Improving Service Quality with the Theory of Constraints

Date: March 1, 2007 **Publication:** Journal of Academy of Business and Economics
Author: Moss, Hollye K.

ABSTRACT

Aside from success stories and case studies there have been very few in-depth studies of TOC in service industries. This study assesses the dissemination of TOC principles into services and looks at benefits that services are reaping as a result. An instrument to explore the penetration of TOC principles into services without using a vocabulary specific to TOC is developed and validated. SERVQUAL is adapted to evaluate the impact of the TOC principles on the five dimensions of customer service quality--tangibles, reliability, responsiveness, assurance, and empathy.

Using responses solicited from a broad range of organizations, the use of the principles underlying the logistics and thinking process paradigms was found to lead to significantly increased customer service quality. The use of the principles underlying the logistics paradigm was found to have significant positive effects on each of the dimensions of customer service quality with the exception of tangibles. Services providers can increase their customer service quality by implementing TOC principles.

INTRODUCTION

The theory of constraints (TOC) is a management philosophy that has been effectively applied to manufacturing processes and procedures to improve organizational effectiveness. Three TOC paradigms that have evolved over the last twenty-five years: logistics, global performance measures, and thinking processes (Blackstone, 2001; Draman 1995). More recently, Boyd and Gupta (2004) have referred to these three paradigms as decision making, performance measurement systems, and organizational mindset, respectively. Originally, the logistics paradigm had managers looking for, and elevating, system constraints in order to increase throughput. This included using drum-buffer-rope scheduling techniques and the five focusing steps of TOC. In the second paradigm, global performance measures were effectively utilized. These measures, based on throughput, operating expense, and inventory, allow managers to easily assess the impact of any given decision and help the manager to focus on the corporate goal. Most recently, the thinking processes (logic trees, evaporating clouds, etc.) have come into a more widespread use.

The usefulness of TOC in the manufacturing environment is well documented Rahman (1998). A meta-analysis by Mabin and Balderstone (2000) found TOC implementations reduced cycle times 65%, lead times 70%, and inventory levels were reduced 49%. As a result, companies were better able to meet promised customer delivery dates, improving their delivery date performance by 44%. Improvements were also seen on the financial side of the companies with revenue, throughput, or profit (depending on the reporting measure)increasing 76%.

The literature concerning TOC in manufacturing can be broken down into four categories. First, comparisons have been made between the use of TOC and other scheduling methods such as materials requirement planning (MRP), manufacturing resource planning (MRP II), and JIT manufacturing (Fawcetter and Pearson, 1991; Gardnier, et al., 1994; Holt, 1998; Lambrecht and Segaert, 1990; Sale and Inman, 2003). Second, there is an area of research that uses TOC to focus improvement programs like preventive maintenance (PM) (Chakravorty and Atwater, 1994), re-engineering (Hinneburg et al., 1996; Pierce and Newstrom, 2000; Tanner and Honeycutt, 1996), and TQM (Dettmer, 1995; Gardiner et al., 1994; Hansen and Hansen, 1996; Koksal, 2004; McMullen, 1998). The third area of research involves the application of TOC principles to project management (Goldratt and Fox, 1987; Lynch and Newbold, 1998; McClelland, 1998; McMullen, 1998; Walker, 1998). Finally, there is a mixed body of literature that suggests that TOC can best be used in combination with other manufacturing techniques (Grunwald et al., 1989; Krajewski et al., 1987; Gardiner et al., 1994; Goldratt, 1988; Neely and Byrne, 1992; Olhager and Ostlund, 1990; Ptak, 1991; Reimer, 1991; Schragenheim and Ronen, 1991; Spencer, 1991; Swann, 1986; Umble and Srikanth, 1990).

Recently, Boyd and Gupta (2004) introduced a theoretical model or framework for TOC. They suggest, without testing, a positive relationship between an organization with a throughput orientation, that is one that embraces the TOC concepts, and organizational

performance. More specifically, they suggest that there is positive relationship between each of the three TOC dimensions or paradigms and performance. This current work specifically looks at service organizations and their use of the principles underlying the paradigms and also uses customer service quality as a measure of organizational performance.

Because TOC is a management philosophy, it has broad applicability. Schragenheim (1999) defines a management philosophy as "guiding real world managers to make better decisions, meaning to take a course of action that helps an organization as a whole to better achieve its goal" (p. vii). Nothing in this definition limits the TOC philosophy to manufacturing. It then follows that TOC may have application to service industries; services can improve their processes and procedures just as can manufacturers. There is a precedent for such applications of a manufacturing management philosophy to services: the application of just-in-time (JIT) (Inman and Mehra, 1991; Wasco, et al., 1991) and total quality management (TQM) (Sureshchandar et al., 2001) to service. Service industries often contain quasi-manufacturing components within their operation in which the TOC logistics or scheduling paradigms may be adapted and utilized. The use of global performance measures and/or the TOC thinking processes can be beneficial in virtually any type of organization.

There is a variety of anecdotal evidence to confirm that some service organizations are using TOC as will be discussed. Aside from these success stories and case studies, however, there have been very few in-depth studies of TOC in service industries. To help fill this void, a survey was conducted to ascertain how service industries are utilizing components of TOC and what results are being obtained.

The use of empirical studies within the operations management field is useful in describing "the state of the art in operations management" (Flynn et al., 1990). The primary contributions of this research are the assessment of the use of TOC in services and the development an instrument for this research. While there may have been limited formal TOC training for service providers, many of the underlying principles may be gaining widespread acceptance through industry publications or books like The Goal (Goldratt and Cox, 1986).

BACKGROUND

Popularized by Eli Goldratt and his book, The Goal (Goldratt and Cox, 1986), the theory of constraints is a management philosophy that seeks to increase manufacturing throughput (efficiency or system performance measured by sales) by identifying those processes that are constraining the manufacturing system--the bottlenecks.

THE LOGISTICS PARADIGM

There are five steps in the theory of constraints logistics paradigm. First, identify the constraints. Find the process (or policy) that limits the ability of the remainder of the organization to meet its goals of higher performance. Second, decide how to exploit the constraints. What can be done to eliminate the bottleneck? Third, subordinate all else to the decision in step two. Everything possible must be done to ensure that the bottleneck operation runs smoothly. Forth, elevate the constraint. This may result in the acquisition of additional capacity, new machines or new technology to lift or break the constraint. Improving the performance of the constraint leads to improvement in the performance of the entire system. Finally, if a constraint is broken, go back to step one; do not let inertia become the constraint. It is very likely that once a constraint has been identified and addressed, another constraint will become evident. This should be addressed through the same 5-step process. A process of ongoing or continuous improvement has begun.

Associated with the logistics paradigm is the drum-buffer-rope technique for scheduling to synchronize the organization (Goldratt and Fox, 1986). The drum is the pace at which the system runs and is based on the capacity of the constraint. The strategically placed buffers protect the system from variations in production. The rope is the link between production points to ensure that the system is synchronized.

GLOBAL PERFORMANCE MEASURES

Under TOC, all company performance measures are driven by the global goal of making money now and in the future. This is accomplished by increasing throughput ("the rate at which the system makes money through sales"), reducing inventory ("all the money the system invests in purchasing things it intends to sell") and reducing operational expense ("the money the system spends in turning the inventory into throughput").

