An analysis of the economic effects of improper electronic data interchange methods at a small company

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ABSTRACT

The purpose of this study is to provide insight into the financial implications of inefficient implementation of electronic data interchange (EDI) systems for the use of processing electronic customer orders, as well as discuss why proper EDI adoption is critical. The specific objective of this study is to estimate the annual cost of improper use of EDI based on employee time spent manually entering orders that are received via EDI transmission. The estimated costs are used to calculate net present value (NPV) over the life of the investment in technology for up to a 10-year time frame. The findings provide organizations who currently use EDI systems, or are looking to adopt, with the information necessary for (a) efficient implementation to obtain the largest cost savings and benefits possible and (b) determining the cost-effectiveness of investments in employee trainings on EDI use.

Primary data was collected for this study from one specific firm which was determined to be using inefficient EDI practices, lowering their return on investment (ROI) in this technology. The data referenced salaries, time and cost estimates obtained from professionals at the firm. After the primary data was collected and converted to dollars, a financial analysis was projected over a 10-year time frame. The NPV of the cumulative expenses incurred from inefficient EDI implementation was calculated using a five percent discount rate to estimate the benefit the firm could gain by investing in improving the efficiency of EDI use.

The results show that inefficient EDI implementation decreases the expected ROI from the initial investment. If the firm continues their inefficient methods, they can stand

to lose at least $143,710 over five years and $206,434 over ten years. It is in the firm's best interest to change their methods, invest in training, and adopt better practices.

For further research, it would be beneficial to conduct an in-depth analysis on all inefficient EDI practices, instead of only order entry processes. Data should also be collected to analyze the emotional cost endured by employees that experience burnout and job dissatisfaction as a direct result from inefficient implementation. The findings in this study, and future research, will guide organizations to use proper techniques from the point of implementation so that they can maximize the benefits of EDI in improving operational efficiency.

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CHAPTER I: INTRODUCTION

Information is a crucial asset to every supply chain; it gives managers the opportunity to make supply chains more responsive or more efficient. Management information consists of data and analysis regarding facilities, inventory, transportation, costs, prices, and customers throughout the supply chain. Information is potentially the biggest driver of performance in the supply chain because it affects each of the other supply chain drivers. Information presents management with the opportunity to make supply chains more responsive and more efficient; it allows managers to know what and when customers are ordering, followed with what to produce and when to ship. Likewise, it lets customers know when their orders have been accepted and shipped. Good information can be used to improve the use and coordination of supply chain flows to increase responsiveness and reduce costs (Chopra and Meindl 2019).

To improve efficiency and responsiveness within the supply chain, a company can look to electronic data interchange (EDI) as a way to analyze demand planning, supply chain coordination, sales and operation planning. Effective supply chains start with effective business partnerships; both of which rely on EDI-enabled programs as a crucial link between suppliers and customers.

1.1 Background

EDI is the exchange of electronic data between companies using precisely defined transactions resulting in a faster, more efficient, and more accurate method of data transfer than the manual alternative, saving companies both time and money. While implementing EDI systems requires significant upfront investment, and often some data translation between the communicating trading partners, it helps make transactions faster and more

accurate than when they are paper based (Chopra and Meindl 2013). EDI fills the need for a timely, reliable data exchange system in response to the rapidly changing global markets. EDI also allows for the spread of more reliable information into many organizational units, from purchasing to accounting to production.

Electronic data interchange was developed in the 1970s to facilitate the placement of instantaneous, paperless purchase order delivery with suppliers (Chopra and Meindl 2013). EDI is exactly that, it is the electronic interchange of business information using a standardized format to facilitate the computer-to-computer exchange of data among multiple business trading partners in standard, machine readable formats through a web of business-to-business communication networks (Min 1970). This process allows companies to transmit information to one another electronically rather than the traditional paper method. The result is quicker delivery of information from customer to supplier.

EDI allows companies to collaborate more efficiently with their suppliers, while eliminating various costs out of the supply chain, such as inefficiencies and manual data interventions. Prior to EDI integration, a buyer would have to generate a purchase order, then mail/fax/email it to the supplier. While emailed purchase orders and documents can be considered electronic, the documents being exchanged would still have to be printed out and handled by individuals, rather than computers.

EDI has been around for decades, but there are organizations that prefer to use their existing systems for processing business-to-business (B2B) transactions. Standard B2B transactions such as purchase and sales order entry, invoicing, advanced shipment notice (ASN) generation, and the distribution of functional acknowledgments typically require a multitude of steps to process. Generating these documents can create an extensive paper

trail and requires manual processing and entry time, which makes them more susceptible to mistakes and human errors. With the computer-to-computer method used with EDI programs, paper documents are eliminated, and human intervention is minimized (Kucharski 2017).

EDI has proven to have many key benefits throughout the supply chain by lowering costs and improving speed, accuracy and efficiency. The greatest benefits come at the strategic business level. Exchanging documents electronically through EDI can improve transaction speed and visibility, while decreasing an organization's expenditures for manual data entry processes. However, cost savings are far from being the only benefit of using EDI. Speed and accuracy are a large part of the benefits of adopting an EDI process.

EDI can speed business cycles up by 61% and exchange transactions in minutes, rather than days or weeks by using the postal service (Benefits of EDI n.d.). EDI also enables companies to send and receive large amounts of information quickly across the globe, while information can flow among multiple trading partners consistently and freely. With traditional EDI (non-internet based), data can be entered off-line in a batch mode, without tying up ports to the mainframe. When EDI information is received, data can be used immediately as opposed to waiting for the information to be manually entered.

1.1.1 Client Background

For the purpose of this research a case study was conducted pertaining to a particular company, but due to privacy reasons the exact name of the company cannot be provided, so the firm is simply referred to as "the company" throughout this paper.

EDI is used by a variety of organizations, from Wal-Mart and Home Depot to Procter & Gamble and Toyota. The company examined in this research also uses EDI services to communicate with their customers in various equipment industries worldwide.

With a vast array of customers, there is a need for information sharing throughout the supply chain. Two customers make up over seventy percent of the company's business portfolio. Significant information pertaining to customer orders and shipments are communicated via traditional electronic data interchange (EDI) methods, however, there has been an observation that the company is not implementing the most efficient EDI practices.

