LEAD TIMES AND ON-TIME DELIVERY IN THE ELECTRIC UTILITY INDUSTRY
THE NORTH AMERICAN ASSOCIATION OF UTILITY DISTRIBUTORS

Capstone Project

by

GEORGE CONTRERAS

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF INDUSTRIAL DISTRIBUTION

Chair of Committee,	Matthew Keblis
Steering Committee Members,	Francisco Santos, Rusty Batch, and Cathy Gutierrez

May 2019

Major Subject: Master of Industrial Distribution

ABSTRACT

This study is designed to address the problem in the electric utilities industry caused by long lead times and poor on-time delivery rates. In this study, through personal interviews and literature review, we look at how these issues have been addressed in the past and how they have affected the supply chain as a whole.

Not having spent time in this industry, I relied upon the feedback given to me from industry professionals on, both, the utilities side and the distribution side. Through these interviews and surveys, it was found that communication and forecasting were severely challenging. In addition, there seemed to be an underutilization of resources.

A more transparent relationship between the electric utilities and their suppliers would benefit both parties. In sharing information sooner and more completely, better planning and forecasting can be done. This is not being done now and it seems to be causing the trend of long lead times and late deliveries to get worse.

Furthermore, utilities depend too heavily on their suppliers to hold inventory. This seems to be a common practice. There is a reluctance to invest in an on-site infrastructure that would allow utilities to be responsible for holding more material. Doing so would give them a greater cushion in the event of a delay in delivery or increased lead time.

TABLE OF CONTENTS

Contents

1. INTRODUCTION

Receiving orders quickly and on-time is more than just desirable for most purchasing managers in the electrical utility industry. In some cases, it is the only thing that matters. In order to alleviate the problems associated with long lead times and late deliveries, distributors must utilize the best practices to ensure utilities are able to complete their projects and fulfill their contracts.

This research will look at ways to improve supplier scorecard ratings in this area. To do this, we will look at those methods which have been successful in the electrical utilities as well as other industries. We expect to find that information flow, both upstream and downstream, is a key factor in this process. To accurately forecast orders, distributors and suppliers must receive current and accurate information from utilities. In turn, communication of realistic lead times and stock status can help tame purchasing manager expectations.

In business, partners sometimes tend to hold information close to the vest for fear of giving away strategic advantages in negotiations. In this paper, we will examine how an increased transparency between utilities and distributors can be beneficial to both parties.

We will also study the primary drivers that cause delivery metrics to be considered so heavily in purchasing decisions. Terms of the contracts can play a part in these choices as can the types of funding being used. In addition, the importance of first cost versus total cost of ownership is weighed differently depending on the character of the transaction. This study will look at how each of these inputs drives the decision-making process of the purchasing managers and how it relates to the importance of lead times and on-time deliveries.

2. Literature Review

Research into the science of Supply Chain management has really taken off in the past few decades. With it, the study of delivery strategies and information sharing has grown. Electrical utility industry distribution, while sharing typical concerns with other industries, has its own peculiar difficulties which have not been left out in these studies. Researchers from all over the world have studied various parts of our problem, as we will see in the following articles. We will use the various studies to better understand the decision-making process of utilities, how to better share information amongst supply chain members, and reduce lead times.

Forgionne and Guo (2009) wrote a very interesting article that addressed very applicable observations on the topic of information sharing. In this article, Forgionne and Guo identified that, through full information sharing, the optimal production and inventory policies are able to be created. The study recognizes that information sharing is vital to the creation of policies and practices. They further analyzed the difficulties that utilities faced when making decisions in a competitive market. (Forgionne & Guo, 2009)

Another article by Rafique, Mun, and Zhao (2017), studied the energy supply chain in developing countries. While this document is focused on developing countries, it discusses the uniqueness of the energy supply chain as compared to a standard logistics network. One of these differences that affects the area of lead times and on time deliveries can be illustrated by the placement of power plants. These plants may be placed nearer to mines or other sources of fuel, but this pushes them farther from the traditional demand zones. These initial designs play a part in the supply chain problems for years to come.