From the three operational measures, three global measures have been defined. Net profit, throughput minus operating expense, is an absolute measure reflecting the company's ability to make money now and in the future. Return on investment, the ratio of net profit to inventory, is a relative measure. Finally, cash flow is a survival measurement (Lockamy and Spencer, 1998). As long as the company has cash, this is not a concern. Without it, however, the company does not survive. Having only a few operational measures makes it easy to assess the impact of various decisions.

THINKING PROCESSES AND PROBLEM SOLVING

Goldratt states that managers make three decisions when dealing with constraints: What to change? What to change to? and How to cause the change? The TOC logical thinking process (TP) has evolved to answer these generic questions (Schragenheim and Dettmer, 2001; Spencer and Cox, 1995b). The past ten to fifteen years have shown that it is often managerial policies are most often the main constraint (Rahman, 1998); the thinking process also helps in these situations.

The thinking process consists of "trees" or logic diagrams. The first three are cause-and-effect, or "If ... then ...", trees (Schragenheim and Dettmer, 2001). The current reality tree (CRT) depicts the current state of affairs, designed to identify the system constraint, links causes and effects within the current operation to reveal root causes of problems. Managers then can focus on the core problem rather than wasting time on side issues. Future reality trees (FRT) are used to test potential solutions by diagramming cause and effect relationships for events in the future. Important objectives from the future reality tree are broken down into intermediate objectives by use of the prerequisite reality tree. Transition trees (TT), also called a cause-and-effect trees, is a flow diagram describing the states of the system as it changes based on a prescribed action plan; it is an implementation plan that has been time-sequenced.

Two other tools are slightly different. The evaporating cloud (EC) and the prerequisite tree (PRT) are used to identify necessary conditions. These tools complete the sentence "In order to have ... we must ..." and are used to identify and overcome obstacles to meeting an objective or implementing a solution. The PRT provides a bridge between the future reality tree and the transition tree. As such, the PRT is also time-sequenced.

THEORY OF CONSTRAINTS IN SERVICE FIRMS

During the past 15 years, there has been a move to expand TOC non-manufacturing applications. The TOC principles and ideas can be used to improve and implement change in any system, be it strategic planning for a firm or for one's personal life (Blackstone, 2001). Mabin and Gilbertson (1993) advocate that "the principles of Constraint Management need to be adopted by all organizations". They draw a parallel from manufacturing to service to support their claim. Today, there are many empirical and case studies (listed below) of the use of TOC principles as applied to services although little has been done to link these case studies.

Rahman (1998) noted that only two articles in refereed journals relating to TOC in service firms were published between 1980 and 1995. In 1993, Mabin and Gilbertson note that there were only a "few" published articles using TOC in services prior to their paper; they mention only two. Mabin and Balderstone (2000) note 12 articles in refereed journals from 1990 to 1999 that make TOC applications to service.

In contrast, one finds numerous examples of service firms' TOC implementations or use of the TOC thinking process within APICS (The Educational Society for Operations Management, formerly known as American Production and Inventory Control Society) Proceedings as well as from workshops sponsored by the Goldratt Institute; the audience is primarily the practitioner.

THE LOGISTICS PARADIGM IN SERVICES

The five step focusing process has been applied to processes and procedures within services. It has been used to improve service times (Olson, 1998), information flows (Coman and Ronen, 1994; Feather and Cross, 1988; Jolley and Patrick, 1990), and in re-engineering of administrative functions (Spencer and Wathen, 1994). The focusing steps have been used to improve sales (Hodgdon, 1998), and logistics functions with the military (Underwood, 1994). It has been used in medical settings (Roybal et al., 1999).

The drum-buffer-rope (DBR) scheduling technique can be used in services as well as in manufacturing (Demmy and Demmy, 1994; Demmy and Petrini, 1992; Gillespie et al., 1999; Ronen et al., 1994). While manufacturing uses DBR to schedule machinery, services may use DBR to schedule people within the organization, to set appointments for customers, or to predict lead-times for customers. Schragenheim and Ronen (1991) suggest that buffer management can be used to identify problems and weaknesses that will cause disruption to a system. It has been recommend that the DBR technique to be used to manage supply chains (Gupta, 1997; Perez, 1997; Watson and Polito, 2003).

GLOBAL PERFORMANCE MEASURES IN SERVICES

Within manufacturing, there are well-defined definitions of throughput, inventory, and operational expense; the goal is to make a profit now and in the future. Services share this goal, defining throughput based on sales. However services may have to be a little more creative when it comes to defining inventory and operating expenses (OE). In fact, Motwani et al. (1996a) suggest that under TOC the more effective statements of corporate goals are those that lead to more effective measures of inventory and operating expense within the service. Most services will have limited amounts of "traditional" inventory (Cook et al., 1999; Motwani et al., 1996b; Motwani and Vogelsang, 1996); the service is often produced at the time of sale and can not be carried in inventory. Inventory will be a smaller fraction of the service firm's assets than it would be for a manufacturing firm. Operational expenses will include their supplies and labor; OE in services may or may not have the impact on bottom line measurements in the service industry that has been shown in manufacturing.

TOC's global performance measures are based on throughput, inventory, and operational expense. Just because inventory is often a smaller fraction of assets for services, these global performance measures can still be utilized (Bramorski et al., 1997; Motwani et al., 1996a; Walker and Cox, 1998; Hinneburg, et al., 1996; Simons and Moore, 1992a and 1992b; Underwood, 1994).

THINKING PROCESSES IN SERVICES

The use of the TOC thinking processes can be used in services just as effectively as in manufacturing (Angst et al., 1996; Austin, 1998; Coman and Ronen 1994; Covington, 1998; Dettmer, 1997; Roadman, et. al., 1996; Tanner and Honeycutt, 1996). Services need a guiding management philosophy that will focus on process improvement. It may be the TOC thinking processes and problem-solving techniques that provide the most benefit to services.

SERVICE QUALITY MEASUREMENT

Over the past 30 years, thought patterns regarding the study and management of operations have changed. It was almost a century ago when Frederick Taylor began his work in efficiencies that would become the basis of "scientific management". This was applied almost exclusively to manufacturing for the next fifty years. Eventually, as the economies of the world shifted more toward services, the operations management field began to include services. There was a "growing awareness of the importance of service, customer operations, and customer contact" (Johnston, 1999). It was realized that manufacturing could not be completely separated from "service" (Cook et al., 1999). Over time, service operations research has moved into the area of service management, encompassing marketing, human resource management, and the service operations areas.

There are differences between goods and services; however, every industry has a service component, with some industries having more of a service component than others. There is such a breadth of services that it is hard to come up with a comprehensive definition that captures the diversity and attributes of all of them (Cook et al., 1999). In general, services are seen as intangible and heterogeneous; production and consumption occurs simultaneously. Harvey (1998) defines a good as "something tangible that customers use to derive a desired result" and a service as "a result that customers want".