While information is shared via traditional electronic data interchange methods, the company is not using the system to its fully intended purpose, resulting in a waste of time, money and resources. For example, instead of receiving and processing all EDI transactions electronically, the company is receiving the data from their trading partners, then printing the raw information on a daily basis for manual processing and data entry. The company would like to fully integrate EDI processes into their enterprise resource planning (ERP) system to be used efficiently, and to show their team the benefits of proper implementation methods. This will save the company time and money and will allow employees to focus their business efforts on other daily tasks. As an organization overall, the corporation would like this location to follow the business practices of their other locations across the United States, including the use of the same software and EDI practices.

1.2 Problem Statement

The purpose of electronic data interchange (EDI) is to reduce cost, while increasing efficiency and productivity. Historically, companies were able to become more competitive by migrating from a paper-pencil driven processes into electronic media systems. To get the full extent of the EDI software, and the money that is being invested, an EDI integration program should be implemented into the company's current enterprise

resource planning (ERP) system called Syspro, or they should invest in a newer ERP system that is equipped with EDI capabilities. It has been shown in previous studies that manually processing a paper-based order can cost seventy dollars or more, while processing an EDI order costs less than one dollar (Lusk 2017). Faster transactions support inventory level reductions, better use of warehouse space, fewer out-of-stock occurrences and lower freight costs via fewer emergency expedites (Ram 2016).

1.3 Objectives

The overall objective of the study is to provide insight into the financial implications of inefficient customer order entry when received via electronic data interchange (EDI) practices at an organization, as well as discuss why proper EDI adoption is critical. The specific objectives are as follows:

1. Estimate the annual cost of improper use of EDI based on employee time spent manually entering orders that are received via EDI transmission.
2. Use estimated costs to calculate net present value (NPV) over the life of the investment in technology for up to a 10-year time frame.
3. Synthesize the findings to inform decisions of organizations on (a) efficient implementation of EDI to obtain the largest cost savings and benefits possible and (b) determining the cost-effectiveness of investments in employee trainings on EDI use.

Numerous studies have examined the adoption and use of EDI, along with the expected results, but not many have taken an empirical approach. Typically, studies primarily address questions like what EDI is, how is it used, and what are the benefits. These types of studies are useful in giving insight into the importance of EDI. However, it is also

important to examine the drivers and impediments of EDI implementation, as well as costs and inefficiencies associated with improper practices.

1.4 Outline of Thesis

The rest of the thesis is organized to provide background information on electronic data interchange (EDI), a review of EDI practices and other research findings, data analysis pertaining to the objectives of this study, discussion of results, followed by summary of further research opportunities resulting from this study. Chapter I provides EDI background information and the client situation for the research conducted. Chapter II contains the literature review to provide context for the research problem. Chapter III presents discussion of the theory, the methods and the data used to address the EDI situation at the firm examined in this thesis. Chapter IV presents the analysis, the results and the discussion of the research findings. Finally, Chapter V discusses the summary and future recommendations resulting from the study.

1.5 Contributions to Research

This research is relevant to organizations that manually enter their customer's orders, as well as those who do not efficiently use their electronic data interchange (EDI) systems to their full extent. EDI encompasses more than just order receipt and entry, but this study focuses primarily on the cost analysis of inefficient order entry methods of EDI practices. As technology becomes more advanced, and businesses are looking to take a more streamlined approach to their order receipt and entry, they need to understand inefficiencies that may arise if they do not adopt proper EDI practices upon implementation. The uptick in business expenses related to inefficient EDI implementation can be equal to that of one employee's salary, if not more. This research also opens the

door for investigating other inefficiencies associated with EDI implementation, and refinement of current EDI practices by a firm.

CHAPTER II: LITERATURE REVIEW

Electronic data interchange (EDI) was developed as a replacement to the traditionally complicated and fallible ways of manually communicating business documents between firms. Before the invention of EDI, documents such as purchase orders, receipts and invoices were exchanged through other channels including emails, faxes or traditional mail carrier methods. All previous forms of processing required extensive human effort on both ends with inputting received data and processing document transmission. The manual efforts led to slow order processing times that became inefficient and expensive. Data entry errors were frequent, and processing was unable to keep up with the progressively fast pace of modern businesses.

The concept of EDI was to digitize processes by removing most human intervention and paper usage from the equation. Order processes became acceleratingly digitized, increasingly accurate, more secure and cost effective. Despite improving purchase order processes, EDI does come with its own set of complications and challenges that can cause delays and present inefficiencies.

This chapter presents a review of the literature on the implementation of EDI. The chapter is organized into the following subsections: adoption factors, driving force of adoption, re-evaluation of EDI systems, automation of EDI processes, challenges and disadvantages of EDI systems, future directions, and adoption by agricultural organizations.

2.1 Factors Affecting the Adoption of Electronic Data Interchange

EDI systems have the ability to automatically transmit documents across all business processes, from supplier system to customer system. EDI allows for smoother

communication between trading partners, leading to a reduction in both staffing costs and transaction errors, while forging stronger relationships between organizations. Factors that determine EDI adoption include the cost of implementation, opportunity for a competitive advantage, compatibility with current management systems, business partner influences, pressure from competing organizations, a general understanding of EDI practices, a company's IT capabilities, their current market standings, and the potential benefits of implementation. Although most enterprise resource planning (ERP) systems have EDI software capabilities, adoption of EDI practices is not always utilized due to the lack of awareness. This creates a need for training programs designed for educating relevant decision makers on EDI's benefits and implementation practices (Vesela 2017).

2.2 The ABCs of EDI

For successful transactions to occur across markets, both domestically and internationally, efficient data management and transfer systems are needed. Among the most commonly adopted such systems is the electronic data interchange (EDI). While EDI systems may seem like a logical move to make, based on time and cost savings benefits, managers must determine the financial feasibility of using such practices. Research has been done to determine the driving force behind EDI adoption timing by using the activity-based costing (ABC) method or by determining if the benefits alone will justify the adoption decision (Walton 1996).

Proponents of activity-based costing believe that if they are to adopt EDI processes, they should be provided with detailed information regarding cost and consumption of activities throughout an organization, and that costing information should be accurate so managers can make better decisions. With ABC systems, companies need to examine

logistics processes and define the costs of performing such activities. While using ABC to evaluate adoption of electronic data interchange practices can result in valuable information, it can be very tedious and time-consuming, leading to delays for implementation (Walton 1996). This particular study suggests that not all EDI decisions are contingent on using ABC systems to scrutinize the financials of a company.

