through to the customer including…distribution across channels, delivery to the customer, and the information systems necessary to monitor all of these activities" (Lummus & Vokurka, 1999).

Here are some important factors impacting the effectiveness of the distribution network.

CENTRALIZATION VS. REGIONALIZATION

In distribution network planning, there is a well-established relationship between the number of distribution points, transportation costs and customer service targets. In a graphical sense, the point at which these three entities merge is the optimum balance of facility and transportation costs to develop a low-cost, high service distribution network. Normally, as distribution networks become more centralized, so do the internal support structures such as facility management, order entry, customer service and data processing. Depending on the degree of centralization achieved in support staffs, it is not uncommon to see cost savings of 50% or higher over decentralized networks. The service levels, limitations on total facility size; risk mitigation and throughput peaks must be factored into the decision matrix.

Energy

Any significant shift in the cost of energy could have an impact on operating costs and distribution. Many distribution projects that are otherwise viable fail once the cost of energy becomes a factor. This is especially true for energy-intensive facilities such as refrigerated warehouses. For this reason, it is crucial to work with all energy providers to determine the load that a prospective operation would put on the local energy system and develop solutions that conserve energy while achieving goals.

Some interesting energy solutions are:

Abatement Programs

Many energy providers provide incentives to users who cut back their usage during defined high load periods. This could be as simple as running the facility on minimal power during off-shifts or as complicated as metering the use of the facility or using a secondary power source (high power generator or solar power) to run normally on a reduced energy load.

High-Efficiency Units

Many companies install high-efficiency appliances and fixtures in a facility to conserve energy usage with no performance penalty. There is some investment required, but the payback is often reduced rates and/or a lower monthly bill.

Rising fuel costs make this a very sensitive component of distribution costs regardless of whether transportation is handled via third party carriers or private fleet. Some strategies to consider mitigating this are:

Cube Out Containers

When a trailer is partially cubed out, we are often paying to transport air. Utilizing the maximum cube ensures that more of the shipping costs are being used to ship product.

Mode Assessment

Depending on service requirements, it may be possible to move from LTL services to truckload, or from parcel to LTL. In general, each shift will result in reduced freight costs.

Transportation Management Systems (TMS)

Poor transportation performance often stems from poor transportation planning. A TMS can provide more efficient route planning and load tendering, and result in savings in the process.

Private Fleet Concerns

Private fleets can benefit from an in-house fuel supply program to gain control over fuel costs and usage. The investment can be offset by the elimination of one or more fuel supply chain links, reducing operating costs and sometimes allowing fuel blends that are more efficient and economical.

REGIONAL VS. CENTRALIZED NETWORKS

The costs of delivery using different modes of transportation, as well as service availability, can be directly impacted when fuel costs rise. Understanding the modes used most often, the customer expectation and the risk associated play into the network structure decision.

Flexibility

It is a key to continued success for some and survival for others. When designing a distribution facility, specifying versatile equipment is a critical requirement. The latest technology may look nice at start up, but if it cannot keep pace with unpredictable events, it is simply a waste of money. Planning for likely (and unlikely) changes in the distribution profile should drive the warehouse design and equipment specifications. For the majority of distribution operations, flexible equipment is the more practical choice.

Global Marketplace

In the ever-changing supply chain, global impact must always be considered. This could be as minor as a domestic customer wanting direct shipments to an international location, or as major as an acquisition by a global company or addition of a key global account. Successful distribution operations are ready for this type of change. Transportation systems should be designed with exports in mind; there should be contingencies for customs documentation and international shipping paperwork. Operations should be designed in a manner that product relabeling or special packaging for international customers can be accomplished easily. Facilities may need to accommodate inbound or outbound airfreight or ocean freight containers. Customer service functions may need to operate in 24-hour mode to assist customers in all time zones. Preparedness is the critical element in a global marketplace. If you are not a global company today, your success will drive you into that marketplace sooner rather than later.

Government Involvement

Just as government involvement has an impact on distribution, distribution leadership has an obligation to be involved and aware of legislation that involves their industry. Many decisions are made daily at a local, state, and federal level that impact distribution operations. Taxes, labor regulations, transportation restrictions, and infrastructure decisions are continually up for review and discussion at every level of government. Without proper input, uninformed decisions often have a dramatic effect on the distribution community.

In addition, involvement in professional societies (many of which conduct lobbying activities) is an effective way to track the pulse of legislative movement and also an ideal forum to make our concerns known. For some ambitious souls, a direct role in local or municipal government may be an effective and fulfilling way to make an impact. By being proactive, distribution leaders can ensure that distribution and government entities can collaborate to provide benefit to both sides without unpleasant surprises.

