The Relationship Between Enterprise Resource Planning and Supply Chain Management

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Abstract

Supply chain management (SCM) is a management style that focuses on the supply portion of a business with the goal to gain a competitive edge over competition and maximize value and relationships between suppliers and customers. In order to create a sustainable supply chain, there are five important stages that must be involved: Planning, finding sources, making the product, delivering the product, and managing defects or end-of-life's. Enterprise resource planning (ERP) is a set of process, usually in real-time, used for management purposes. Though these two things can stand alone, they work very well together as well. ERP gives SCM the opportunity to automate the sources stage and its inventory, the scheduling of the making stage, the scheduling of delivery, and just reduce blocking between suppliers and the business itself. This study provides the relationship between ERP and SCM and identify the benefits and areas of improvement specifically focusing on the effect on competitive edge. My findings show that although ERP does have a positive effect on SCM, decreases cost, improves communication, and gives a competitive edge, it is still proving to be very difficult to implement.

Keywords
Enterprise resource planning, ERP, Supply chain management, SCM

1. Introduction
Businesses are always looking for a way to get and stay ahead of their competitors and on good terms with their customers. In the modern day business world, it is proving to be less about the direct product and more about how fast can the business produce and ship or how quickly they are adding to versions or features. There are two steps businesses most take to get this lead. First, a solid supply chain is what businesses are using to get this competitive edge. Second, the supply chains have to ever evolve in all stages in order to keep the competitive edge.

A product or goods supply chain takes raw material and transforms it into a finished product. A service supply chain is a network of services with a goal of fulfilling a task as the output for a customer. In laymen's terms, supply chain management (SCM) is no more than the management of the flow of those goods and services. SCM process is made up of different parties i.e. retailer, manufacturer, and supplier involved in providing products and services to the customers, and the sole purpose is to add value in their products, both in upstream and downstream, through some channel with the proper flow of information and resources (Parkhi 2015). SCM is seen has a way to add value to a business but there are ways to enhance it using modern technology.

A worker on a supply chain can only work so fast but if that supply chain is computerized then not only does it get faster but human error gets reduced. Enterprise resource planning (ERP) is exactly what that is for. When paired with a SCM system, it makes it autonomous and faster by using technology. It (ERP) is basically an information system that combines different subsystems into one system (Almgren and Bach 2014). Once ERP is in place, it can improve business performance and customer relationships but in order to get to that point, a business has to integrate their SCM with an appropriate ERP for them. This process is long and difficult and often fails but ERP companies today put a lot of their money, time, and effort into their implementation consultants to help stop these problems. In order to make the integration process as smooth and painless as possible, it is important that SCM companies take the time to figure out which ERP system is right for them before proceeding. There are many different systems out there to serve every sector but not every one of those systems serve every possible customer within the sector.

1.1 Objectives

One objective of this paper is to collect real world data regarding SCM and ERP to see if the integration between the two serve to benefit SCM. There are many past studies that show connections to SCM and continuous success, this paper will analysis to continue to show that. The main objective of this paper is to show how to improve upon the supply chain, ERP already does that but there are always points that fall short. Integrating ERP is notoriously difficult and time consuming. This paper will use statistical analysis to pin point the most prominent issues reported through the collected data and offer improvements via analysis and past research.

2. Literature Review

Supply Chain Management (SCM) is the systematic theory and practical tools to provide integrated supply chain to the "Supply Value Chain" in order to meet customers' satisfaction needs and expectation requirement (Liu 2007). Many studies from the past and present have focused on proving that SCM is a valuable resource for businesses of all shapes and sizes. Businesses in all countries have put in a lot of time, effort, and money to try to better their business practices and achieve a competitive edge over their competitors. In the USA, the businesses have spent more than $670 billion on the supply chain related activities during the year 1993 which was the 10.5% of the total GDP (Salmon 1993, Nemati and Mangaladurai 2013).

