods that sensitively measured the relationship between perceived and actual performance.

Our results can be measured quantitatively as an improvement in product availability from 95 percent to 98 percent at the nursing stations and we also realized important operational improvements. Of equal importance are the behavioral changes that have allowed us to sustain this new level of performance. Today our supply system operates with individuals who have new individual competencies and a new culture of collaboration.

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