Service quality has been shown to have a direct relationship to company performance. This link has been studied in depth. A number of studies note the relationship between service quality and profitability (Aaker and Jacobson, 1994; Bell et al., 2005; Bullard et al., 1993; Goodman et al., 1986; Keiningham et al., 1994-95; Kimes, 1999). It has also been noted that there is a link between service quality and repurchase intentions (Cronin and Taylor, 1992; Cronin and Taylor, 1994; Fornell, 1992; Keiningham et al., 1994-95; Reichheld and Sasser, 1990).

What, then, makes for a quality service? This has been discussed at length in the literature. In trying to articulate a definition for service quality, it may be useful to describe what constitutes poor service quality. Parasuraman et al. (1985) list problems with service delivery. They define all of these problems as differences or gaps. First, there is a gap between what the customer wants and what service providers think the customer wants. Second, there are problems translating the expectations of the customer into the design of the service. Third, the design of service systems does not always lead to the delivery of the service as planned. Finally, there is the problem of promising more than the service provides. It is these differences (gaps) that have become the basis for Parasuraman et al.'s 'Gap Models' (1985, 1988, 1991).

But what is "high" service quality? Crosby (1979) defined product quality as conformance to requirements. Juran (1992) defined quality as fitness for use. There is a general agreement that it is the customer who defines service quality (Fornell, 1992; Gronroos, 1984; Parasuraman, et. al., 1985). Gronroos (1984) defined service quality as being a judgment the customer makes when he compares his expectations to the perception of the service he has just received. A similar definition by Parasuraman et al. (1985) is often cited. They define service quality as the extent to which the service meets or exceeds customer expectations.

Once service quality has been defined, the measurement of service quality is not easy. A major, early work in this area was carried out by Parasuraman et al. in 1985. A list of 10 determinants of service quality was generated. The work ended by proposing a model that service quality was a function of the differences in expected service and perceived service. The subsequent phases of Parasuraman et al.'s (1988, 1991) work resulted in an instrument to measure service quality. A 97-item scale was developed, later refined to a 22-item scale, named SERVQUAL, spanning five dimensions of quality:

- tangibles (the facilities/equipment/tools are fit for the task),
- reliability (the customer receives the desired results time after time),
- responsiveness (the service provider responds quickly and accurately),
- assurance (the customer is in able and competent hands), and
- empathy (the customer is receiving caring service and individualized attention).

Several uses or applications for the SERVQUAL instrument were given. In addition to tracking service quality trends, it could be used to determine the relative importance of each of the five dimensions of customer service quality to the customers' overall perception of quality, allowing management to concentrate efforts. Another use was to assess performance relative to competition.

Rationale for the Research Question

Peer-reviewed research in the area of TOC has shown positive benefits in manufacturing; reductions in lead times, costs, and inventory levels as well as increases in quality and delivery performance have been demonstrated. There is a variety of anecdotal evidence and case studies concerning the use of TOC in services. An empirical study that supports or refutes the claims and case studies would benefit the literature. This leads to the question: What benefits are service organizations seeing from the use of TOC?

Johnston (1999) suggested that service operations research should refocus "on the traditional strengths of operations management, such as performance quality, design, and operations improvement". Doing so would "help provide greater rigor to the developing subject of service management" (Johnston, 1999). This current work makes a contribution toward that goal.

Boyd and Gupta (2004) have postulated that there is a positive relationship between organizations with a throughput orientation, those using TOC principles, and organizational performance. Implied in their hypothesis is that throughput orientation is a continuous variable. They do not specify a measure of organizational performance. Certainly customer service quality would be one such measure. Further, this measure can be operationalized by using each of the five dimensions of service quality. Because there is nothing in the discussions of Boyd and Gupta that limits the type of organization, their arguments should apply to services as well as manufacturing.

The literature review contained numerous examples of service organizations that have successfully implemented the logistics paradigm, the global measurements paradigm, and/or the problem solving paradigm. While these are examples of formal programs, they also illustrate the point that some organizations may be using only portions of TOC or a single paradigm. It is not a long leap to envision organizations weaving some of the TOC principles into their own improvement programs. It is possible that some service firms are using the underlying principles of TOC without formal training in TOC. Service providers may be familiar with The Goal, The Race, or Critical Chain (Goldratt and Cox, 1986; Goldratt and Fox, 1986, and 1987) or they may have read about TOC in industry publications or practitioner-oriented journals. If this is the case, there may very well be service organizations using some of the underlying TOC principles or some portion of the three TOC paradigms. This leads to the question: What aspects of TOC are services currently using?

From the questions, hypotheses were developed.

> **Hypothesis 1:** Service organizations using the principles underlying TOC will have higher levels of service quality with respect to each of the five dimensions of customer service quality.
>
> **Hypothesis 1a:** Service organizations using the logistics paradigm will have higher levels of service quality with respect to each of the five dimensions of customer service quality.
>
> **Hypothesis 1b:** Service organizations using the global performance measures paradigm will have higher levels of service quality with respect to each of the five dimensions of customer service quality.
>
> **Hypothesis 1c:** Service organizations using the thinking process paradigm will have higher levels of service quality with respect to each of the five dimensions of customer service quality.

What remains is to determine which, if any, of the paradigms, services are utilizing and the extent of their use. The following sections describe the creation and use of an instrument that can be used to make such an assessment. It is assumed, as implied by Boyd and Gupta (2004), that each of these constructs is continuous and that the combination can be used as a surrogate for the organization's use of TOC, or throughput orientation as Boyd and Gupta refer to it.

METHODOLOGY

An electronic survey was constructed to gather information concerning service quality and improvement methods utilized by services. Service quality and improvement methods were assessed using a Likert-scaled questionnaire. Development of this survey follows the framework outlined by Malhotra and Grover (1998). The survey was administered using Dillman's (2000) Tailored Design Method (TDM), a method designed to increase reliability, validity, and response rates.

An initial contact cover letter explained the survey and included a link to the survey web page. If the recipient felt they were not the proper person in the organization to respond, the cover letter asked that the survey be forwarded to the correct person. An

introductory question on the survey asked the respondent to verify that he or she was in a service industry. If they were not in a service organization, they were asked to scroll to the bottom of the screen and submit the survey without completing the balance of the survey. One week after the initial contact, a second contact was made. It included a thank you for those who had responded and a request for others to respond to the survey. The survey reminder letters included a statement allowing the respondent to request a copy of the survey via mail or fax if they did not wish to respond electronically.

The first section adapts the SERVQUAL (Parasuraman, et, al., 1988) items to assess service quality. Respondents answer with their perceptions of their service quality relative to their competition. The second section seeks information on improvement practices used within services. As no previously validated instrument was available, one was developed.

The construction process began by looking at the three TOC paradigms. A beginning assumption was that a majority of the survey respondents would be unfamiliar with TOC. It was therefore necessary to develop a survey without the use of TOC "lingo" or "jargon". Statements were developed relative to the underlying TOC principles. For example, the logistics paradigm first identifies the constraint or bottleneck. The associated survey item states, "Primary obstacles to obtaining goals are identified". This statement avoids the use of "constraint" or "bottleneck". Respondents are asked the extent to which these statements are true or are practiced in their organization.

Because this section required the development of new items, its face validity (Judd et al., 1991) was evaluated by a group of eight experts in the TOC field. Their comments were used to refine the instrument. In addition, a group of six likely respondents was asked to evaluate the survey for ease of use and clarity of questions. Their comments led to a rearrangement of the survey and to simplification of some of the items.