2.3 Re-Evaluating EDI Systems to Benefit Operations

For decades, continuous improvement in document handling has encouraged organizations to prefer electronic methods over standard paper-based means of communicating information along the supply chain. Electronic data interchange (EDI), paired with advancements in technology, has led many organizations to gain a competitive advantage over those that process transactions manually with paper. Since EDI has been around for decades, it makes sense that organizations are going to be accustomed to the way that they do things. Typically, EDI is paired with what users call a value-added network (VAN), which can easily lead to excessive costs when there are multiple trading partners involved. VAN services are expensive to establish, maintain, and use; charges are based on a minimum usage volume in addition to a per transaction (and/or per kilo-character) fee. In 1999, it was estimated that price structures for VAN EDI systems could bring access costs to $100,000 or more per year versus the much lower pricing for high-speed internet access (Werner 1999).

While EDI is fairly common throughout the supply chain, there are some trading partners who insist on continuing to do things manually. Manual transactions tend to result in additional costs, both in labor and time, not to mention the unavoidable risk of human error. Instead of doing things manually, some organizations can implement a paper-to-

digital capture technology using a cloud-based EDI platform without any VAN costs attached (Simpson 2020). The ability to automatically generate orders into a system is a great timesaver for all facets of effective communication.

2.4 Integrated EDI versus Stand-Alone

B&L systems published a case study in their B&L News newsletter in April 2004 analyzing integrated EDI systems versus stand-alone systems (Richler 2004). The company in question discussed their client's decision to initially bypass the purchase of integrated EDI technology. The client requested a cost estimate for implementing an integrated EDI module to automate their current processes. After reviewing the quote, the client decided that the cost was excessive, and opted to purchase and install a third party translator (stand-alone solution). The client experienced a barrier to entry that many potential clients face; they did not consider their EDI growth to be substantial enough to justify the effort or money required for an integrated solution. After using the stand-alone system, which still required manual intervention and the risk of entry errors, the client quickly realized how arduous their process was. Over time, the client's EDI volume continued to grow, and trading partners pressured for more EDI services, like advance ship notices (ASNs).

The increase in EDI growth and customer demands eventually led the client to a point where orders which were received on Monday morning were not posted to their order entry system until Wednesday afternoon. This ultimately led to shipping delays and penalty charge-backs from some of their customers. To add to the processing costs at this firm, a temporary employee was hired just to handle the invoice volume (Richler 2004). It is unknown how much the solution costs, but the total operating cost alone was significantly more than the amount to install the integrated solution at the beginning.

While stand-alone solutions are enticingly cheaper than integrated solutions to implement, they can come with an ongoing cost from shipping delay penalties, temporary employee needs, manual processing costs, entry errors, etc.

2.5 Automation of EDI Processes

During order processing, EDI takes the data, which has been entered into the system from the buyer, and puts it through a series of translation, mapping and processing steps before the requirements are sent to the supplier. These processes have multiple instances at which errors and exceptions may arise. Studies have found that up to one third of EDI orders can contain exceptions such as incorrect pricing, invalid material numbers and missing segments; addressing these exceptions can be time-consuming and expensive (EDI Made Easier Through Automation 2018). The extensiveness of EDI means that when an error (or exception) occurs, a customer service representative (CSR) must bring in the IT team to determine the problem and find a solution. Essentially the firm is now paying two people to handle a single error. Exceptions create a ripple effect throughout the entire supply chain, where everyone from the supplier to the customer is now involved. Slowdowns caused by inaccuracies and inefficiencies throughout the supply chain can create a domino effect.

While EDI has helped to digitize order entry processes, a complexity of challenges and exceptions remains. Automated order processing solutions are designed to alleviate problems that arise from EDI exceptions. Automation can ensure precision, efficiency, and system security and remove the need for human intervention. In essence, the automation solution becomes an overlay to a firm's EDI system and becomes the center of order processing. Unlike traditional EDI, automation systems can process orders received via

email, fax, paper or any other media and create a sales order in the firm's enterprise resource planning (ERP) system.

Automated solutions create readable orders with full visibility and control over every order. Purchase orders can be received by the trading partner through the firm's EDI system, or they can come separately via other avenues. The handling of errors and exceptions also becomes automated; giving control back to the customer service rep and eliminating the need for IT assistance to resolve the issue. This speeds up the process, increases efficiency, and reduces the number of errors that need to be resolved. Automated solutions can reduce EDI processing time by an average of four days when compared to EDI systems which still require manual intervention (EDI Made Easier Through Automation 2018).

2.6 Common Challenges and Disadvantages

As trades continue to be globalized, and shared data requirements continue to rise, businesses must cooperate with many partners, suppliers, manufacturers and other contacts along the supply chain. It is more than a mere increase in transaction velocity, but information visibility is becoming a foundation to any trust based business-to-business relationship; this is why overcoming challenges associated with EDI implementation is so critically important.

Firms need to connect with all stakeholders and communicate electronically in real-time by connecting their systems to exchange transactions, which can result in flaws in the quality, different EDI formats, and security concerns. Avoiding errors and missing data fields within EDI transmission is difficult, particularly with larger volumes. EDI errors can be anything from poorly formatted data, meaning the composition or the message is

incorrect, to the business data transmitted within the messages. Both errors result in a delay or inaccuracy sent to the trading partner, which can cause halts in production and heavy fines.

EDI transactions across the supply chain involve sending data in the correct formats for each system to interpret. As EDI systems continually develop over time, so do the standard formats that are used by each firm. One organization may be using one version of a standard, while its trading partners might still be using older versions; this will lead to error transmissions. Older formats of EDI transactions were not meant for individuals to read and understand, therefore catching and fixing errors can be difficult. Even when it is possible to decipher the information, manual error detection is time-consuming and expensive, and still leaves room for error in inputs, duplications or other inconsistencies. During these operational inefficiencies, employees can become stressed; if problems continue to occur, employees may end up suffering from burnout.

Automating error detection can significantly increase overall productivity and gross margins of a firm by reducing data errors and substantial reliance on manual processes. Also, outsourcing the ownership to an EDI managed service provider can ensure EDI risks are managed successfully.