Gracia and Quezada (2015) published a report in which they study several aspects, including social, environmental, and economic, when evaluating the performance of a supply chain in the electric industry. The methodologies used in this study included several mathematical computations which may not be applicable to our study, but it did discuss several parts of the collaborative and inter-organizational supply chain, including analysis of those who make up the environment of the supply chain, such as the market, shareholders, community, regulations, and stakeholders. Depending on the type of electric utility, this environment can affect the information flow as well as the factors faced when considering lead times and on-time deliveries.

Glock and Ries (2011) presented a case study that looks at how variable lead times affect a buyer who uses a continuous review order point. This is useful in our study because it is important to understand what is driving a buyer to be primarily concerned about lead times over other factors when choosing a supplier. In this example, a stochastic demand is analyzed when determining the size of each order and the quantity of orders submitted. This demand is much like the electric industry in that it can be analyzed but is difficult to predict. The paper also examines the influence of the delivery system when considering out of stock conditions due to long lead times.

One article that give us an insight, not only into the methods for reducing lead times but, into how two types of supply chain models compare, was presented by Borja Ponte, José Costas, Julio Puche, Raúl Pino, and David de la Fuente (2018). This article looks at how shipping lead times affect multi-echelon supply chains financially. The authors use various methods in creating a framework for supporting investment decisions. We learn the importance of reduced lead times internally in the distribution systems and when examining customer satisfaction as well as sustainability. One of the big takes from this article is how collaborative supply chains, that share information and take ownership of the process, are stronger and more profitable.

Khurrum Bhutta (2002) contributed a paper that compared the total cost of ownership and analytic hierarchy process approaches. These two methods of evaluating suppliers are widely used in industrial distribution but they can have contrasting outcomes. The analytic hierarchy process utilizes a framework that looks at multiple criteria to make selections. Total cost looks at the costs beyond the price of purchase in selecting and maintaining supplier relationships.

3. Methodology

Several methodologies will be used in determining this projects outcomes and recommendations. Among those will be previous research and analysis in the various topics related to this study, study of textbook material and scholarly journals on best practices in the supply chain. In addition, we will utilize the past experiences of others in academia and industry by conducting interviews with industry professionals in the electrical utilities procurement field, and discussions with scholars and professionals who have already studied related topics. Lastly, we will look at factors peculiar to the electrical utilities supply chain and compare them to other supply chains.

Though this project intends to gain new insight into how utilities value lead times when selecting suppliers, there has already been some background work in the subject. We will utilize information gained from these previous efforts to determine a pattern in the decision-making process of purchasing managers in the electrical utilities industry. Among such studies was a recent survey conducted by Karen Bennet and Karl Siebert which helped direct the focus of this paper. These studies will help to define where the industry currently is and what factors are important to the key players in procurement.

In addition to studies of lead times, we are going to discover better ways to communicate within the electrical utilities supply chain by analyzing research and articles on information flow. We can adapt successful models from other industries to improve the flow of information in the electrical utilities supply chain. Much work has been done in this area as the importance of a certain amount of transparency has been realized in recent years.

To understand this case, we will talk directly to those affected most. Interviews will be conducted with electrical utilities purchasing managers. We will pose key questions to better understand how they think when evaluating a purchase. This will give us insight into how they view the problem and how it affects their decisions. We will attempt to understand several considerations, such as how total cost plays into the importance of lead times and on-time deliveries. In addition to the purchasing side, it is important to understand the concerns and limitations of upstream players, such as distributors and suppliers. For this reason, we will also interview those whose charge it is to get supplies to the utilities in a timely manner. By comparing the needs of the purchaser to the constraints of the supplier, we hope to find a solution that is practical and beneficial to all parties. Finally, we will also reach out to those in academia and industry who have studied our topics, or those topics related to our problem. We will be able to clarify their previous findings as well as find out where they encountered roadblocks.

"No problem can be solved from the same level of consciousness that created it."

– Albert Einstein

To gain fresh perspectives and, perhaps, better insights, it is beneficial to look outside of one's own field of expertise. For our purposes, we will include interviews with supply chain professionals from other industries. We will look at whether other industries are affected by the same factors. We expect to find some similarities or enlightening viewpoints. We will seek participation from professionals in areas such as, HVAC, food and beverage, and aviation, to name a few.