The unit of analysis is the organizational unit. If a service firm has multiple locations, each of these may have different levels of service quality. It is also possible that administrative (service) organizations within manufacturing facilities may respond to the survey. The intent is to capture service quality from each of these units. The survey sample size needed to provide for a minimum of 105 usable surveys in order to carry out Factor Analysis on the new items (Hatcher, 1994). The goal of the survey was a minimum of 200 usable surveys.

The survey sample came from a variety of places. A wide variety of services were represented in the services directory for associate members of the American Resort Development Association; this was available on the Internet. Headquarters USA (Perkins, 2002) was also used. This book references U.S. companies by industry (or service) type, listing addresses, phone numbers, and web sites. While email addresses are not listed, these web sites are often a source of email addresses for various managers. Two on-line university alumni directories yielded other names. (These directories are available to any alumni of the respective schools.) Finally, another, much smaller group came from the APICS service management and constraints management special interest groups (SIG's). A message was placed on their list serve's requesting potential respondents to contact the researcher if they would be willing to take a survey. A total of 1293 potential respondents were identified. Twenty percent were randomly assigned to be used in the pretest. An overall response rate of 33.5% was obtained in pretesting. The responses represented a wide variety of types of services and organizational sizes (based on both number of employees and number of customers served).

Pre-testing or pilot testing of an instrument is considered an integral part of the survey construction (Flynn et al., 1990; Dillman, 2000). This allows feedback to the researcher and can highlight potential problems with either the survey or the survey administration. The pre-test was used to evaluate both the survey and the survey delivery method.

Several lessons were learned from the pre-test. Survey instructions had to be clarified. Comments received from several respondents indicated that they did not think they were the appropriate people to reply. In some cases, the respondent thought only those administrative areas related to manufacturing were sought. In other cases, the respondent thought that because they were in a manufacturing administrative area that they were not a service.

It appeared that many of the respondents thought very highly of their customer service. It seemed that almost every respondent thought his customer service was better than his competitor's. The instructions for customer service section of the survey were changed to ask how their customers would rate their service relative to their largest competitor. The instructions were reworded in order to lead to more realistic responses. The instructions were also expanded to include examples of who a respondent's customers might be. A copy of the final survey is provided as an appendix. (Unlike the survey, the appendix has section headings to make for easier reading.)

A respondent's score on each of the dimensions of quality was calculated by averaging the response to each of the items underlying that dimension. This procedure was also followed in calculating average scores on each of the dimensions underlying TOC. Following the recommendations of Roth et al. (1999), "Don't Know" answers or missing data were not used in calculating that average. The work of Roth et al. found that using this technique in multiple item scales preserves data, acknowledges differences among respondents, and is a robust approach.

Hypothesis Testing

Hypotheses 1 a-c, that organizations using more of each of the principles underlying TOC within their improvement programs will have higher levels of service quality, were tested in three phases, each using regression. First, the set of three TOC constructs was used to predict each of the five individual dimensions of quality using multiple regression. (That is, the set of three TOC constructs was used to predict tangibles; the set was used to predict reliability, etc.).

Second, this combination of TOC constructs was used to predict the combination of dimensions of quality using a multivariate-multiple regression. (Each of the independent variables (TOC paradigms) was used to predict the vector of customer service quality dimensions.) Support for these hypotheses was determined by examination of the individual regression coefficients. It was expected that the regression coefficients will not be equal to zero and that the slopes will be positive. The third step of testing the hypotheses was regression of the vector of TOC paradigms against the vector of dimensions of customer service quality.

RESULTS

Surveys were sent to a total of 1293 individuals. From the original list, 270 addresses came back undeliverable. Seventy people chose not to, or could not, participate; eighty terminated the survey by indicating they were not in a service organization. One returned survey was unusable as the respondent failed to respond to any of the customer service quality items. The final sample size was 872. Of those, 264 completed the survey, resulting in a 30.3% response rate. Respondents represented a variety of service organizations and organizational sizes.

Raw data were analyzed first. As normally distributed data with equal variance across groups are generally required for parametric univariate and multivariate techniques of analysis, data were first examined for normality. Tests using the Shapiro-Wilk technique indicated nonnormality for some variables. Conover (1999) recommends that one use the usual (parametric) analysis "on the data and then ... use the same procedure on the rank transformed data" (pp. 419-420). Further analysis, evaluating the data with parametric and non-parametric techniques, as described, yielded very similar results. Following the suggestions of Conover (1999), analysis proceeded using the usual parametric techniques.

Reliability

Reliability of the instrument was evaluated with respect to internal consistency reliability and test-retest reliability. The data in Table I show the analysis of the independent variables, the principles underlying each of the TOC paradigms. Both the composition of the original scales and their standardized scale alpha values are presented. Within operations research, coefficient alpha (Cronbach, 1951) values greater than 0.6 are generally considered acceptable (Flynn et al., 1990). This threshold was used for analysis. For the principles underlying the problem solving paradigm, the coefficient was 0.91. Item number 30 exhibited the lowest correlation, 0.57.

When this item was deleted, the coefficient did not change. This item was not dropped at this point, but was identified for further monitoring in the validity checks. For the principles underlying the global performance measures paradigm, the coefficient was 0.89. Item number 32 (management has only a few measures for control purposes) exhibited the lowest correlation, 0.47. When this item was deleted, the coefficient increased to 0.93. At this point, it was decided that item 32 should be dropped. It was felt that other items within the group captured the same information. For the principles underlying the logistics paradigm, the coefficient was 0.95. There is no improvement in the coefficient if any item is deleted.

Although the SERVQUAL instrument has been previously shown to be reliable and valid, the reliability was again evaluated to confirm this. Again, using apha > 0.6 as the threshold, these data were deemed reliable. Results were as one would expect from a validated instrument.

At the time the survey was administered, 103 respondents indicated they would be willing to participate in a follow-up test. Each of these was asked to answer again the 43 items. Forty-four sets of responses were compared for test-retest reliability. The average scores for each construct were used for comparison purposes. As some of these variables were not normally distributed, both nonparametric and parametric tests were run. Summary information is given in Table II. At [alpha] = .05, only the tangibles construct was found to be significantly different between the test and retest (pr > [absolute value of T] = .0028). When eight comparisons are made at [alpha] = .05, there is a 33.7% chance of rejecting the null when it is true. Therefore, this difference may have been due to random error. Based on this analysis, it was concluded that the instrument showed reasonable test-retest consistency over time.

VALIDITY

After establishing reliability of the instrument, the validity of the instrument was reviewed. Face validity seeks the opinion of experts to answer the question "Does the instrument appear to capture what its name suggests?" Face validity was addressed during survey development.

Confirmatory factor analysis was then used to further evaluate the convergent and discriminate validity of the instrument with respect to the principles underlying TOC, items 24-43 (as numbered in the appendix). Both convergent validity and discriminate validity were evaluated. Results of these analyses are presented in Table III. The responses for items 24-43 were subjected to factor analysis using squared multiple correlations as prior communality estimates. The principle factor method was used to extract the factors; this was followed by a promax (oblique) rotation to analyze different numbers of factors. An item was said to load on a given factor if the factor loading was .50 or greater for a factor, and less than .50 for other factors (Hatcher, 1994). Initially, considering all of the items and without specifying the number of factors to be retained, the computer program retained five. As items with low loadings were eliminated, three factors emerged.

