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Abstract

Demand chain management is a set of practices aimed at managing and coordinating the entire chain, motivated by the final customer and working back to raw material suppliers. The Internet enables the consumer and provides the consumer with greater knowledge. By matching products to the appropriate value stream, product development time can be reduced, manufacturing costs can be reduced, and delivery times can be dramatically reduced.

Analysis and design of focused demand chains involve a number of alternative channels and forms. In this paper, we propose a soft systems version of goal analysis with the intent of viewing information systems design as a system with interacting parts with a shared purpose. Identification of goals can be a way to develop conceptual models to better understand problems in interaction among system parts. Analysis of systems models can lead to identification of weak points, which can lead to redesign to overcome such problems, thus leading to the analysis of the system leading to better system solutions.

Keywords: Supply chains, business process reengineering

Introduction

Demand chain management is a set of practices aimed at managing and coordinating the entire chain, motivated by the final customer and working back to raw material suppliers (Selen and Soliman, 2002). Fundamental objectives are to develop synergy throughout the demand chain, and to focus on meeting customer needs rather than focusing on optimization of the logistics and production system. The Internet plays a major role, enabling the consumer and providing the consumer with greater knowledge (Kuglin, 1998). The customer can now dictate what they want, at their desired location. By matching products to the appropriate value stream, a major United Kingdom lighting manufacturer was able to reduce product development time 75 percent, reduce manufacturing costs 27 percent, and reduce delivery lead times up to 95 percent (Childerhouse, et al., 2002).

Demand chain management has roots in operations management, with primary concern in logistics (Williams et al., 2002). It is also concerned with strategy across the value chain (Langley and Holcomb, 1992; Shapiro et al., 1993). Close integration of operations between manufacturers, suppliers, and customers relies to some degree upon business process reengineering (Frohlich and Westbrook, 2001). Demand chain management includes research in just-in-time manufacturing, mass customization, and use of third-party logistics.

Analysis and design of systems to support demand chains involve a number of alternative channels and forms. Contemporary marketplaces involve diverse requirements, and no single demand chain strategy is best for all requirements. Focus is needed to ensure that demand chains are engineered to customer requirements (Childerhouse et al., 2002). A strategic planning approach

would help practitioners choose and prioritize desired system features, leading to identification of better designs of demand chain systems. Each company would have to plot its own path, recognizing their unique position in the supply chain.

In this paper, we propose a soft systems version of goal analysis with the intent of viewing information systems design as a system with interacting parts with a shared purpose. Identification of goals can be a way to develop conceptual models to better understand problems in interaction among system parts. This process can lead to a broad set of alternatives. Analysis of systems models can lead to identification of weak points, which can lead to redesign to overcome such problems, thus leading to the analysis of the system in turn leading to better system solutions. Within the context of a demand chain environment, this can lead to a win-win environment and a system design that improves operations for all concerned.

Retail Channels

Internet operations are expected to supplement brick and mortar retailing operations. Implementing web operations often involve the need to reengineer retailing functions. Demand chain views expand the personalization of retailing, and call for further reengineering.

We view five basic channels for retailers to provide customer contact access:

- Traditional brick & mortar stores where customers can physically view products and talk to human sales personnel,
- Telephone contact, where you can talk to a human, but can't see the merchandise,
- Mail order, where you neither talk to humans nor see the merchandise,
- Web sites, where you don't talk to humans, but can efficiently access a broader set of sources,
- Mobile technology, using handheld devices to access Internet sites, with personalized agents providing customized information to the customer.

There are a number of retailing processes that demand chain views would impact. We have developed the information displayed in Table 1 as an example.

Table 1. Retailing Functions by Concept

Function	Brick & Mortar Processes	Internet Processes	Demand Chain Processes
Merchandising	Merchandise planning Product development Supplier selection Ordering Allocation Pricing	Same Same Broader selection Expedited Same Same	Demand driven More responsive Same as Internet Further expedited More responsive Can be dynamic
Distribution	Receiving Shipping Returns	Better control Better control Same	Same as Internet Same as Internet More contact
Selling	Store management Merchandise presentation Customer service Promotion	Web access Web presentation Web link Add Web exposure	Can customize Can customize Can personalize Can apply CRM
Marketing	Customer identification Market research Advertising	Broader clientele Could do on-line Same	CRM Can tailor product design Can focus advertising

Issues in Moving to Demand Chain Focus

The principal reasons to move to a demand chain focus include providing better customer service, taking advantage of information technology to better identify customer needs. This can supplement the gains in efficiency obtained from supply chain focus, obtained by eliminating redundancies and expanding market access. ERP systems provide one way to gain supply chain

efficiency, reducing the operating cost of information systems through centralized and standardized data. The most recent ERP systems emphasize Internet access, thus supporting both supply chain and open system demand chain features.