Through these methods, we expect to be able to collect the necessary data to be able to determine how utilities and distributors can best reduce lead times, decrease late deliveries, lower total costs, and increase information flow.

4. LEAD TIME

Lead time is a phrase we hear all the time in the field of industrial distribution. We hear it so often, in fact, that we don't really stop to think about what it means. At its core, it is how long it takes for the customer to receive the product that is ordered, but there is a whole lot more to it than that. Figure 1 shows the supply chain and how it flows to the customer. Conversely, the order flows up the chain to the supplier.

Figure 1. Wholesale Distribution Framework. Reprinted from *Optimizing Distributor Profitability: Best Practices to a Stronger Bottom Line*, by F. Barry Lawrence, Ph.D., 2009

Lead time consists of the time that passes between when an order is placed and when it is received. This time includes the summation of transmitting the order to the supplier, the time it takes for the supplier to prepare and ship the order, and the transit time up to receipt by the customer. (Council of Supply Chain Management Professionals, n.d.)

This can be broken down into two distinct phases we will call lead time from order receipt to complete order manufacture and lead time from complete order manufacture to customer receipt. This can be thought of as the order going up the chain and back down.

Lead time from order receipt to complete manufacture consists of several steps and processes. Once the order is received, it has to be checked and validated, parts may need to be sourced or scheduled for manufacturing. Once that has been accomplished, there may be a wait time for engineering and design, depending on the requirements of the order. Finally, to get the order to the point that it is ready to be shipped, it must be released to manufacturing or distribution, specifications must be verified that they meet customer requirements, a production time must be scheduled, and the product must be assembled or built. (Council of Supply Chain Management Professionals, n.d.)

Lead time from complete manufacture to customer receipt also has numerous steps that reverse the flow of the order back to the customer. These steps include picking and packing the order into units, preparing them for shipment, and transiting the order to the customer for final receipt. (Council of Supply Chain Management Professionals, n.d.)

Components of Lead Time

Lead Time = Pre-processing Time + Processing Time + Waiting Time + Transportation Time + Storage Time + Inspection Time

In the above formula, each component is defined below:

Preprocessing time - Time taken for receiving the request, understanding the request, and creating a purchase order.

Processing time – Time taken to produce or procure the item.

Waiting time – Amount of time the item is in queue waiting for production

Transportation time – Time the item is in transit to reach the customer.

Storage time – Time the item is waiting at a warehouse or factory.

Inspection time – Time taken for checking the product for any non-conformity. (What is Six Sigma, n.d.)

5. ON-TIME DELIVERY

Another Key Performance Indicator (KPI) that is related to lead times is on-time delivery. On-time delivery is the ratio of completed orders that are received by the customer on or before the agreed upon time. It is important to recognize that complete and on-time delivery (COTD) is more than just getting part of the order delivered on-time. The complete order must arrive on or before the agreed upon time in order to be an on-time delivery. Our on-time delivery rate is calculated below.

On-Time Delivery Rate

OTD = (Orders delivered On-time) / (Total Orders)

To give an example of an on-time delivery ratio, we can consider a supplier who has 14 orders of timber for a utility. Of these 14 orders, 2 arrive later than the agreed upon delivery date. This would give the supplier an on-time delivery rate of 86%.

12 Orders Delivered On-time / 14 Total Orders = .857 = 86%

On time delivery can refer to more than just late deliveries. If a contract calls for an on-time window of -5+0, the supplier can deliver in a time frame of 5 days before the due date or on the due date, but not after. It is easy to see why a customer would not want a delivery after the due date, but it can be just as inconvenient, and costly, for both parties if the delivery is made too early.

In an interview with a buyer for an investor owned utility in the Midwest, an example was shared of a delivery that showed up early and how it affected the supply chain. A truckload of pipe showed up unexpectedly on a Friday afternoon at 4 p.m. Since the utility was not expecting the delivery at that time, they did not have the personnel to unload it. In this particular case, the workers were union and could not be held over to unload the truck. The truck driver was forced to sit with a loaded truck over the weekend. This took resources off the road that the supplier and manufacturer could have used elsewhere. (Johnson, 2019)

One measure that suppliers are judged by is the Perfect Order Index (POI). Without on-time delivery, perfect order status cannot be obtained, and it will be reflected in the supplier scorecard, if used. (Council of Supply Chain Management Professionals, n.d.)