Three items were dropped: items 30, 31, and 32. Item 30 (problem-solving training is given to employees throughout the organization) was dropped from the principles underlying the problem solving paradigm. This was an item that had been identified during the reliability checks for further monitoring. Both items 31 and 32 had been included in the principles underlying the global performance measures paradigm. Item 31 (people are aware of the overall goal(s)) was also dropped. The decision to drop item 32 (management has only a few measures used for control purposes) had been made during the reliability check; the decision to drop this item was confirmed during factor analysis. It was felt that the essence of items 31 and 32 was captured in items 34-36. Each factor retained at least three items, the number often used as the minimum acceptable. The resulting standardized factor loadings are given in Table III. This three-factor structure accounted for 98% of the common variance. Factor 1 is the principles underlying the logistics paradigm and accounts for 87% of the common variance. Factor 2 is the principles underlying the problem solving paradigm; it represents 7% of the common variance. Factor 3 is the principles underlying the global performance measures paradigm and accounts 5% of the common variance. Final communality estimates totaled 12.5.

Analysis after this point was performed on a respondent's average score on each construct. As in the SERVQUAL instrument, items 1-4 composed the tangibles dimension; 5-9, reliability; 10-13, responsiveness; 14-17, assurance; and 18-22, empathy. For the TOC

constructs, items 23-29 composed the principles underlying the problems solving paradigm; 33-35, the principles underlying the global performance paradigm; and 36-43, the items underlying the logistics paradigm.

HYPOTHESIS TESTING

The hypotheses suggested that organizations using more of the principles underlying each of the TOC paradigms (having higher average scores on each of those dimensions) within their improvement programs will have higher levels of service quality with respect to each of the five dimensions. Hypotheses 1 a-c were tested in three phases, each using regression, in an effort to identify significant relationships. In the first phase, the use of the principles underlying each of the paradigms was used to predict the individual dimensions of customer service quality. This resulted in five models being analyzed, one for each customer service quality dimension. The multiple regression equation shown below was used:

[y.sub.i] = [[beta].sub.0] + [[beta].sub.1] (THNKPROC) + [[beta].sub.2] (PERFMEAS) + [[beta].sub.3] (LOGISTIC) (1)

where [y.sub.i] represents each of the dimensions underlying customer service quality

THNKPROC is the average score on the principles underlying the thinking process paradigm,

PERFMEAS is the average score on the principles underlying the global performance measures paradigm, and

LOGISTIC is the average score on the principles underlying the logistic paradigm.

Results of stepwise regression and parameter estimates are shown in Table IV. Also included in that table are the resulting prediction equations. Variance inflation factors indicate that multicollinearity is not a problem. Non-significant variables have been dropped from the model. The use of principles underlying the thinking process paradigm was found to be a significant predictor of each of the dimensions of customer service quality (pr > F =

Following this, in the second phase of testing the hypotheses, each of the independent variables (TOC paradigms) were individually regressed against the vector of customer service quality dimensions using multivariate, simple regression. This model is

[[y.sub.1], [y.sub.2], [y.sub.3], [y.sub.4], [y.sub.5]] = [[beta].sub.0] + [[beta].sub.1] [x.sub.i] (2)

where [x.sub.i] represents average scores on each of the constructs underlying improvement methods, THNKPROC, PERFMEAS, and LOGISTIC; and [[y.sub.1], [y.sub.2], [y.sub.3], [y.sub.4], [y.sub.5] is the vector of dimensions of customer service quality.

Here, each [x.sub.i] is found to be significant (pr > F =

The third and final phase of testing the hypotheses consisted of testing the same model, using multivariate, multiple regression and letting [x.sub.i] represent the vector of improvement methods (all three of the [x.sub.i]'s). At this point, THNKPROC and LOGISTIC were found to have an overall effect on the customer service quality vector, but PERFMEAS did not. This is shown in Table VII.

DISCUSSION

The items underlying the thinking processes were found to have a significant positive impact on each dimension of customer service quality. This is consistent with much of the literature. Johnston (1999) commented on two frequent problems that service organizations encounter. Implementing new technologies often leads to disasters, failing to meet expectations because this new technology is superimposed on systems that are inherently inefficient. The second problem is management's difficulty in assessing the impact of proposed changes. Two of the principles underlying the thinking process are that the entire organization is viewed as a system and that new process designs are thoroughly reviewed before implementation. By using the principles underlying this

paradigm, problems such as those named by Johnston (1999) can be minimized or eliminated, leading to improved customer service quality.

The items underlying the logistics paradigm had a significant positive effect on each of the dimensions except tangibles. Tangibles are those things that can be seen: the facilities/equipment/tools should be fit for the task. The logistics paradigm looks at the system as a whole and considers constraining resources. It makes intuitive sense that tangibles may not be related to those principles underlying the logistics paradigm.

Under the logistics paradigm, a system-wide view must be taken. Having this broad perspective leads to better customer service quality. Those organizations failing to have the system-wide view struggle with improving quality (Dettmer, 1995; Stewart and Chase, 1999). Chase and Heskett (1995) stressed the need for extensive coordination within the service organizations.

The positive effects of the principles underlying the logistics paradigms have been illustrated by Berry and Cooper (1990) who were not espousing the values of TOC, but illustrating the advantages of improving process convenience for customers. Using bank tellers' lunchtime rush of customers, they illustrated the advantages of reducing the time customers spend in a bank (lead-time). They determined the most critical point (the number of tellers) and started improvements from there. They identified obstacles and changed policies (lunch breaks and operating hours) as needed. Part time employees were scheduled to maximize the number of customers that could be served during the rush times, expanding capacity. Hours were changed to encourage customers to use the services during off-peak hours. All of this was done to increase the quality of customer service. Each of these moves illustrated one of the principles underlying the logistics paradigm.

The items underlying the global performance measurement paradigm were found to have an effect on customer service quality only in the second phase of testing the hypotheses. Johnston (1999) stated that "many organizations seem reluctant to critically review and develop their performance measurement systems". He cited an example of an organization that had developed some performance measurement standards, but did nothing to verify the improvement impact of those activities. The value in using performance measures is tracking improvement. Ineffective measures are, by definition, not going to lead to improvement. Further, simply having performance measures, even if an organization goes so far as to track the measures, means nothing if management does not use them to evaluate performance. The conclusion of this current study is the same as the conclusions of Berry (1991) and Johnston (1999): performance measurement systems that are in place may be ineffective at improving customer service quality.

During the second phase of testing, as predicted, those items underlying each of the TOC paradigms were individually found to be significant in predicting overall customer service quality (the vector of customer service quality dimensions). In practice, one would probably not implement the use of TOC's global performance measures without also using the logistics measures. The change in significance of PERFMEAS may be due to slight multicolinearity. Variance inflation factors, however, were not high, indicating no serious problem with multicolinearity. This finding demonstrates that a variety of improvement methods can be useful, but it also demonstrates the value of the TOC theory. This suggests that there is still much more room for improvement.