Countering the positive aspects of demand chain emphasis is the added cost of reengineering and system acquisition and implementation. Demand chain systems provide greater customer loyalty through providing more personalized service, and real time response enables firms to adapt more quickly to changing markets. Negatives to demand chain systems include the extra cost of reengineering, extra system acquisition, and training. The more open system also makes equity more of an issue, with the need to present an image of fairness in pricing to customers who can check on company pricing policies.

Retailers seeking to implement demand chain concepts will face a number of choices. ERP vendors will argue that it is obvious that each retailing organization must adopt all possible technologies in order to keep up with their competition. The recent faltering of the information technology economic sector brings such a view into question. Management is responsible to identify those combinations reasonable for consideration. Whatever IT configurations are considered then need to be analyzed for the best way to reengineer operations. Again, however, management must select a reasonably small set of alternatives to compare. Each alternative involves cost, in reengineering analysis, as well as subsequent cost estimation.

Systems View

System theory has a long tradition, beginning in Western scientific culture with Ludwig von Bertalanffy's (1968) biologically based general systems theory and the work on cybernetic systems of Stafford Beer (1967) and others. Open systems theory views organizations relative to their environments, with a continuous flow of information between the organization and the environment. GST principles have been widely applied in the study of human systems, to include information systems. Checkland (1999) credited Herbert Simon with originating systems thinking as applied to organizations. Simon (1997) stated that the main requirement in the design of organizational communication systems is not to reduce scarcity of information, but rather to combat the glut of information. Should an information system be judged solely on the volume of its output, the receivers of these reports would have no means to cope with being over-informed. Viewing information systems as systems in the GST sense would begin with identifying information requirements, and then designing the system to generate that information, focusing on what Rockart (1979) called critical success factors. ERP systems are usually based on business process reengineering in various degrees, also applying GST principles. SAP seeks to apply best practices in an effort to attain ERP system optimality. Some organizations have particular business processes that they do very well, and they should not sacrifice any competitive advantage by adopting vendor best practices in those instances, but rather should modify the system to retain their advantage. Also, human organizations involve high levels of change and uncertainty, both within systems and dealing with external environments. Rarely do systems in human organizations attain optimality, nor in those rare cases where they do, are they able to maintain it.

Simon (1997) applied systems thinking to his ideas about decision processes. He gave the decision-making activities of:

1. Setting the agenda
2. Representing the problem
3. Finding alternatives
4. Selecting alternatives.

There is nothing linear about the decision process, because new situations constantly arise in human decision-making, and new facts are constantly being discovered. Under conditions of uncertainty, prospects have to be balanced against risk, thus making conventional views of utility optimization inappropriate (Simon, 1999). There is a large body of evidence showing that human choices are not as consistent and transitive as they would be if utility functions accurately reflected human preference. Simon stated that the marvel was not that markets optimized (they don't), but that they often clear.

Bounded rationality is a key concept from the work of both March (1978) and Simon (1997). Rational choice makes sense if the future consequences of current actions and future preferences are known. But that rarely is true. Individual preferences are often fuzzy and inconsistent, and appear to change over time. Furthermore, people often protect themselves by obscuring the nature of their preferences, making rational utility analysis problematic. Simon argued that actual human choice behavior was more intelligent than it appeared. The use of aspiration levels, incrementalism, and satisficing rules were argued to be sensible under general business decision-making circumstances.

Vickers (1965) differentiated himself from Simon, using a more explicitly dynamic conceptual model of an organization. Vickers argued for the ubiquitous interaction of priority, value, and cost. He rejected the use of a weighted utility function to compare

criteria, and insisted on the information concept of matching, along with the reciprocal process of a system operated on by judgment. Vickers was a major influence on Checkland, whose *Systems Thinking, Systems Practice* (Checkland, 1984) tried to avoid reductionism. Checkland and Holwell (1998) focused on information systems treated IS/IT as centrally concerned with the human act of creating meaning. Checkland (1999) stated the soft systems method epistemology consisted of three analyses.