There are always downfalls to most business practices and for supply chain, poor implementation is a big one. Many supply chains which are not configured with the ERP systems have already placed complaints over poor business relationships and as well as loss in business (Nemati and Mangaladurai 2013). With the advancement of technology in all aspects of business, it drove businesses to look for a better solution without having to take down their already existing supply chain. Enterprise Resource Planning (ERP) proved to be a popular answer for many businesses issues. The strength of an ERP system is integration and automation and that is why implementation of ERP will help in improving accuracy and in better decision making (Nemati and Mangaladurai 2013). A supply chain passes along a lot of data to their customers and suppliers and receive just as much, if not more, back. When they have to do that manually, it involves a large amount of man power and room for human error. Integrating ERP into the supply chain network allows a business to get an almost custom fitted process that takes away most of the dangers they had before and results in better relationships with external clients due to seemingly flawless execution.

In order to continue making improvements within a business, improvements to a business's SCM processes must also be made. A way to ensure continuous progress is to integrate with the adaptable set of tools, ERP. ERP system offers a viable management capability to helping enterprise in particular manufacturing enterprises manage the resources (Liu 2007). SCM on its own is very powerful, allowing businesses to function more efficiently and effectively internally, which includes sales, production, and distribution, and externally, which includes customers and suppliers. According to (Gupta 2006) Enterprise Resource Planning systems 'effectively integrate islands of information and structure systems with transparency and real-time information sharing across the intra-organizational processes (e.g. major functional areas) as well as inter-organizational processes (e.g. suppliers and customers) '(Matičević et al.f 2007). When integrated with ERP, there is an opportunity to increase competitive edge and enhance business performance by increasing transparency and information flow. ERP provides several tools; the two most important for supply chain integration are the real-time transaction tracking and the internal process integration (Kelle and Akbulut 2005).

In order to keep up with competitors, businesses need to keep their SCM solution running at peak possible performance. ERP quickly became the most popular toolset to obtain the competitive edge necessary to build an efficient supply chain network. Increasing decision making and accuracy builds trust and partnership with customers and suppliers which then allows the business to build credibility within the market. Over the past three decades, ERP and SCM have been working together to enable businesses to succeed to the best of their abilities when it became apparent that SCM could no longer do it alone in most cases.

3. Methods

3.1 Participants

Six people who work in various sectors of Supply Chain Management (SCM) took a survey posted on LinkedIn. The participants were from various parts of SCM including manufacturing and health care. Majority of the responses came from people working in engineering or management within the United States.

3.2 Materials
The survey named The Relationship Between Enterprise Resource Planning and Supply Chain Management Survey was 25 questions long and broken up into four parts with one of the questions being outside the parts. It was adapted from three surveys conducted by Mwanyota (2004), TaeHyung and Heeseok (2006), and Themistocleous, et al. (2001). The purpose of the survey was to figure out where the participant fell within SCM and then get their opinions of integrating Enterprise Resource Planning (ERP). The responses were short answer unless otherwise noted in the description.

The first question was to see if the participants responses could be specifically discussed in the paper.

The first section focused on geographic data which asked the participant where they are from, what sector they work in, and their job title.

The second section focused on business and management data. The purpose of this section was to find out where in the ERP adoption process their business was and who within the company decided to adopt ERP. It also asked about any managerial issues they had with ERP implementation, along with what benefits they will see.

The third section focused on technical data. The purpose of this section was to find out the different kinds of ERP that got implemented, the number of modules, and any technical or integration issues that were faced.

The fourth section focused on level of agreement and statements on ERP systems. Participants were asked to respond to each statement or opinion with strongly agree, agree, neutral, disagree, or strongly disagree. They are all general questions about ERP and/or SCM to get an understanding of the participants opinions on the topics.

3.3 Empirical models for relationship - regression
From the fourth section of the survey, the level of agreement and statements on ERP systems, the responses (strongly agree, agree, neutral, disagree, or strongly disagree) where assigned a value 5, 4, 3, 2, or 1 respectively. From there,

Table 1 Survey Mean

the mean value for each statements agreement was calculated and can be seen in Table 1.