2.7 Future Directions

Electronic data interchange (EDI) has been used to conduct business-to-business (B2B) transactions for decades. Even though the costs associated with EDI have made companies apprehensive to adopt such procedures, web based practices have made the technology attainable even for smaller organizations. The development of internet-based infrastructures has had a positive impact on EDI usage, but it also warrants the need to

clearly inform business managers of the profitability of EDI usage within their supply chain. From a business management standpoint, an understanding of the dependable results from EDI implication would allow organizations to successfully allocate resources in the EDI adoption process and maximize their returns (Narayanan, Marucheck and Handfield 2009).

While EDI systems seem like a process of the past, they are not going anywhere soon. However, new entrants are relying on Application Programming Interface (API) connections, a software that allows two programs to communicate in real-time. APIs can be implemented quickly and can be more cost-efficient than EDI solutions. They can be used for managing similar transactions to EDI, but they work on a request/response basis. While APIs make data more accessible for trading partners, security is still a concern. By joining together the capabilities of both EDI and API systems, organizations can unlock the most value from their data.

When the Covid-19 pandemic hit, it brought light to the importance of modern B2B cloud integration by highlighting how outdated integration capabilities led to compressed margins and reduced bottom line. In a market survey that was conducted in 2020 by Team Cleo, an ecosystem integration software company, ninety six percent of companies stated that they planned to prioritize cloud migration and digital transformation in 2021 (Team Cleo n.d.). Firms can either capitalize on today's eCommerce market or lose ground to their more digitally savvy competitors.

2.8 Adoption of Electronic Data Interchange by Agribusiness Organizations

Electronic data interchange (EDI) implementation throughout the supply chain has greatly changed the way that firms operate. EDI implementation brings about significant

cost savings and transaction productivity, as well as the facilitation of food supply chain management. EDI simplifies the exchange of data and information such as invoices, purchase orders, advances shipping notices (ASN), order receipt notices, and scheduling information. Although electronic business generally grows at a relatively quick pace, growth in agriculture has taken more time than initially anticipated. The intricacy and cost associated with adopting EDI practices are perceived as the greatest barriers to implementation. Smaller businesses lack evidence regarding EDI success cases and how competitors and customers have profited from EDI systems. The majority of smaller agribusiness firms reported that they would most likely adopt EDI practices as a result of external pressure, rather than to achieve a competitive advantage (Vlachos 2004).

CHAPTER III: THEORY, METHODS AND DATA

This chapter presents the theory, methodology and data used to determine the cost savings of establishing proper electronic data interchange (EDI) practices after an EDI system has been integrated by an organization or business. Previous research has been conducted to examine the cost benefit analysis for companies adopting and implementing EDI practices. The results in this study indicate the importance of following through with proper procedures once the process is implemented. If the firm does not follow through with proper implementation practices, they could actually lose money instead of reaping the benefits that an EDI system has to offer.

3.1 Theory and Methodology

EDI practices are adopted to fully integrate a firm's internal system with that of their customers and other trading partners. After successful EDI integration within a firm, there should be little to no human/manual intervention needed. However, if EDI practices are not implemented properly, and instead include a substantial amount of human intervention, it can lead to higher costs in the form of time, money, and manual data entry errors. The purpose of this study is to estimate the costs associated with improper use of the EDI and calculating net present value (NPV). The conceptual framework draws insights from the Lean Six Sigma approach.

3.1.1 Lean Six Sigma

Understanding Lean Six Sigma (LSS) is fundamental for determining the return on investment in identifying and correcting improper use of EDI. Lean Six Sigma is built on the idea that for a firm to bring about product and service excellence, they not only need an in-depth knowledge of their internal processes, but they must have a deep understanding of their customers' current expectations and future needs (Shaffie and Shahbazi 2012).

One of the main goals of Lean Six Sigma (LSS) is to reduce operational costs and risks, both of which are significant factors that can contribute to lower profits and losses. While not all risks can be eliminated, and operational cost is ever-present, LSS can provide direction for a firm to drastically reduce their exposure to risk, all while making the firm more efficient in delivering their product/service. LSS is an excellent measuring tool for understanding the return on investment of a project.

3.1.2 Return on Investment (ROI)

Return on investment (ROI) is a key calculation to show a project's value with respect to its impact on a firm's margin. Depending on the industry, there are a multitude of interpretations of ROI. For the purpose of this study, ROI is an indicator to measure the financial gain/loss, or the "value", of implementing EDI practices correctly from the point of adoption. Typically, ROI is used in determining whether a project will produce a positive payback and have value for a firm (Schweighardt n.d.).

ROI is important because it can quantify a project's value in a way that shows business leaders the dollar figures of a project's worth, which is exactly what this study is aiming to do. ROI makes the subjective turn into the objective; it can change a firm's uncertainty into certainty. The formula for calculating ROI is as follows:

$$ROI = [(Total\ Benefits - Total\ Cost)/Total\ Cost] \times 100$$

Equation 1

In this equation, there are two components to consider: the total costs and total benefits. Total cost of the project will be the costs associated with investments in training and education of employees to increase the proper use of EDI. The benefits will include the total cost reduction based on the sum of labor, administrative expenses, and resources saved as a result of more efficient use of EDI. Labor is equal to the number of business

hours per day spent on the effort, multiplied by the number of business days per week, then multiplied by the average labor rate per hour. Administrative expenses will be equal to the total administration work hours multiplied by the labor rate per hour. Lastly, resources pertain to the sum of all resource costs and related miscellaneous costs (such as paper usage). Once costs are estimated, they can reflect the financial gain to the firm, due to new or improved processes, as a result of reduced waste, reduced cost of operations, and/or productivity gain if necessary investments are made to train and educate employees in proper and more efficient use of EDI.

3.1.3 Cost and Benefit Estimation Challenges

The most challenging part of estimating the total cost is determining the required number of people to complete the project, as well as the total number of hours needed to complete the task, both of which call for an in-depth knowledge of the firm. Estimating the total benefits can also be very difficult, primarily when there is little to no data on the current processes. However, when the data is based on the amount of time spent correcting errors, or time wasted on fruitless tasks, there is opportunity to determine improvement. If data is available, the expenses need to be quantified; the sum of which will represent the potential gains from investing in identifying and correcting improper use of EDI (e.g. training).

3.1.4 Time Value of Money

While ROI is a central concept in determining cost savings of a Lean Six Sigma process, it is also important to consider the change in the value of money as time passes during an improvement program/project. This concept means that a dollar today is worth more than a dollar tomorrow. Caution is to be taken to avoid using today's costs to

compare with tomorrow's benefits. A helpful financial tool for this purpose is the net present value (NPV) of money. The formula for NPV is as follows:

$$NPV = \text{sum of benefits}/(1+r)^n$$

Equation 2

In this equation, r is the rate of discount and n is the period (time) in years. The NPV formula offers an opportunity to compare the ROI if the money were to be invested elsewhere.