- Analysis One: Identify roles and objectives of each stakeholder. This is analogous to systems parts.
- Analysis Two: Examine interacting roles, norms, and values, analogous to the interaction of system parts.
- Analysis Three: Examined power related political aspects of problem situations. This led to a focus on the interests of stakeholders.

This view can lead to better understanding of the processes, relationships, and issues within a system. Soft systems applies conceptual models to compare alternative solutions to problems, and to better identify changes that can lead to improved system performance.

Checkland (1984) extended the idea of systems modeling to include mental models, viewing systems as consisting of interacting parts working toward some end, with the same feedback control discussed by Beer. The primary extension provided by Checkland was a soft systems view, incorporating expert (or at least experienced participant) input of subjective data as the basis for hypothesized relationships.

Demand Chain Processes

A process is a pattern of interaction, coordination, communication, and decision making to transform resources into products or services. Business processes are the procedures through which organizations get their work done. If a customer places an order, a business process is needed to record the order, determine if stock is available or if new stock is needed (through purchase or production), send the item to the customer, bill the customer, and monitor the status of the transaction throughout. Every organization has many processes. The success of organizations is determined in part by how well they develop accurate, efficient procedures to implement management strategies.

Initially, computer support might come through a variety of software programs. A database file might be provided salespeople with item data and policies on terms weekly. Orders might still be placed periodically, possibly by telephone call at the end of each day (or in multiple calls throughout the day for rush orders). Accounting might process transactions in batches daily (weekly for reports) so that computing can be accomplished more efficiently. Shipping might also fill orders in batches by day. Demand records would be accurate only on weekends when sales stopped and all computer programs run, at which time forecasts for items could be made based on past sales records. Bills to customers could be batched as well, possibly on a monthly basis. Such a system would result in periodic reports on weekly or monthly bases.

Application of Systems Approach

With time, information technology capabilities have increased at a rapid pace. Hopefully, business volume would increase, often outstripping the capacity of the business processes that worked quite well when the business was in its initial stages. Even for those firms with stable demands, the increase in the power of information technology might force businesses to adopt new business processes for competitive reasons.

We are proposing a general procedure, without rigid steps. This may not fit the precise ideas espoused by Checkland in his many useful publications of the soft systems methodology, but seeks to apply the overall principle.

Analysis One is to identify roles and objectives of each stakeholder. In this instance, management is one stakeholder, interested in providing products attractive enough to do business with customers, who thus are another stakeholder. Our focus of interest is on providing information systems support, and thus the third stakeholder is the information system/technology group (IS/IT).

Customers seek quality products at low cost, available through multiple channels. Some of the purchasing public prefer brick and mortar outlets, while some proportion prefer electronic access. Others might even prefer the ability to order by mail or telephone.

Management is interested in satisfying customers, in a way that produces a profit. This requires close monitoring of raw materials from suppliers, control of production processes and costs, delivery costs, and product quality. It also calls for the ability to monitor customer relations and manage them to increase market share at a profitable rate.

Suppliers are very important in the production process. The firm requires quality inputs in a timely fashion. In order to obtain this, demand chains start with customer focus, but carry analysis through to suppliers. Monitoring supplier resource availability as well as quality performance is important in this demand chain.

The last stakeholder is the IS/IT group. Their interests are in providing reliable computing support to the organization within their allotted budget. They also are interested in obtaining additional resources to enable them to do a better job.

Analysis Two examines the interaction among participants. Here we assume norms and values to be extraneous to the study, although these factors should be considered in real applications.

There are conflicting interests in this demand chain. Management tends to begin with high levels of agreement with customers in demand chain views. Management would like to provide the highest quality product at prices lower than their competitors, delivered in a timely fashion with high levels of reliability. This would enable the firm to gain large shares of the market, and if costs of production and overhead (to include computing) are contained, the firm will enjoy substantial profits. Suppliers for our purposes are extraneous, as we assume that they are interested in playing their role of providing quality inputs at fair prices. They do impact the system in that linkages need to be maintained and information shared about resource availability, and feedback about quality provided by the firm.