Information Systems

In today's e-enabled world, timely and accurate information is a requirement. The days of keypunching in daily distribution activity and nightly updates to host financial systems are becoming a distant memory for successful distribution operations. Today's reality is that distribution execution systems must be:

Real-Time

Customer requirements are moving toward being able to instantly track an order through every step of the fulfillment process to delivery. Optimally, this information is linked to an Internet front-end where a customer can easily log in and see the exact status of their order. Real-time interfaces and host system updates enable this customer-focused initiative.

Paperless

The reality is that paper equates to errors. Language and educational barriers result in paper

pick documents that are often misinterpreted, at best resulting in lost dollars within the distribution operation or, worse still, lost customers due to fulfillment issues that escape even the best inspection processes. The solution is paperless systems requiring operator validation that the right steps were followed and that the correct product was picked and packed.

Standardized

With the high growth associated with a successful distribution operation, many of these companies are finding that the investment to develop and maintain an in-house system no longer is viable. Standardized, industry-tailored software is now the rule rather than the exception. Software companies leverage their client base to continually update their product, adding far more base functionality than inflexible legacy systems.

Modularity

As companies in the distribution space come and go, their business will typically move to a new distributor or distributors. The ability to quickly take on significant business volumes dictates that modularity is a necessity for a thriving distribution organization. Modularity must be evident in:

Assets

Distribution assets must be modular, providing the ability to easily expand facilities, capacities and equipment to meet increasing demands and diverse products. Many companies design this into a facility, while others are constantly tracking alternate local space that could be closed on quickly.

Work Assignments

The workforce must be able to handle new work assignments and transfer knowledge to new employees effectively. This is a key to a successful start-up of a new operation or an addition to an existing operation.

Labor Management Systems

These systems must be able to handle the addition of new operations quickly and economically so that performance can be measured and costs kept under control.

Off-Highway Vehicles

In the United States, issues regarding the environment and air quality continue to be under scrutiny. The push for more stringent air-quality regulations will impact the warehouse. Electric vehicles will take over as the preferred models in the warehouse, displacing non-electric vehicles in the process. As this evolution occurs, manufacturers of electric rolling stock will respond with higher power, higher efficiency vehicles to facilitate this process.

Pace

Anyone with access to Web sites can now order product, specify their service requirements, pay for their order online, and track the order right to their doorstep. For distributors, this means that the pace of distribution must increase significantly to account for the reduced lead times, shorter product lives, increased inventory turnover, and greater customer expectations that is considered standard in the modern business-to-business and business-to-consumer marketplace. If a customer places an order today with next-day delivery, a company that picks and ships the order the next day will not be competitive for long. The entire supply chain needs to keep pace, from vendor compliance to information and execution systems in order to support the new economy that the Internet has enabled.

People

Success demands a team-based, participatory organizational culture and a total dedication to customer satisfaction. There are many ways to achieve this, ranging from simple solutions such as employee celebration days, employee suggestion programs, and other simple programs to more structured approaches such as revised organizational designs, compensation/incentive/bonus plans, and other processes that

directly tie the distribution associates on the floor to satisfied customers.

Price

While service and quality are key factors in selecting a distribution partner, for many companies, decisions still comes down to price. Successful past relationships are no longer a good indicator of the future. Modern free enterprise demands efficient, effective, and low-cost distribution. Competition is fierce and many low-cost providers will not be here tomorrow as they undercut the market to get short-term volumes at an operating loss. The goal of a successful distribution operation should be to operate within their core values at the lowest cost possible. The path to competitive pricing is to operate efficiently and flexibly at low cost—to offer low prices any other way is inviting failure.

Accountability

A successful distribution operation must have accountability. Accountability is made possible by effective leadership, clear communications, and efficient systems and equipment to enable productive operations and a fulfilling work environment. Accountability requires that leadership make difficult decisions while maintaining the commitment of the organization. Accountability requires establishing standards, identifying improvement opportunities and measuring performance. Also required is some form of a reward process that answers the inevitable question, "What is in this for me?" Care must be taken that any rewards are tied to something that can be quantified as a true benefit to the organization; rewards without a basis will result in lack of credibility and a process that will ultimately fail.

Reverse Logistics

How to handle the products that are coming back into the operation as well as any returnable packaging that must be accounted for on a regular basis is a challenge. The decision on whether to accept the product, whether a refused shipment, an authorized customer return, or an unexpected return must be planned for and communicated with the distribution operation as well as the receiving and handling process for the product or chaos will likely ensue.