During the third phase of testing, the vector of improvement methods was regressed against the vector of customer service quality. The result was found to be significant. That is, the vector of improvement methods was useful in predicting customer service quality. It should be noted here, however, that those principles underlying the global performance measures paradigm did not significantly contribute to the relationship. This is consistent with the findings from the first phase. This is also consistent with the theory put forth by Boyd and Gupta (2004).

CONCLUSIONS

As a management philosophy, TOC has broad applicability and this work has explored its application to services. Contributions have been made by exploring the penetration of TOC principles into services and by developing and validating an instrument for that exploration. The instrument captured the principles underlying each of the three TOC paradigms--logistics, global performance

measures, and the thinking processes. Previously, no such instrument was available. It was felt that the more of those underlying principles that were used, the better an organization would function, resulting in higher customer service quality. SERVQUAL, a previously validated instrument was adapted to capture and rate customer service quality.

The use of the principles underlying the problem solving paradigm lead to significantly increased customer service quality with respect to all five dimensions of customer service quality. By using the principles underlying this paradigm, problems encountered as a result of incorporating new technology or problems with the assessment of proposed changes to the service system can be minimized or eliminated, leading to improved customer service quality. The use of the principles underlying the logistics paradigm was found to have a significant effect on each of the dimensions with the exception of tangibles. Under the logistics paradigm, a system-wide view must be taken. Having this broad perspective leads to better customer service quality. The principles underlying the global performance measurement paradigm were not found to affect customer service quality.

This study has addressed a need that Johnston (1999) noted when he suggested that service operations research should refocus "on the traditional strengths of operations management". This study has helped to provide some rigor to the subject of service management by demonstrating how service management can be improved.

There are some limitations of this study. One may involve the measurement scales for improvement methods, especially those underlying the global performance measure paradigm. Global measures for services are not as straightforward as they are for manufacturing. For example, in manufacturing, inventory is anything that can be sold. This leads to some creative definitions of inventory in services. Within the current study, by using only three items for measuring the principles underlying the global performance measurement paradigm, it is possible that some of the nuances were not captured by the survey.

This survey used information from both traditional services as well as from administrative functions within manufacturing facilities. To have more broadly applicable and widely generalizable results, responses were solicited from a broad range of organizations, with singe responses per organization. This did not allow for inter-rater reliability checks. The research failed to consider some other important determinant of customer service quality. The variances in the models used accounted for just under half of the variance in customer service quality.

Clearly there is more research to be done with respect to the use of TOC within service organizations. Future research should refine the assessment of what aspects of TOC service organizations are actually using, especially with respect to global performance measures. This may include refining the items used to describe the principles underlying the global performance measures paradigm. Future work may also concentrate on a limited number or type of services or may concentrate on the size of the service organization. It would be interesting to know if some of the more scheduling-intensive services (hospitals, call centers, delivery companies) or any specific type of service might benefit more from implementation of the principles underlying TOC than would other types of services.

REFERENCES:

Aaker, D.A. and Jacobson, R., "The Financial Information Content of Perceived Quality", Journal of Marketing, Vol 31 (2), 1994, 191-201.

Angst, D.R., McKinney, B.L. and Klein, C.F., 'Johnson Controls' Experience with the Theory of Constraints', in 1996 APICS Constraints Management Symposium Proceedings, APICS, Detroit, Michigan, 143-145.

Austin, K., "Experiences Applying TOC to a Medical Practice", presentation to ISSI, November 1998.

Bell, S.J., Auh, S. and Smalley, K., "Customer Relationship Dynamics: Service Quality and Customer Loyalty in the Context of Varying Levels of Customer Expertise and Switching Costs", Journal of the Academy of Marketing Science, Vol 33 (2), 2005, 169-183.

Berry, L.L., "Mistakes That Service Companies Make in Quality Improvement", Bank Marketing, Vol 23 (4), 1991, 68-69.

Berry, L.L. and Cooper, L.R., "Competing with Time-Saving Service", Business, Vol 40 (2), 1990, 3-7.

Blackstone, J.H., "Theory of Constraints--A Status Report", International Journal of Production Research, Vol 39 (6), 2001, 1053-1080.

Boyd, L. and Gupta, M., "Constraints management: What is the Theory?", International Journal of Operations and Production Management, Vol 24 (4), 2004, 350-371.

Bramorski, T., Madan, M.S. and Motwani, J., "Application of the Theory of Constraints in Banks", The Bankers Magazine, Vol 180 (1), 1997, 53-59.

Bullard, W.R., Cronin, Jr., J.J., and Shemwell, Jr., D.J., "The Effect of Strategic Customer Service Level on Corporate Performance", in R. Johnston, N. Slack (eds.), Service Superiority. The Design and Delivery of Effective Service Operations, Operations Management Association, UK, 1993, 155-162.

Chakravorty, S.S. and Atwater, J.B., "How Theory of Constraints Can Be Used to Direct Preventative Maintenance", Industrial Management, Vol 36 (6), 1994, 10-13.

Chase, R.B. and Heskett, J.L., "Introduction to the Focused Issue on Service Management", Management Science, Vol 41 (11), 1995, 1717-1718.

Coman, A. and Ronen, B., "IS Management by Constraints: Coupling IS Effort to Changes in Business Bottlenecks", Human Systems Management, Vol 13 (1), 1994 65-70.

Conover, W.J., Practical Nonparametric Statistics, 3rd ed, John Wiley & Sons, Inc., New York, 1999.

Cook, D.P., Goh, C. and Chung, C.H., "Service Typologies: A State of the Art Survey", Production and Operations Management, Vol 8 (3), 1999, 318-338.

Covington, J., 'A System Is a System Is a System', in 1998 APICS Constraints Management Symposium Proceedings, Seattle, Washington, 1998, 29-31.

Cronbach, L.J., "Coefficient Alpha and the Internal Structure of Tests", Psychometrika, Vol 16, 1951, 297-334.

Cronin, J.J. and Taylor, S.A., "Measuring Service Quality: A Reexamination and Extension", Journal of Marketing, Vol 56 (7), 1992, 55-68.

Cronin, J.J. and Taylor, S.A., "SERVPERF vs. SERVQUAL: Reconciling Performance-Based and Perceptions Minus Expectations Measurement of Service Quality", Journal of Marketing, Vol 58 (1), 1994, 125-131.

Crosby, P.B., Quality is Free: the Art of Making Quality Certain, McGraw-Hill, New York, 1979.

Demmy, W.S. and Petrini, A.B., "The Theory of Constraints: A New Weapon for Depot Maintenance Planning and Control", AirForce Journal of Logistics, Vol 16 (3), 1992, 6-11.

Demmy, W.S. and Demmy, B.S., "Drum-Buffer-Rope Scheduling and Pictures for the Yearbook", Production and Inventory Management Journal, Vol 35 (3), 1994, 45-47.

Dettmer, H.W., "Quality and the Theory of Constraints", Quality Progress Vol 28 (4), 1995, 77-81.

Dettmer, H.W., Goldratt's Theory of Constraints. A Systems Approach to Continuous Improvement, ASQC Press, Milwaukee, WI, 1997.