Most of the conflicts arise in our example from the IS/IT group. They have needs to provide comprehensive computing support within budgets that are often restricted. Demand chains require open computer systems, making it easy for customers to access the firm for ordering, monitoring of status, billing matters, and possible complaints. Open systems are also required to adequately link with suppliers. Management would like to have access to information relating to firm operations in a timely and easily accessible fashion. However, this openness creates many operational demands on IS/IT systems, and induces security nightmares (real or potential). IS/IT problems are complicated even more by the many available solutions available from the growing software industry (ERP, middleware, bolt-ons, and e-business systems) enhanced by a strong consulting industry to help the firm make its many IS/IT decisions, all for fees that are not very nominal.

Analysis Three is concerned with stakeholder interests and power. We are not as concerned with political aspects as with the role that power might have on the interactions among stakeholders. Customers have the ultimate power in demand chains. This manifests itself through management, who have the final say within firms. Suppliers play an external role, environmental to management. IS/IT is an internal faction, working toward the same ends as management, but with complex problems that lead to conflict with management through demands for quality service and control through budget limits.

Generation of Alternatives

Assume that our small firm has seen demand for the products increase not only in quantity, but also in the breadth of product line, making it very difficult for existing systems to keep up. There are a number of tasks that need to be accomplish to satisfy customer demands.

- Provide sales personnel with product information on price, quality, and availability by time,
- Forecast demand by item
- Track inventory records
- Determine the most efficient way to acquire goods to stock (making internally when time and planning allow; buying from alternative sources for rush orders if appropriate)
- Determine the most efficient way to ship goods to customers in light of customer needs
- Establish and implement policies for production (what to make each day; how many)
- Establish and implement policies for customer billing (which affects their relationship with the organization).

There are alternative means to accomplish this required work. The next step of the systems approach is to generate alternative solutions. These alternative solutions are not final, and can be refined at a later stage if none are deemed completely acceptable. Implicitly, the current method of doing things is an alternative (although not necessarily attractive). At the other extreme, the

business could adopt a vendor solution. There are, in fact, many vendor solutions available. It also is possible that modifications of vendor systems can be made to better fit computer products to a particular business's operations, although this involves the creation of additional work. At this stage, let us assume that the alternatives given in Table 2 have been generated for initial consideration. The current system was internally developed. It involves a great deal of data redundancy, and a lot of work is required to transform data readable by all the programs required to generate needed reports. The other alternatives are variant systems offered by vendors.

Table 2. Initial Alternatives

Alternative	Features
Current	Described above
Vendor A1	Financial & Accounting module, Production Planning, Retail
Vendor A2	Financial & Accounting module only
Vendor B	Financial & Accounting module with integrated Production Planning
Vendor A2mod	As Vendor A2, with extensive modifications
Vendor Bmod	As Vendor B, with extensive modifications
Vendor A1 electronic	As Vendor A1, with e-business linkage
Vendor A2mod electronic	As Vendor A2mod, with e-business linkage
Current with electronic	As Current, with web-site developed internally

Vendor B does not do electronic linkage.

Systems Perspective as the Basis for Goals

The three analyses of the soft systems approach presented above form the basis for identification of firm objectives. In light of stakeholder interests, the following objectives are identified:

1. Cost
2. Time
3. Process Quality
4. Customer Service
5. Linkage to suppliers & customers
6. Project Risk
7. Strategic position

The impact of each alternative on each objective can be expressed in matrix form in Table 3. This is accomplished by objective measures if available, or subjective decision maker assessment. The data in this table is based upon understanding gained by building the soft systems model.

Now we arrive at a decision point in Simon's perspective of systems. One approach is to screen alternatives, eliminating those that have unacceptable features. There can be required limits, such as budget constraints, time constraints, and other situational aspects that management may impose in order to focus on productive aspects of decisions. In our case, assume the following mandatory features.