3.2 Processes and Data

A typical EDI implementation system looks like Figure 3.1, where there is no manual (human) intervention or paper trail. When manual intervention and paper usage is continued after EDI implementation, this will cost the organization in time, money, and resources.

Figure 3.1: Proper EDI Process Flow

(Benefits of EDI n.d.)

The company receives a majority of their customer purchase orders through EDI methods. All EDI transmissions are sent and received daily using a file transfer software called ecConnect. Since the company is not using their EDI systems efficiently, EDI transmissions are manually received every morning through ecConnect, then the transmissions are converted into readable files through a program called TrustedLink. TrustedLink is an Internet Protocol (IP)-enabled Business to Business (B2B) translator

solution for electronic data interchange integration. The data is then converted into more concise files through an internally designed IT program. Once the data is converted into usable reports, the orders are printed, manually checked, and entered for production purposes. The company also receives and sends various other EDI transmissions, including invoices, order planning, advanced shipment notices and order acknowledgements.

3.2.1 Data Collection

For the purpose of this study, manual purchase order receipt and processing time are analyzed as one of the inefficiencies that result from improperly implementing EDI practices by a firm. The company uses an enterprise resource planning (ERP) system called Syspro, where all orders are entered for processing. Once the daily orders are entered, an order intake query can be generated in Syspro to display a line-by-line query of all order lines entered during a specific time frame. This query displays the customer, product code, the system operator who entered the order line, quantity ordered, date entered, and time entered.

The necessary data are collected from the order intake query and analyzed to estimate the annual costs associated with manual intervention of purchase order processing for each business day during the 2021 calendar year. Daily data consists of the time from manual receipt of EDI purchase orders to the time all orders are entered into the firm's ERP system, over a one year period. Daily start and end times are tracked in an Excel spreadsheet by month, then calculated into hourly totals for each of the twelve months analyzed. Only orders received via EDI transmissions from various trading partners are tracked in the order intake query for this study.

The data collected pertaining to manual order entry processes are organized into Excel spreadsheets. The original data are broken down into business days by month, with

the respective start and end times for each day listed. To convert the data into usable information for this study, the daily times elapsed are calculated into hours and minutes and entered into a "time elapsed" column in the Excel spreadsheet. The minute portions of the data are then converted into decimals of an hour. Once the data are converted into decimals of an hour for each business day, monthly totals are then calculated.

To get a full economic understanding of the inefficiencies associated with manual order processing, data pertaining to paper usage are also collected. When EDI transmissions are automatically integrated into a firm's ERP system, there is little to no paper waste associated with daily order receipts. Since the company manually checks all EDI order receipts by printing readable EDI transmissions, which are then compared to in-house order reports, paper usage data must be analyzed. The paper usage data are collected and organized in an Excel spreadsheet for analysis.

3.2.2 Methodology and Data

The collected data are analyzed using the methods described earlier in this chapter. A projected financial analysis is conducted for the business as it currently stands, assuming no changes are made to the current manual processing of EDI purchase orders, over the next five and ten years to provide the firm with the economic impact of inefficient EDI implementation. The primary analytical tool used in this study is net present value (NPV). Determining NPV allows the company to analyze the financial impact that can be eliminated by adopting proper EDI processes. This data will be beneficial to future studies as it analyzes the economic impact incurred from improper implementation techniques.

CHAPTER IV: ANALYSIS, RESULTS AND DISCUSSION

This study shows that it would be economically beneficial for the company to implement proper electronic data interchange (EDI) practices. Implementing proper EDI methods would eliminate the extra workload placed onto current employees and their need to fill the empty position overall; a position which has been vacant since early 2020 due to labor impacts from the Covid-19 pandemic. This vacant position has led to the workload being distributed among several members of the company, in addition to their respective job duties. This study provides a hard and soft savings financial analysis for manually processing EDI orders, which directly impacts the staffing and morale of the company in this research.

4.1 Hard Savings

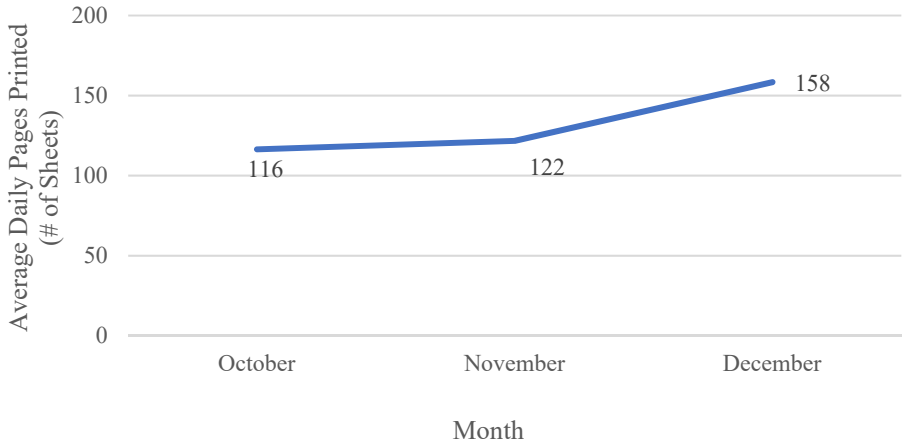
Most improvement processes either result in a soft or hard savings benefit, or a combination of the two. The easiest savings to calculate are hard savings because they are linked to actual dollar values. Hard savings are found through reduction of material costs used in a process, reduction of expenses linked to overtime, or reduction of production scrap costs, just to name a few. These types of costs savings can be viewed in the financial statements and cash flows of a firm. In summary, if the improvement leads to less cash output from a firm's financial accounts, then it is considered a hard savings (Thor 2018).

4.1.1 Paper Usage Related to Manual EDI Processing

Through previous Lean Six Sigma (LSS) projects at the company, a concept described in Chapter 3.1.1, it was found that each piece of paper used cost one cent. Paper usage over a three month time frame is examined in the hard savings calculation of this study. The number of pages physically printed for manually checking EDI order

transmissions were tracked from October thru December 2021. The results were then analyzed to determine the average daily paper usage by month as shown in Figure 4.1.