Statement	Mean
1. ERP system will/has greatly improve(d) our supply chain management	4.67
2. ERP system will/has greatly improve(d) communication and co-operation within our business	4.5
3. ERP systems require too many components	4.33
4. ERP systems are too new for our current analysis	2.5
5. An ERP system will/does offer us competitive advantage	4.33
6. ERP systems are complex to implement	4.17
7. We will/have not reduce our costs by using ERP systems	3.17
8. ERP systems have no real advantages	1.5

Using the results from each of the statements, a regression analysis was done against the first statement, 1. ERP system will/has greatly improve(d) our supply chain management, to see the relation between the two and can be seen in Table 2. The results show that statement 2, ERP system will/has greatly improve(d) communication and co-operation within our business, statement 3, ERP systems require too many components, statement 5, An ERP system will/does offer us competitive advantage, and statement 6, ERP systems are complex to implement, have the best cause and effect with the first statement. The Excel add on tool XLMiner Analysis ToolPak - Linear Regression was used to reform the regression analysis.
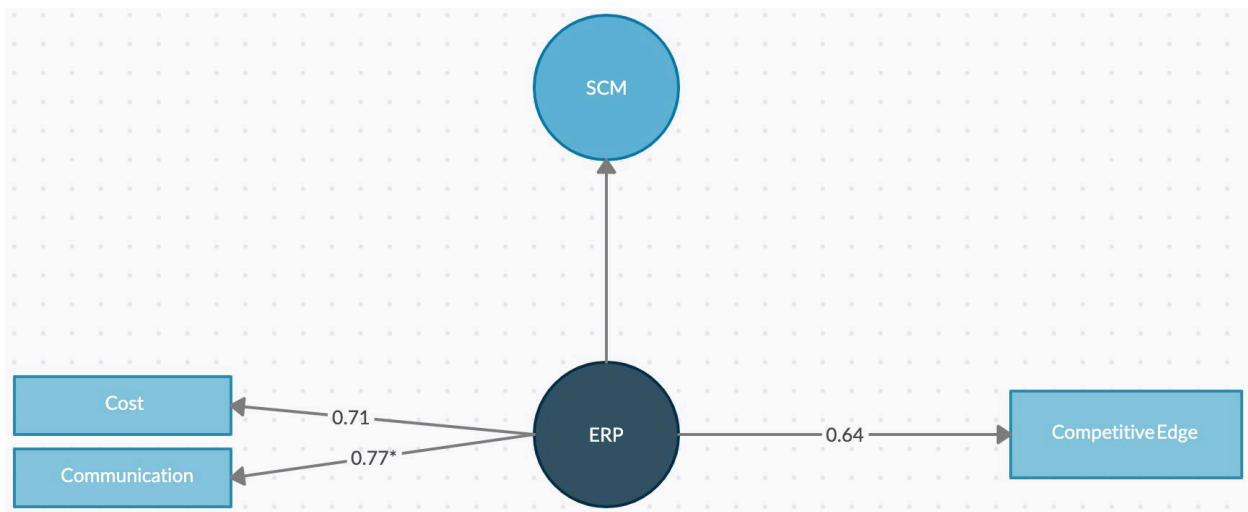
Table 2 Regression Results

Statement	Regression against statement #1
1. ERP system will/has greatly improve(d) our supply chain management	1
2. ERP system will/has greatly improve(d) communication and co-operation within our business	0.77
3. ERP systems require too many components	0.64
4. ERP systems are too new for our current analysis	0.17
5. An ERP system will/does offer us competitive advantage	0.64
6. ERP systems are complex to implement	0.63
7. We will/have not reduce our costs by using ERP systems	0.71
8. ERP systems have no real advantages	0.17

4. Data Collection
The survey discussed above was taken online using Google Forms, by choice by the participants. They had access to any resources and as much time as they needed to answer all the questions. They were given contact information if they had any questions or concerns regarding the survey or this paper.