Rigid constraints:

Cost <= 10 million	eliminates A1, A1 electronic, A2mod electronic
Time <= 12 months	eliminates A2mod, A1 electronic, A2mod electronic
Project risk not terrible	eliminates current system with electronic enhancement
Strategic position not poor	eliminates current

This leaves three of the original alternatives:

Vendor A2 Vendor B Vendor Bmod

Table 3. Impact Matrix of Alternatives on Objectives

Alternative	Cost	Time	ProcQual	Service	Linkage	Risk	Strategic
Current	0	0	Low	Low	Low	None	Poor
Vendor A1	$12 mill	12 mos	High	High	Low	Medium	Good
Vendor A2	$5 mill	6 mos	Medium	Good	Low	Good	Fair
Vendor B	$6 mill	8 mos	Medium	Good	Medium	Medium	Fair
Vendor A2mod	$8 mill	15 mos	High	High	Medium	Bad	Very good
Vendor Bmod	$7 mill	11 mos	Very high	High	Good	Bad	Good
Vendor A1 electronic	$15 mill	14 mos	Excellent	Excellent	High	Very bad	Very good
Vendor A2mod electronic	$13 mill	18 mos	Excellent	Very good	High	Very bad	Excellent
Current with electronic	$3 mill	4 mos	Excellent	Good	Good	Terrible	Fair

The systems approach would not limit itself to those alternatives originally proposed. The primary value of examining system parts, roles, and their interrelationships is to identify attractive as well as unacceptable features, and seek to design better solutions. In this case, this could yield:

Refinement of alternatives

None have electronic left	revise Vendor A2 system to include electronic; ask Vendor B to consider electronic; reduce risk of current system with electronic

This leads to a new impact matrix, as in Table 4. The refined alternatives will lead to increased cost and time requirements, but will improve customer service, linkage, and strategic positions. The modified vendor systems will have worse risk positions. Developing the current system in a less risky way will increase perceived process quality and reduce risk (although risk will still be bad).

Table 4. Revised Impact Matrix of Alternatives on Objectives

Alternative	Cost	Time	ProcQual	Service	Linkage	Risk	Strategic
Vendor A2	$5 mill	6 mos	Medium	Good	Low	Good	Fair
Vendor B	$6 mill	8 mos	Medium	Good	Medium	Medium	Fair
Vendor Bmod	$7 mill	11 mos	Very high	High	Good	Bad	Good
RevVendorA2	$8 mill	10 mos	Medium	High	High	Medium	Good
Vendor B+ele	$7 mill	12 mos	Medium	High	Good	Bad	Good
In-house +ele	$9 mill	12 mos	Very high	High	High	Bad	Excellent

Profiles

We can first provide profiles of relative performance over the alternatives (here we have six alternatives, combinations of two decision variables). A chart giving profiles over the nine alternatives is shown in Figure 1 (an idea applied by Korhonen 1988, and others). Here values between 0 and 1.0 were assigned to each cell, reflecting a possible assessment of value. Anchors of 1.0 are for the best imaginable performance, and 0 the worst acceptable.

This profile shows the relative advantages and disadvantages of each alternative. For instance, the Vendor A2 option has clear cost, time, and risk performance, but performs relatively poorly on the other criteria. The in-house alternative adding Web capabilities is very good on all criteria except for time, risk, and cost. The other alternatives considered tend to be good compromises. A profile is very good at visualizing relative performance, although care must be taken as only those aspects of the problem that are measured are displayed, of course. The intent is to inform managerial judgment.