Example

A client in the direct-to-consumer home goods industry was having a horrible experience with returns. An item would be returned and graded "return to stock". An order would come in for the same item and the returned item (which was first quality) would be shipped. Once the customer received the item, they would return it with the comment that it appeared not to be new. The solution was to establish a vendor-quality packaging initiative that looked very similar to the original vendor packaging. By implementing the new packaging for returns, the client was able to realize a 75% decrease in second-pass returns, saving in returns freight and reducing the size of their returns department. Another opportunity in reverse distribution is returnable packaging, either pallets or containers.

Third Party Logistics (3PL)

A growing number of companies are turning to 3PL organizations to handle the customer fulfillment portion of their supply chain. Companies that are accustomed to true partnering with customers and suppliers have less trouble migrating to the 3PL world and achieving the potential cost savings. The key steps are to conduct a comprehensive search for the right 3PL vendor, thoroughly review cost proposals and contracts to ensure there is financial benefit, and work with the 3PL to make their operation is a seamless extension of your company. This may involve shared management, integrated execution systems and a unified appearance to partners and customers.

Variety

Special packaging, unitizing, pricing, labeling, kitting and delivery requirements are becoming the norm and must be addressed in any distribution plan. These tasks should be designed into the operation, not "tacked on" as a reactive afterthought. Many companies invest large

amounts of capital setting up specialized packing or value-added services (VAS) lines with the mandate to gain competitive advantages and in hindsight gain little except increased costs and headaches. A few key points need to be concentrated when setting up these operations:

- Benefit of the process
- Recoup the investment
- Charge the customer for the services
- Outsource the operation

A simple review process can often provide justification to move forward and establish key design parameters to ensure that any "extra" requirements are integrated into the operation responsibly. Properly planned, these services can be a profit center, providing differentiation in a competitive marketplace while boosting the bottom line at the same time.

CONCLUSION

The intent of this study was to identify factors that influence supply chain efficiency and effectiveness. Here, efficiency is defined as the ability of the distribution function to maximize the ending auction price. Effectiveness is defined as the ability of the chosen factor levels to attract bidder customers. Since many of those factors are under the control of the seller, identifying them may help sellers improve the outcome of their sales.

There are several steps we should take to make the most of these keys to distribution network planning.

Assessment

Take each of the 15 points and score the operation using a scale that makes sense. An honest assessment is critical in this step.

Prioritization

Take the areas with the three best scores and those with the three worst scores and focus on them. It is important not to focus solely on deficiencies because if we lose focus on our strengths, then we could lose the momentum that made us successful in the first place. Improving strengths should always coincide with fixing weaknesses.

Action

Use the power of your organization to attack these issues, unleashing the intelligence of our resources to solve problems. Often, the answers are right on the warehouse floor—simply need to look.

Look Outside

Sometimes, it will not be practical or possible to make improvements from the inside. Do not be afraid to seek help from outside entities (consultancies, vocational or university programs, professional societies, etc.). Sometimes a push from someone with new or different ideas is all need to get the process moving.

Enjoyment

Make sure there is a defined goal. When achieve it, take the time to enjoy the success and maintain the energy and momentum for the next level of change.

Some operations may experience only a few of these factors every year, while others face them all daily. However, planning and following the described methodology can configure your distribution network to be both efficient today and flexible tomorrow to handle ever-changing requirements.

REFERENCES

Chopra, S., & Meindl, P. (2001). *Supply chain management: Strategy, planning, and operation*. Upper Saddle River, NJ: Prentice-Hall.

Lummus, R., Vokurka, R., & Alber, K. (1998). Strategic supply chain planning. *Production and Inventory Management Journal, 39*, 49-58.

Lummus, R., & Vokurka, R. (1999). Defining supply chain management: A historical perspective and practical guidelines. *Industrial Management & Data Systems, 99*, 11-17.

Keskinocak, P., & Tayur, S. (2001). Quantitative analysis for internet-enabled supply chains. *Interfaces, 31*(2), 70-89.

Vokurka, R., & Lummus, R. (1998). Balancing marketing and supply chain activities. *Journal of Marketing - Theory and Practice, 6*, 41-50.

Vokurka, R., & Zank, G. (2001). Critical success factors in e-business. In *Proceedings to the Thirtieth Annual Meeting of Western Decision Sciences Institute* (pp. 425-427).

M. Sreenivas, working as a asst. professor in Alluri Institute of Management Sciences, Warangal, India in the Department of Informatics & Business Administration. Presently continuing the research work in Operation Research at Kakatiya University.

T. Srinivas, asst. professor, Department of Mathematics, Kakatiya University, Warangal, INDIA. Presently six research scholors and ten MPhil students are continuing in the mathematical research areas.