Perfect Order Index (POI) Calculation

(Percent on Time) x (Percent Complete) x (Percent Damage Free) x (Percent Complete Documentation)

If our timber supplier above completed all of their orders, including the two that were late, had all of the required documentation accurately filled out, but had 2% damaged, we can use the POI calculation to determine their Perfect Order Index to see the overall health of their deliveries. In this case we would see a POI of 84%.

$$.86 \times 1 \times .98 \times 1 = .8428 = 84\%$$

Knowing that lead times are an important decision-making factor when awarding contracts, suppliers may be tempted to agree upon a target that is difficult to hit. Those who promise shorter lead times than they can deliver will be exposed by their on-time delivery rate. While on-time delivery rates and lead times are not the same thing and it is possible to see satisfactory lead times with unsatisfactory on-time delivery rates, we can see how the two are closely related and affected by each other.

6. THE CURRENT STATE

The decision-making process of the average purchasing manager is not as complicated as it may appear to be on the surface. First and foremost, they must get the product delivered on-time. This means, as we pointed out earlier, the complete order, conforming to required specifications, on-time. Price is a consideration, but it is not the first consideration or even the second. In fact, as we can see from data presented at the 2018 Utilities Purchasing Management Group Conference, of purchasing managers surveyed, on-time delivery is the most commonly considered criteria when grading a supplier using scorecards, while cost is near the bottom.

Figure 2. Most Common Criteria Used in Supplier Scorecards. Adapted from *An Effectiveness Review of Supplier Scorecards,* by Karl Siebert and Karen Bennett, 2018

According to a transportation study conducted by Texas A&M University and FedEx, Cost was the main consideration, over customer service and delivery times, when suppliers chose transportation providers (Texas A&M University, FedEx, and Industrial Supply Association, 2006). This is contrary to the sentiments expressed by buyers in the electric utilities industry in this and other studies. So, essentially, we have two opposing forces in the same supply chain with opposite goals. One side wants it here and wants it fast, while the other side wants to get it there cheap.

One Gulf Coast utility said that their system requires that they justify the bid. One of the reasons for justification is “Best evaluated bid.” They do not select based on “Lowest bid” or “Best compliance.” They consider all of the criteria when selecting the bid, but, most often, when they choose “Best evaluated bid,” it is because lead time trumped price. (Shumate, 2019)

Though there are government mandated goals for considering minority or woman owned businesses, they do not trump the criteria of lead times or on-time delivery rates. If determining between a supplier who meets a special consideration and one who does not, even though they may be equal on price, the one with a poor OTD will be knocked out of contention. (Shumate, 2019)

In addition to the decision-making process of selecting bids, we must also look at how well utilities and suppliers communicate between each other. My personal experience has been that parties on both sides are very well intentioned and concerned about the state of the relationship, but communication could be better. Those purchasing decision makers who were engaged and interested in this study while at conferences away from the office, suddenly became impossible to reach for further cooperation. Of those who agreed to be a part of this study, only a handful actually responded to multiple attempts at later contact. Now, I do not believe that means that they precipitously became uninterested in the outcome. One buyer who did respond, had to continually reschedule until it was obvious that he was not even able to complete a written list of interview questions at his own convenience. On one particular day, his entire office was out for training. If you throw in the possibility of storm restoration necessitating everyone's routine stuff getting suppressed to handle the response, purchasers and suppliers can find it hard to not let things fall through the cracks.

When it comes to lead times. Most of the participating interviewees agreed that the situation has gotten worse. One buyer who has been in the industry for a number of years shared that it has never been this bad and it seems like the problem is long term. During our interview, an employee came in with the news that the lead time on a $35 bracket was out to 44 weeks. These brackets are not special items. They are routine purchases for use on their meters. This can potentially put them in a bind if they are not able to procure another source before their safety stock runs out. In the worst-case scenario, crews may be forced to improvise with homemade devices, compromising the reliability of the system. (Johnson, 2019)

Sole-source suppliers is part of the problem. While alliances can simplify the supply chain, it also limits the number or potential sources should one suffer a manufacturing setback. It can also increase the price because, instead of going direct to the manufacturer, utilities are now buying through an alliance and having them warehouse the product for them. When the supplier is unable to meet the demands of the utility, it is not always feasible to run to another fabricator to have the part made. Engineering must get involved to make sure that the parts are manufactured to specifications and that they are compliant with any regulations.