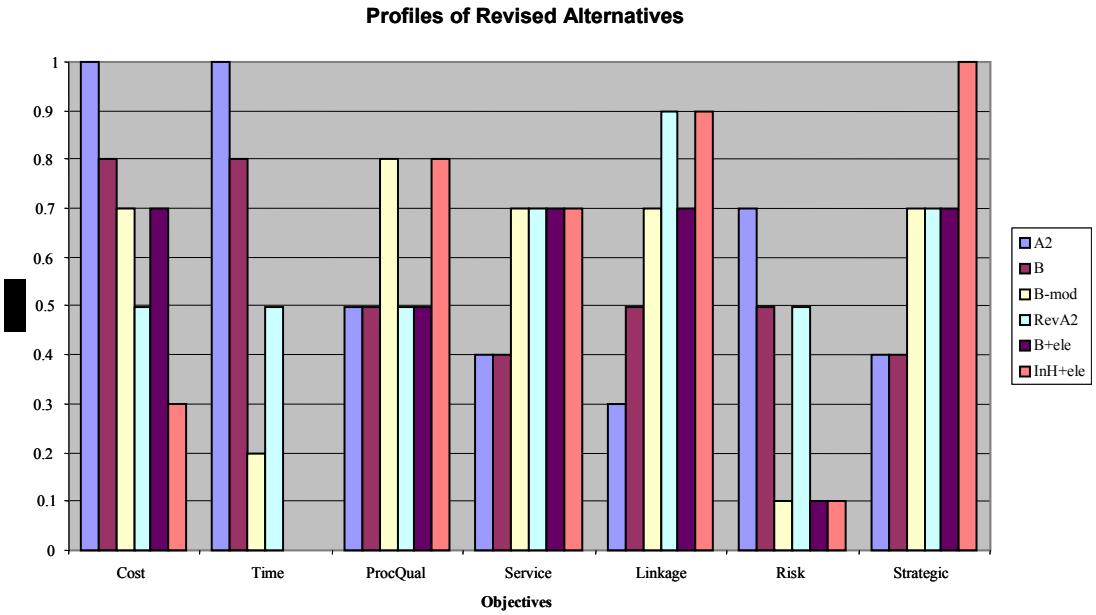

Figure 1. Profiles of Alternative Performances

Tradeoff Analysis

The weakness of the modified Vendor B proposal is time and risk. The Vendor B option with Web access does very poorly on time and risk. The original Vendor B option and the revised Vendor A2 option both do relatively well on all objectives. Vendor B is cheaper and faster, but the revised Vendor A2 option is better on customer service, linkage, and strategic potential.

A number of tradeoff techniques could be used at this stage, to include multiattribute utility theory (Edwards and Barron, 1994) and alternative methods (Olson, 1996).

Decision

Another approach is to preemptively set targets for criteria, and then prioritize these target attainment levels to be used as a contingent filter in a process of elimination (Lee, 1972). For instance, in this case (Table 5), decision makers might select the following target attainment levels by priority:

Table 5. Preemptive Targets by Priority

Priority	Criterion	Standard
1	Cost	= $10 million
2	Time	= 12 months
3	Customer service	At least good
4	Process quality	At least medium
5	Strategic impact	At least good
6	Cost	= $9 million
7	Risk	At least as good as medium
8	Cost	= $8 million
9	Customer service	At least high
10	Cost	= $5 million
11	Process quality	At least good
12	Linkage	At least good

This set of preemptive priorities can be applied as follows:

Priority 1: all six alternatives acceptable
Priority 2: all six alternatives acceptable
Priority 3: all six alternatives acceptable
Priority 4: all six alternatives acceptable
Priority 5: Eliminates alternatives Vendor A2 and Vendor B
Priority 6: All four remaining alternatives acceptable
Priority 7: Eliminates alternatives Vendor Bmod, Vendor B + ele, In-house + ele

Since there is only one remaining alternative, revised alternative Vendor A2 is recommended.

Priorities 8 through 12 were not needed in this instance. This preemptive approach is that applied in goal programming. It is a very workable means to reflect managerial judgment. Theoretically, it has been criticized for not investigating tradeoffs among alternatives.

Conclusions

Demand chains are useful for their focus on the purpose of the firm – providing what the customers want. This focus can lead to local system optimization rather than local optimization of system components while failing at the overall system level. Keeping focus on the purpose of the organization has proven to be important in many contexts. It does no good to do a great job for an outdated function. The systems view provides this focus.

In this paper, we have presented an approach that implements decision making with respect to information systems/information technology design. The process would begin with soft systems ideas, identifying stakeholders, their roles, and their aims as a guide to identify system objectives. By considering interactions among stakeholders, alternatives can be designed aimed at satisfying stakeholder desires. This will almost inevitably lead to tradeoff conflicts, calling for redesign based upon prioritized objectives. Here we presented a single iteration, although in principle the approach could refine solutions as long as was desired. This approach is not algorithmic. It is rather a process, leading to development of better solutions.

Our purpose was illustrative, so we have presented the methodology at a macro level. However, the methodology proposed fits within the idea of Checkland's soft systems methodology as a means to understand the organization's demand chain system, serving as a basis for quantification of multiple criteria for evaluation of alternative business process reengineering designs. This approach is easily applied to many important information systems decisions.

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