Figure 4.1: Average Daily Paper Usage for a Three Month Manual EDI Analysis



The number of pages printed varies from day to day for a multitude of reasons, including the volume of orders that are received, customer business levels at a particular time of year, the number of orders entered on open order reports, weekly customer order forecasting, and customer payment remittances.

After analyzing three months of paper usage data, it can be determined that the average number of pages printed per day is 128 pages. Using previous calculations that a sheet of paper cost one cent each, it is determined that the cost of paper usage related to manually entering EDI data is $1.28 per day. By assuming that the company operates for 249 working days of the year, determined by using the COUNT function in Excel on the manhour data collection, paper usage expenses for the year 2021 are estimated at $319. This number is only an estimate and can vary greatly based on the factors listed above.

4.2 Soft Savings

Soft savings are less noticeable as they are typically linked to productivity improvements, such as decreasing EDI processing time by implementing proper techniques and programs. The calculation and analysis associated with manual EDI implementation would be a soft savings; processing time is being reduced as improvements are made, yet the people working are still getting paid the same during each pay period, so there is no cash flow impact to the firm. Quite simply, if an improvement leads to no change in an organization's cash flow, then the result is considered to be a soft savings (Thor 2018). The cash flow of the organization is not changing, but what has changed is the volume of work. The time once used for manual EDI order processing can be reduced and redirected towards performing other value-added tasks.

4.2.1 Manual EDI Processing Time

The amount of time between receipt of EDI data transmission to the time that the last order is entered for processing was tracked from January thru December 2021. The total number of manhours per month spent manually entering EDI orders are found in Table 4.1, with a full table presented in Appendix A.

Table 4.1 Manual EDI Order Processing Time January – December 2021

Month	Total Processing Time (Hr.)
January	**224.48**
February	**143.84**
March	**171.11**
April	**159.75**
May	**147.98**
June	**163.50**
July	**148.50**
August	**164.09**
September	**147.78**
October	**148.30**
November	**132.89**
December	**138.40**
Grand Total	**1890.62**

The average salary for the position previously responsible for processing all EDI transmissions is assumed to be $16.00/hr. Since this position is currently vacant at the company, manual processing time is distributed between 2-3 employees, all with varying salary ranges; the assumed base salary listed above is used for calculation purposes in this study. The grand total of 1890.62 manhours for the year 2021 was multiplied by the base salary of $16/hr. to get the minimum dollar value associated with manually processing EDI purchase order data over a one year period. For the year 2021, it is estimated to have cost the company a minimum of $30,250 in manhours to manually process and enter all EDI orders.

4.3 NPV Analysis of Inefficiencies

Earlier in this chapter, it was found that the annual paper usage associated with manual EDI order processing was estimated to be $319 for the year 2021. For the purpose of this study, let this value serve as the paper usage cost for Year 0 in Table 4.2. It was also found that the manual order entry processing time to be a minimum of $30,250 in labor hours for the year 2021, let this serve as the manhour value for Year 0 in Table 4.2. To fully analyze the financial impact of improper EDI implementation, pertaining directly to order intake processes, the data was assessed over a 10-year period for the total cumulative financial impact of both paper usage and manual data processing time.

Estimations were made assuming that the total yearly financial impact of inefficient EDI order processing is a constant $30,569 over a 10-year period. The data collected in the year 2021 for this study are represented by Year 0 in Table 4.2. The yearly NPV of the total cumulative cost was calculated using a discount rate of 5% per year for 10-years. Assuming that all values remain constant, if changes are not made this year, the financial impact over 5 years is expected to be $143,710 and in 10 years $206,434. Table 4.2

displays the financial impact that the company stands to incur if they do not change their EDI processes to more efficient, automated methods.

4.4 Return on Investment Discussion

The concept of ROI is relevant in this discussion in two ways. First, the proper use of EDI will increase the ROI of the adoption of EDI. Second, the investment in training to improve EDI use after adoption can result in ROI in terms of savings from eliminating the costs associated with improper use. By investing in identifying and correcting improper use of EDI programs, businesses should experience a ROI when compared to standard paper based communication methods. However, if the systems are not used properly, the expense of any inefficiencies must be deducted from the overall expected ROI. In Chapter 3, it was stated that ROI = [(Total Benefits – Total Cost)/Total Cost] x 100. In this equation, the benefits would be the overall savings that the company experiences by switching to EDI methods from standard paper communication and the cost is that of the EDI program and training. Since the company is not using proper implementation techniques, they must deduct the NPV that is calculated in Table 4.2 for Year 0 if they do not make a change immediately.

By investing and training employees correctly, the company adds to their expected ROI. While manhours and paper usage can be tracked, there are factors affecting ROI which are not quantifiable (such as emotional impact, employee burnout and turnover, and job satisfaction), making calculations difficult in this study, which would need to be analyzed in greater detail for further

research.

Table 4.2 NPV Analysis of Manual EDI Processing Methods

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cost of Paper Usage	$319	$319	$319	$319	$319	$319	$319	$319	$319	$319	$319
Cost of Manhours for Data Entry	$30,250	$30,250	$30,250	$30,250	$30,250	$30,250	$30,250	$30,250	$30,250	$30,250	$30,250
Total Cost of Inefficiencies	$30,569	$30,569	$30,569	$30,569	$30,569	$30,569	$30,569	$30,569	$30,569	$30,569	$30,569
Total Cumulative Cost	$30,569	$61,138	$91,707	$122,276	$152,845	$183,414	$213,983	$244,552	$275,121	$305,690	$336,259
NPV	**$30,569**	**$58,227**	**$83,181**	**$105,627**	**$125,746**	**$143,710**	**$159,677**	**$173,799**	**$186,213**	**$197,050**	**$206,434**

(Year 0 = 2021; NPV Discount Rate = 5%)

CHAPTER V: CONCLUSION AND RECOMMENDATIONS

This study evaluates the financial impact of practicing inefficient electronic data interchange (EDI) methods at a small company. The company does not practice proper EDI implementation methods, leading to a negative financial impact on the organization, employee burnout and turnover, decreased return on investment (ROI), and decreased productivity, among many other consequences that could be analyzed in future research.

This study analyzed hard and soft savings directly related to EDI order processing methods within the company's customer service department; the data analyzed pertained directly to unnecessary paper usage and manhours spent on manual data entry processes. The findings of this study illustrate potential cost savings benefits that the firm can achieve if they are to implement proper EDI practices, or an entire new program, and eliminate their manual EDI order processing methods.