One side effect to the poor planning and forecasting is the bullwhip effect. This is common in other industries such as food and beverage and others and is not peculiar to the electric utility supply chain. It is a phenomenon of orders and inventory getting larger and larger as we go backwards through the supply chain. Since it takes time for orders to go through the supply chain, it takes longer for the fulfillment of that order to begin. Any ripple in the demand signal from the customer, in our case the utility, is amplified as it goes through each supply level.

In my time in the dairy industry, I found that by not taking the time to produce an accurate forecast, I would end up ordering more inventory than I needed. This would cause me to not order as often or as regularly. In turn, the warehouse would wait for my bulk order before it put a demand on the plant which had cut back production due to the delay in orders coming through. Once an order would come through, the plant would overproduce in anticipation of continuing large orders, which would never come. This would leave everyone with a high inventory with periodic out of stocks. This would eventually lead to long lead times and late deliveries.

7. RECOMMENDATIONS

In addition to the problem of long lead times and poor on-time delivery ratios, a contributing factor seems to be poor communication. We will address all three of these issues in our recommendations.

Electric utilities are in the business of producing electricity, which is a non-storable good (Forgionne & Guo, 2009). However, the material that they procure through the supply chain is storable. While they do carry a minimum level of safety stock, they depend on their distributors to store much of the inventory for them. Some of this material is pre-purchased while others are owned by the distributor waiting to be demanded by the utilities. Utilities generally have large acreages at their disposal and therefore the capability to store larger safety stocks on their own premises. If not having the material available when needed is driving up the total cost for the utilities, an investment in greater storage capacity would be a prudent decision when faced with the alternative of having union workers on the clock with nothing to do because a seal for a boiler door won't arrive for several weeks. If the utilities attempt to release the union workers and craftsmen in order to avoid idle time payment, they run the risk of the workers leaving for another job and not returning. Thus, the job will not get done.

Adjusting safety stock will also be a good idea for the distributors. It may mean increasing inventory on the balance sheet, but it will also increase the number or successful bids gained due to higher customer satisfaction. When suppliers are scored poorly for on-time delivery ratios and long lead times, it is less likely that they will be selected for future contracts.

Forecasting is probably the most important act when it comes to inventory management. This falls heavily on the utilities since they are the customer. In other industries, such as food and beverage or HVAC, the suppliers can look at past sales to predict future orders. This is not as simple in the electric utilities industry because demand depends on projects and when the scheduled outages will occur. For this reason, it is crucial that utilities set aside the time to produce an accurate forecast for their suppliers.

Forecast collaboration is the sign of a maturing relationship between an electric utility and a supplier. Currently the increasing complexity is one reason that supply chains are slowing down. Buffer inventories are one way that both parties can attempt to compensate, but they can only hold you over for so long until manufacturing can't catch up. ERP's can be used in integrated networks between suppliers and utilities. These networks can keep the ERP's separate while integrating key information in real time.

Also contributing to long lead times is a lack of information sharing downstream. Manufacturers, like utilities, have scheduled downtimes for maintenance and other planned activities. Manufacturers should share those schedules as soon as they are planned. This will give utilities the opportunity to forecast ahead. If utilities only order certain items every few months but are unaware of a scheduled downtime at the manufacturing plant or one of their suppliers, they may be caught having to rush to get another source validated by engineering in time to meet their requirements, or, in worst case scenarios, they may miss a project start date.

For communication to be effective, it is going to be important for suppliers and purchasing managers to schedule communication. With busy schedules, communication is likely delayed until there is already a major problem causing delays. Depending on the needs and circumstances, the frequency of scheduled meetings should be set to a schedule that best fits the relationship between the supplier and the utility. For this to be effective, the two parties should define the key performance indicators and use them. Scorecards are the perfect way to utilize KPI's. Knowing what is expected and how it is weighted gives the suppliers a goal. Feedback from the utility on how these expectations are being met gives the allows the supplier the opportunity to rectify any shortfalls.