Dillman, D.A., Mail and Internet Surveys: The Tailored Design Method, 2nd ed., John Wiley & Sons, Inc., New York, 2000.

Draman, R.H., A New Approach to the Development of Business Plans: A Cross Functional Model Using. the Theory of Constraints Philosophies. Ph.D. Dissertation, University of Georgia, 1995.

Fawcett, S.E. and Pearson, J.N., "Understanding and Applying Constraint Management in Today's Manufacturing Environments", Production and Inventory Management Journal, Vol 32 (3), 1991, 46-55.

Feather, J.J. and Cross, K.F., "Workflow Analysis, Just-in-Time Techniques Simplify Administrative Process in Paperwork Operation", Industrial Engineering Vol 20 (1), 1988, 32-40.

Flynn, B.B., Sakakibara, S., Schroeder, R.G., Bates, K.A. and Flynn, E.J., "Empirical Research Methods in Operations Management", Journal of Operations Management, Vol 9 (2), 1990, 250-283.

Fornell, C., "A National Customer Satisfaction Barometer: The Swedish Experience", Journal of Marketing, Vol 56 (1), 1992, 6-21.

Gardiner, S.C., Blackstone, Jr., J.H. and Gardiner, L.R., "The evolution of the Theory of Constraints. Industrial Management 36 (3), 1994, 13-16.

Gillespie, M.W., Patterson, M.C. and Harmel, B., "TOC Beyond Manufacturing", Industrial Management, Vol 41 (6), 1999, 22-25.

Goldratt, E.M., "Computerized Shop Floor Scheduling", International Journal of Production Research Vol 26 (3),1988, 443-455.

Goldratt, E.M. and Cox, J., The Goal, 2nd ed., North River Press, Croton-on-Hudson, New York, 1986.

Goldratt, E.M. and Fox, R.E., The Race, North River Press, Croton-on-Hudson, New York, 1986.

Goldratt, E.M. and Fox, R.E., Critical Chain, North River Press, Croton-on-Hudson, New York, 1987.

Goodman, J.A., Mara, T. and Brigham, L., "Customer Service: Costly Nuisance or Low-Cost Profit Strategy", Journal of Retail Banking, Vol 8 (3), 1986, 7-16.

Gronroos, C., "A Service Quality Model and Its Marketing Implications", European Journal of Marketing, Vol 18 (4), 1984, 36-44.

Grunwald, H., Striekwold, P.E.T. and Weeda, P.J., "A Framework for Quantitative Comparisons of Production Control Concepts", International Journal of Production Research, Vol 27 (2), 1989, 281-292.

Gupta, S., "Supply Chain Management in Complex Manufacturing", IIE Solutions, Vol 29 (3), 1997, 18-21.

Hansen, R. and Hansen, D., "Achieving Breakthrough Performance--It's Not Luck,', in 1996 APICS Constraints Management Symposium Proceedings, APICS, Detroit, Michigan, 1996, 98-100.

Harvey, J., "Service Quality: A Tutorial", Journal of Operations Management, Vol 16 (5), 1998, 583-597.

Hatcher, L., A Step-by-Step Approach to Using the SAS System for Factor Analysis and Structural Equations Modeling, SAS Institute, Inc., Carry, NC, 1994.

Hinneburg, P.A., Lynch, W. and Black, J., 'Lean Logistics', in 1996 APICS Constraints Management Symposium Proceedings, APICS, Detroit, Michigan, 1996, 89-97.

Hodgdon, B., 'Identifying and Elevating the Constraint Sales Skill', in 1998 APICS Constraints Management Symposium Proceedings, APICS, Seattle, Washington, 1998, 62-63.

Holt, J.R., 'A Candid Comparison of Operations Management Approaches', in 1998 APICS Constraints Management Symposium Proceedings, APICS, Seattle, Washington, 1998, 76-78.

Inman, R.A. and Mehra, S., "JIT Applications for Service Environments", Production and Inventory Management Journal, Vol 32 (4), 1991, 16-21.

Johnston, R., "Service Operations Management: Return to Roots", International Journal of Operations & Production Management, Vol 19 (2), 1999, 104-124.

Jolley, A. and Patrick, A., "The Office Factory", Management Today, 1990: July, 100-102.

Judd, C.H., Smith, E.R. and Kidder, L.H., Research Methods in Social Relations, 6th ed., Holt, Rinehart, and Winston, Inc., Fort Worth, 1991.

Juran, J.S., Juran on Quality by Design: The New Steps for Quality into Goods and Services, Free Press, New York, 1992.

Keiningham, T., Zahorik, A.J. and Rust, R.T., "Getting Return on Quality", Journal of Retail Banking, Vol 16 (4), 1994-95, 7-12.

Kimes, S.E., "The Relationship Between Product Quality and Revenue Per Available Room at Holiday Inn", Journal of Service Research Vol 2 (2), 1999, 138-144.

Koksal, G., "Selecting Quality Improvement Projects and Product Mix Together in Manufacturing: An Improvement of a Theory of Constraints-Based Approach by Incorporating Quality Loss", International Journal of Production Research, Vol 42 (23), 2004, 5009-5029.

Krajewski, L.J., King, B.E., Ritzman, L.P. and Wong, D.S., "Kanban, MRP, and Shaping the Manufacturing Environment", Management Science, Vol 33 (1), 1987, 39-57.

Lambrecht, M. and Segaert, A., "Buffer Stock Allocation in Serial and Assembly Type of Production Lines", International Journal of Operations and Production Management, Vol 10 (2), 1990, 47-61.

Lockamy, III, A. and Spencer, M.S., "Performance Measurement in a Theory of Constraints Environment", International Journal of Production Research, Vol 36 (8), 1998, 2045-2060.

Lynch, W.E. and Newbold, R. 'A Practical Approach for Implementing Critical Chain Management', in 1998 APICS Constraints Management Symposium Proceedings, Seattle, Washington, 1998, 64-67.

Mabin, V.J. and Balderstone, S.J., The World of the Theory of Constraints: A Review of the International Literature, St. Lucie Press, Boca Raton, FL, 2000.

Mabin, V. and Gilbertson, D., 'The Application of Constraint Management to Manufacturing and Services in New Zealand', in A. Kouzmin, L.V. Still, P. Clarke, (eds.), New Directions in Management, McGraw-Hill, Sidney, 2003.

Malhotra, M.K. and Grover, V., "An assessment of Survey Research in POM: From Constructs to Theory". Journal of Operations Management, Vol 16 (4), 1998, 407-425.

McClelland, B., 'TOC Thinking Process Tools Applied to Project Management', in 1998 APICS Constraints Management Symposium Proceedings, Seattle, Washington, 1998, 87-91.

McMullen, Jr., T.B., Introduction to the Theory of Constraints Management System, St. Lucie Press/APICS Series on Constraints Management, Boca Raton, FL, 1998.

Motwani, J., Klien, D. and Harowitz, R., "The Theory of Constraints in Services: Part 1--the basics", Managing Service Quality, Vol 6 (1), 1996a 53-56.

Motwani, J., Klien, D. and Harowitz, R., "The Theory of Constraints in Services: Part 2--examples from healthcare", Managing Service Quality, Vol 6 (2), 1996b, 30-34.