By calculating the NPV of the total cumulative financial impact of the inefficiencies examined in this study, the company can understand why implementing proper EDI practices will benefit their organization long term. These findings also show the organization the worthiness of investing in a new system, so they can fully benefit from their ROI without any deductions due to inefficiencies. Through this evaluation, it can be determined that the longer the organization practices improper EDI techniques, the more time and money they are going to spend in manhours and resources.

Assuming that the data collected remains constant, if the company continues to process all EDI orders manually, it is estimated to cost a minimum of $30,569 a year in paper usage and manhours entering order information. By using a discount rate of five percent, the financial impact of continuing inefficient methods for another five years has an

NPV of $143,710; after another ten years an NPV of $206,434. These findings can help inform management decision on investing in more efficient systems or in training employees to use the current system more efficiently.

5.1 Potential Limitations and Assumptions

While paper usage and manhours spent manually processing EDI order transactions are major contributing factors to the financial impact of inefficient EDI practices at the company, there are limitations and assumptions made in this study. The extensive manual processes that are currently being used can lead to severe employee burnout and turnover, as well as decreased job satisfaction and emotional wellbeing. There was no financial impact analyzed pertaining to these limitations analyzed. It also needs to be emphasized that all costs used in this study are likely underestimated due to wage variances and supply costs associated with inflation; actual costs are likely much higher. Costs would also increase if an employee were to seek new employment due to experienced burnout and job dissatisfaction.

This study was limited to focusing on order entry processes of the EDI system, but there are other EDI functions used daily that would also contribute to overall financial impacts, such as the generation and processing of advance ship notices (ASNs) and electronic invoices, communicating purchase order acknowledgements back to the customers, and the receipt and processing of payment remittances.

ASNs are sent to customers after freight has been picked up by an assigned carrier. By manually generating these documents, they are not immediately sent to customers when the freight is moved. Instead, an employee must locate a signed bill of lading (BOL), generate the necessary information through an internally designed program, then manually transmit the ASN to the customer. Sometimes documents are accidentally sent before

trucks pick up or they are not sent until the next business day when someone returns to the office. If EDI systems were implemented correctly, this process would be automated and require minimal human intervention. Like order entry processes, a dollar value can be applied to the daily time spent processing ASN transmissions and correcting errors that may arise.

Electronic invoices can be sent to customers via EDI methods as soon as they are generated in a company's accounting system. However, the company manually generates all invoices for their EDI trading partners. This inefficiency can also be assigned a dollar value related to manhours spent generating, correcting, and sending data.

Payment remittances are received by the supplier from the customer via EDI transmission. Instead of translating this information into an accounting system, paper is used to print out the translated EDI data and accounting manually matches the payments to invoices within their system.

There were several assumptions made in this study as well, such as the salary used for calculating the financial impact of manhours spent over the year 2021, the average paper usage over the entire year, and that everything would remain constant over a 10-year period when analyzing NPV. Realistically, everyone manually processing the EDI transmissions has a different salary. Also, paper usage volume varies depending on the customer demand, the orders already entered into the system, the time of the year orders are received and the year-to-year demand changes of the economy. Another assumption is that the technology use will remain constant over the period of analysis. However, it is reasonable to expect an increasing rate of new technology development over 10-year period and a new more advanced and efficient system replacing current EDI.

5.2 Future Outlook

The limitations in this study leave room for future research opportunities to fully analyze all factors that may impact an organization financially when they continue to practice inefficient EDI methods; particularly the emotional cost endured. Employee well-being and job satisfaction are very important and should be analyzed in future research. If employees are unsatisfied, there is risk of higher burnout and turnover, which can lead to less productivity and more time spent training new employees to learn processes. Employee training is an effective way to address misuse, limit burnout/dissatisfaction, and minimize costs. It would be beneficial to use the costing data in this study to make sure that training expenses are not greater than the expected savings.

An additional option for future research would be to look at the customer EDI method inefficiencies, instead of the supplier inefficiency methods. If customers are using EDI systems incorrectly, they could be sending misinformation to suppliers, which can lead to transmission errors and extra steps on the supplier side. This misinformation could include incorrect purchase order numbers, incorrect ship to addresses, incorrect part numbers and/or incorrect quantities.

Future research can also be conducted to cover a more in-depth financial analysis of paper usage and manhours spent manually entering orders. In reality, business levels fluctuate throughout the year, whether it is customer induced or related to various business closures throughout the year (i.e., holidays, inventory shutdowns, etc.) causing increases and decreases in customer orders and shipments. This fluctuation could greatly impact the average number of pages printed throughout the year, and therefore the financial impact of paper usage would not remain constant. Since there is a vacancy in the department responsible for processing EDI order receipts, it should not be assumed that there is one flat

salary associated with the manhours for data entry, as the data was entered throughout the year by various employees. By generating an order intake query and assigning the correct salary to the person responsible for each order entry, a more accurate financial impact could be analyzed. Lastly, after implementing a fully integrated EDI system, a study could be conducted to re-evaluate the factors examined in this research and determine new impacts on the firm's ROI.