Another investment that is already a reality, but may be years away from practicality, is 3D printing. This can be useful at any level of the supply chain from manufacturers, to distributors, to the utilities themselves. Right now, 3D printing, or additive manufacturing as it is also known, is used commonly in production prototyping. However, from discussions with industry purchasing managers, there are high hopes that it can be used to cut lead times in the near future. It is unlikely that 3D printing will ever by used to print large items, such as poles and transformer housings, but it could be used to make the smaller components of larger complex items, cutting down on the time it takes to manufacture.

Determining an ROI for these improvements is difficult to put into a monetary amount without specific data, but these improvements would undoubtedly save millions if they were implemented industry wide. What we would expect to see most directly would be an elimination of high inventory holding costs and a reduction in transportation costs. In addition, overpayment of labor due to late deliveries would be significant.

8. CONCLUSION

We can see that lead times and on-time delivery are very closely related. Lead times tells us how long it should take from order input to the receipt of the item. On-time delivery is the result of meeting the agreed upon delivery date when considering the lead times. Through the words of the key players, we can also see that there is a recognition of the importance of improving the performance of each.

If utilities and distributors work together to improve communication, they will begin to see great results for both sides. It is my belief that the trend of longer lead times is due, largely, to the lack of sustained communication between the two. The increase in lead times due to lack of communication, as well as communication failures throughout the process also contributes to lower on-time delivery rates. Once communication is given priority, we will see greater forecasting accuracy, higher customer satisfaction, and increased future bid success.

References

Bhutta, K. (2002). Supplier selection problem: a comparison of the total cost of ownership and analytic hierarchy process approaches. *Supply Chain Management: An International Journal, 7*(3), 126-135. doi:https://doi.org/10.1108/13598540210436586

Council of Supply Chain Management Professionals. (n.d.). *CSCMP Supply Chain Management Definitions and Glossary*. Retrieved from CSCMP: https://cscmp.org/CSCMP/Educate/SCM_Definitions_and_Glossary_of_Terms/CSCMP/Educate/SCM_Definitions_and_Glossary_of_Terms.aspx?hkey=60879588-f65f-4ab5-8c4b-6878815ef921

Forgionne, G., & Guo, Z. (2009, July 16). Internal supply chain coordination in the electric utility industry. *European Journal of Operational Research, 196*(2), 619-627.

Glock, C. H., & Ries, J. M. (2011, January 07). Reducing lead time risk through multiple sourcing: the case of stochastic demand and variable lead time. *51*(1), 43-56.

Gracia, M. D., & Quezada, L. E. (2016, July). A framework for strategy formulation in sustainable supply chains: a case study in the electric industry. *NETNOMICS: Economic Research and Electronic Networking, 17*(1), 3-27.

Johnson, C. (2019, February 12). Personal Interview. (G. Contreras, Interviewer)

Lawrence, F. B., Gunasekaran, S., & Krishnadevarajan, P. (2009). *Optimizing Distributor Profitability: Best Practices to a Stronger Bottom Line.* Washington D.C.: NAW Institute for Distribution Excellence.

Ponte, B., Costas, J., Puche, J., Pino, R., & de la Fuente, D. (2018, March). The value of lead time reduction and stabilization: A comparison between traditional and collaborative supply chains. *Transportation Research Part E: Logistics and Transportation Review, 111*, 165-185.

Rafique, R., Mun, K., & Zhao, Y. (2017, January 10). Designing energy supply chains: dynamic models for energy security and economic prosperity. *Production and Operations Management, 26*(6), 1120-1141.

Shumate, B. (2019, February 12). Personal Interview. (G. Contreras, Interviewer)

Siebert, K., & Bennett, K. (2018). An Effectiveness Review of Supplier Scorecards. *Utility Purchasing Management Group Forum.* Scottsdale: Institute for Supply Management.

Texas A&M University, FedEx, and Industrial Supply Association. (2006). *Transportation Survey.*

What is Six Sigma. (n.d.). *Lead Time*. Retrieved from What is Six Sigma: https://www.whatissixsigma.net/lead-time/