Motwani, J. and Vogelsang, K., "The Theory of Constraints in Practice--at Quality Engineering, Inc.", Managing Service Quality, 6 (6), 1996, 43-473.

Neely, A.D. and Byrne, M.D., "A Simulation Study of Bottleneck Scheduling", International Journal of Production Economics, Vol 26 (1-3), 1992, 187-192.

Olhager, J. and Ostlund, B., "An Integrated Push-Pull Manufacturing Strategy", Journal of Operational Research, Vol 45 (2-3), 1990, 135-142.

Olson, C.T., "The Theory of Constraints: Application to a Service Firm", Production and Inventory Management Journal, Vol 39 (2), 1998, 55-59.

Parasuraman, A., Zeithaml, V. and Berry, L., "A Conceptual Model of Service Quality and its Implications for Future Research", Journal of Marketing, Vol 49 (4), 1985, 41-50.

Parasuraman, A., Zeithaml, V. and Berry, L., "SERVQUAL: A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality", Journal of Retailing, Vol 64 (1), 1988, 12-40.

Parasuraman, A., Zeithaml, V. and Berry, L., "Refinement and Reassessment of the SERVQUAL Scale", Journal of Retailing, Vol 67 (4), 1991, 420-450.

Perez, J.L., "TOC for World Class Global Supply Chain Management", Computers and Industrial Engineering, Vol 33 (1-2), 1997, 289-293.

Perkins, J., Headquarters USA, 24th ed., Ommigraphics, Detroit, MI, 2002

Pierce, J.L. and Newstrom, J.W. (eds.), The Manager's Bookshelf, Prentice Hall, Upper Saddle River, NJ, 2000.

Ptak, C.A., "MRP, MRP II, OPT, JIT, and CIM--Succession, Evolution, or Necessary Combination", Production and Inventory Management Journal, Vol 32 (2), 1991, 7-11.

Rahman, S., "Theory of Constraints: A Review of the Philosophy and its Applications", International Journal of Operations & Production Management, Vol 18 (4), 1998, 336-355.

Reichheld, F. and Sasser, Jr., E., "Zero Defections: Quality Comes to Services", Harvard Business Review, Vol 68 (5), 1990, 105-111.

Reimer, G., "Material Requirements Planning and Theory of Constraints: Can They Coexist? A Case Study", Production and Inventory Management Journal, Vol 32 (4), 1991, 48-52.

Ridings, C.M., Determinants of Trust and Use in Virtual Communities, Ph.D. Dissertation, Drexel University, 2000.

Roadman, C.H., Adams, D.V., Right, Jr., E.J., Womack, D.E., Flowers, S.H., Grass, B.W. and Franklin, K.R., 'TOC Thinking Processes in a Service Organization', in 1996 APICS Constraints Management Symposium Proceedings, Detroit, MI, 1996, 27-41.

Ronen, B., Gur, R. and Pass, S., "Focused Management in Military Organizations: An Avenue for Future Industrial Engineering", Computers and Industrial End, Vol 27 (1-4), 1994, 543-544.

Roth, P.L., Switzer, F.S. and Switzer, D.M., "Missing Data in Multiple Item Scales: A Monte Carlo Analysis of Missing Data Techniques", Organizational Research Methods Vol 2 (3), 1999, 211-232.

Roybal, H., Baxendale, S.J. and Gupta, M., "Using Activity-Based Costing and Theory of Constraints to Guide Continuous Improvement in Managed Care", Managed Care Quarterly, Vol 7 (1), 1999, 1-10.

Salant, P. and Dillman, D.A., How to Conduct Your Own Survey, John Wiley & Sons, Inc., New York, 1994.

Sale, M.L. and Inman, R.A., "Survey-Based Comparison of Performance and Change in Performance of Firms Using Traditional Manufacturing, JIT and TOC", International Journal of Production Research, Vol 41 (4), 2003, 829-844.

Schragenheim, I., Management Dilemmas: The Theo of Constraints A roach to Problem Identification and Solutions, St. Lucie Press/APICS Series on Constraints Management, Boca Raton, FL, 1999.

Schragenheim, E. and Ronen, B., "Buffer Management: A Diagnostic Tool for Production Control", Production and Inventory Management Journal, Vol 32 (2), 1991, 74-79.

Simons, J.V. and Moore, Jr., R.I., "The TheorFy of Constrains Approach to Focused Improvement", Air Force Journal of Logistics, Vol 16 (3), 1992a, 1-5.

Simons, J.V. and Moore, Jr., R.I., "Improving Logistics Flow Using the Theory of Constraints", Logistics Spectrum, Vol 26 (3), 1992b, 14-18.

Spencer, M.S., "Using "The Goal" in an MRP system", Production and Inventory Management Journal, Vol 32 (4), 1991, 22-28.

Spencer, M.S. and Cox, III, J.F., "Optimum Production Technology (OPT) and the Theory of Constraints (TOC): Analysis and Genealogy. International Journal of Production Research. 33 (6), 1995, 1495-1504.

Spencer, M.S. and Wathen, S., "Applying the Theory of Constraints' Process Management Technique to an Administrative Function at Stanley Furniture", National Productivity Review, Vol 13 (3), 1994, 379-385.

Stewart, D.M. and Chase, R.B., "The Impact of Human Error on Delivering Service Quality", Production and Operations Management, Vol 8 (3) 240-263.

Sureshchandar, G.S., Rajendran, C. and Anantharaman, R.N., "A Conceptual Model for Total Quality Management in Service Organizations", Total Quality, Vol 12 (3), 2001, 343-363.

Swann, D., "Using MRP for Optimized Schedules (emulating OPT)", Production and Inventory Management Journal, Vol 27 (2), 1986, 30-37.

Tanner, Jr., J.F. and Honeycutt, Jr., E.D., "Reengineering Using the Theory of Constraints: A Case Analysis of Moore Business Forms", Industrial Marketing, Vol 25 (4), 1996, 331-319.

Umble, M.M. and Srikanth, M.L., Synchronous Manufacturing Principles for World Class Excellence, South-Western Publishing Co., Cincinnati, OH, 1990.

Underwood, J.W., "Applying the Theory of Constraints to Army Logistics", Army Logistician, 1994: July/August (4), 13-17.

Walker, II, E.D., Planning and Controlling Multiple Simultaneous Independent Projects in a Resource Constrained Environment, Ph.D. Dissertation, University of Georgia, 1998.

Walker, II, E.D and Cox, III, J.F., "Generic Airlines Reservation Sales Office", Journal of Systems Improvement, Vol 2 (1), 1998, 9-16.

Wasco, W.C., Stonehocker, R.E. and Feldman, L.H., "Success with JIT and MRP II in a Service Organization", Production and Inventory Management Journal, Vol 32 (4), 1991, 15-21.

Watson, K. and Polito, T., "Comparison of DRP and TOC Financial Performance within a Multi-Product, Multi-Echelon Physical Distribution Environment", International Journal of Production Research, Vol 41 (4), 2003, 741-765.

Dr. Hollye K. Moss earned her Ph.D. at Clemson University in 2002. Currently, she is an Assistant Professor of Management at Western Carolina University in Cullowhee, North Carolina where she teaches operations management and management science.