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APPENDIX A

Table A: Manhours for Manual Data Entry in 2021

Date	Time Elapsed (Hr.)	Date	Time Elapsed (Hr.)	Date	Time Elapsed (Hr.)	Date	Time Elapsed (Hr.)
1/4/2021	7.92	2/1/2021	7.5	3/1/2021	7.65	4/1/2021	8.45
1/5/2021	10.15	2/2/2021	2.7	3/2/2021	7	4/5/2021	5.28
1/6/2021	9.33	2/3/2021	5.95	3/3/2021	7.85	4/6/2021	6.57
1/7/2021	8.28	2/4/2021	7.38	3/4/2021	9.07	4/7/2021	6.33
1/8/2021	9.03	2/5/2021	8.17	3/5/2021	8.02	4/8/2021	8.37
1/11/2021	8	2/8/2021	5.9	3/8/2021	8.12	4/9/2021	8.55
1/12/2021	8.37	2/9/2021	6	3/9/2021	9.05	4/12/2021	6.37
1/13/2021	7.57	2/10/2021	7.7	3/10/2021	7.18	4/13/2021	7.17
1/14/2021	8.85	2/11/2021	7.48	3/11/2021	8.48	4/14/2021	9.33
1/15/2021	8.12	2/12/2021	6.57	3/12/2021	7.83	4/15/2021	7.95
1/18/2021	7.48	2/15/2021	9.53	3/15/2021	7.28	4/16/2021	8.43
1/19/2021	7.98	2/16/2021	7.77	3/16/2021	6.67	4/19/2021	8.85
1/20/2021	5.78	2/17/2021	8.3	3/17/2021	7.6	4/20/2021	7.2
1/21/2021	6.47	2/18/2021	6.37	3/18/2021	9.45	4/21/2021	7.12
1/22/2021	7.02	2/19/2021	8.48	3/19/2021	8.57	4/22/2021	7.32
1/25/2021	7	2/22/2021	8.35	3/22/2021	4.02	4/23/2021	7.2
1/26/2021	77	2/23/2021	6.63	3/23/2021	8.5	4/26/2021	6.4
1/27/2021	7.63	2/24/2021	6.28	3/24/2021	5.67	4/27/2021	8.53
1/28/2021	6.6	2/25/2021	8.48	3/25/2021	6.68	4/28/2021	8.33
1/29/2021	5.9	2/26/2021	8.3	3/26/2021	8.82	4/29/2021	8.33
				3/29/2021	6.28	4/30/2021	7.67
				3/30/2021	6.65		
				3/31/2021	4.67		
Jan Total	224.48	Feb Total	143.84	Mar Total	171.11	Apr Total	159.75

Date	Time Elapsed (Hr.)	Date	Time Elapsed (Hr.)	Date	Time Elapsed (Hr.)	Date	Time Elapsed (Hr.)
5/3/2021	8.27	6/1/2021	8.57	7/1/2021	8.53	8/2/2021	9.62
5/4/2021	7.18	9/2/2021	8.28	7/2/2021	6.9	8/3/2021	7.22
5/5/2021	6.42	6/3/2021	6.45	7/6/2021	6.48	8/4/2021	8.05
5/6/2021	6	6/4/2021	8.93	7/7/2021	7.42	8/5/2021	6.07
5/7/2021	6.7	6/7/2021	6.05	7/8/2021	7.08	8/6/2021	7.45
5/10/2021	5.78	6/8/2021	5.9	7/9/2021	7.4	8/9/2021	9.02
5/11/2021	8.2	6/9/2021	8.4	7/12/2021	6.92	8/10/2021	7.75
5/12/2021	7.37	6/10/2021	7	7/13/2021	7.45	8/11/2021	7.85
5/13/2021	7.55	6/11/2021	8.65	7/14/2021	4.5	8/12/2021	6.68
5/14/2021	9.23	6/14/2021	5.58	7/15/2021	6.62	8/13/2021	8.82
5/17/2021	5.77	6/15/2021	2.93	7/16/2021	7.52	8/16/2021	8.02
5/18/2021	8.45	6/16/2021	9.03	7/19/2021	7.98	8/17/2021	7.93
5/19/2021	6.45	6/17/2021	5.85	7/20/2021	7.82	8/18/2021	8.52
5/20/2021	8.53	6/18/2021	10.1	7/21/2021	7.43	8/19/2021	7.08
5/21/2021	8.4	6/21/2021	6.3	7/22/2021	6.58	8/20/2021	8.58
5/24/2021	7.02	6/22/2021	9.55	7/23/2021	9.63	8/23/2021	7.27
5/25/2021	8.63	6/23/2021	8.08	7/26/2021	7.38	8/24/2021	4.98
5/26/2021	7.9	6/24/2021	7.48	7/27/2021	8.53	8/25/2021	7.48
5/27/2021	7.45	6/25/2021	8.83	7/28/2021	8.25	8/26/2021	8.52
5/28/2021	6.68	6/28/2021	8.03	7/29/2021	5.43	8/27/2021	5.83
		6/29/2021	5.78	7/30/2021	2.65	8/30/2021	5.4
		6/30/2021	7.73			8/31/2021	5.95
May Total	147.98	Jun Total	163.5	Jul Total	148.5	Aug Total	164.09

Date	Time Elapsed (Hr.)	Date	Time Elapsed (Hr.)	Date	Time Elapsed (Hr.)	Date	Time Elapsed (Hr.)
9/1/2021	5.17	10/1/2021	8.83	11/1/2021	8.22	12/1/2021	7.1
9/2/2021	8.73	10/4/2021	7.53	11/2/2021	4.55	12/2/2021	6.78
9/3/2021	7.77	10/5/2021	9.83	11/3/2021	9.45	12/3/2021	7
9/7/2021	6.77	10/6/2021	6.97	11/4/2021	8.77	12/6/2021	6.87
9/8/2021	7.63	10/7/2021	8.48	11/5/2021	8.53	12/7/2021	5.45
9/9/2021	9.12	10/8/2021	6.48	11/8/2021	6.2	12/8/2021	9.2
9/10/2021	6.03	10/11/2021	7.42	11/9/2021	5.55	12/9/2021	7.57
9/13/2021	4.3	10/12/2021	7.25	11/10/2021	5.8	12/10/2021	7.32
9/14/2021	6.05	10/13/2021	7.42	11/11/2021	4.45	12/13/2021	8.53
9/15/2021	7.22	10/14/2021	5.15	11/12/2021	7.95	12/14/2021	9.53
9/16/2021	7.17	10/15/2021	8.07	11/15/2021	7.15	12/15/2021	6.67
9/17/2021	7.12	10/18/2021	7.42	11/16/2021	6.28	12/16/2021	6.67
9/20/2021	5.52	10/19/2021	5.93	11/17/2021	7.3	12/17/2021	8.32
9/21/2021	6.78	10/20/2021	9.13	11/18/2021	7.38	12/20/2021	4.82
9/22/2021	6.6	10/21/2021	6.07	11/19/2021	6.95	12/21/2021	9.02
9/23/2021	7.08	10/22/2021	7.05	11/22/2021	6.35	12/22/2021	8.72
9/24/2021	8.8	10/25/2021	3.35	11/23/2021	7.6	12/28/2021	5.6
9/27/2021	7.78	10/26/2021	4	11/24/2021	6.48	12/29/2021	4.73
9/28/2021	5.45	10/27/2021	8.88	11/30/2021	7.93	12/30/2021	8.5
9/29/2021	7.52	10/28/2021	5.97				
9/30/2021	9.17	10/29/2021	7.07				
Sep Total	147.78	Oct Total	148.3	Nov Total	132.89	Dec Total	138.4