After all the responses are collected, they will be exported to Excel for survey analysis and statistical analysis to compare the experiences of the participants with ERP and to locate any clear and unanimous issues across the sectors.

5. Supply Chain Network Modeling

Image 1 Supply Chain Model
*p<0.05

The supply chain model in Image 1was made using the regression results from Table 2.

6. Supply Chain Improvements

The regression analysis showed a good correlation between ERP's improvement of SCM and improved communication, competitive edge, and cost. The biggest issue from the data collected in the survey section 4 was the general complexity of ERP. Looking at the results from the tables above in the Data Collection section, specifically Tables 7 and 8, it can be deduced that lack of support either from the managers, the employees, and/or the implementors was a problem all around. To improve the supple chain, it is important to have that support but if the implementation goes poorly then it will be difficult for the company support to build. ERP systems are incredible complex so it is critical that the company implementing is flexible and responsive to any and all issues but before that, it is even more important that the company receiving the implementation has vetted all possible options before coming to a final decision. Having to backtrack or even quit the implementation process will leave a bad view on ERP to the people making the decisions which from above, is mostly those in managerial or above positions. Increasing research and implementing team communication would have a positive effect on the supply chain model.

All of the analysis above are satisfactory but can always be improved. For the above model, there was a limited about a data to work with from the response. Assumptions may be missing that would be there if there had been a greater response to the survey or if more questions were asked.

7. Results and Discussion

A survey was posted on LinkedIn and was competed by six individuals who work in the Supply Chain field and have or are implementing ERP into their systems. This survey was only responded to six times. Had more responses been added, the outcome of this data could have changed greatly. All of the data collected is being used and can be seen in the following tables.

The following data was collected from the survey administered. The results will be discussed through this study.

Survey section 1 Data can be seen in Table 4.
Survey section 2 Data can be seen in Table 5, Table 6, and Table 7.
Survey section 3 data can be seen in Table 8.
Survey section 4 data can be seen in Table 1.

Table 4 Survey Section 1 Data

What country do you work?	What sector do you work for?	What is your job title?
USA	Manufacturing	Quality Engineer
Indonesia	Manufacturing	Supply Chain Planning Manager
USA , Egypt	Manufacturing	Master scheduling
USA	Health care	Supplier quality engineer
United States	Automotive	Sr SAP SCM Analyst
Bangladesh	Manufacturing	Industrial Engineer

Table 5 Survey Section 2 Data part 1

Are you in the process of adopting ERP?	Why did you or are you going to adopt an ERP system?	Who initiated the idea for ERP adoption?
Yes	Already Implemented	Management
Yes	1. Top Management Decision & easy to operate	Top Management
Yes	To integrate all sources of data , connect all department	Scheduling
No	We have already ERP system	When i work in Ge,I adppted engineering data
No already adopted	It is better for full enterprise planning which integrates all the processes like purchasing , sales and finance, forcasting of materials etc	Executive Level
Yes	it's sillplify the process & operation which helps to take decission quickly, ultimately safe the cost	Top management of the organizatiin

Table 6 Survey Section 2 Data part 2

Who made the final decision to adopt ERP?	How has ERP been beneficial to your organization?
Management	Many ways.. It helped us in tracking scrap, rework, ppap status, apqp status, production
Us as Manager in Operation	Very easy and suitable also for our Customers and Supplier's
CEO	It will make accurate real time data available for everyone to help decision support
Client	It was good.Because we were trying to replace Semjet to SAP system
CEO	Tighten the process, standard process available in ERP, Ready to adopt and use.
Top management	ERP system where every employee has on-demand access to the entire company's wealth of data, which allows to see the big picture in single gallery .Also this gives the employees the tools they need to make proactive decisions while making them feel more valued.

Table 7 Survey Section 2 Data part 3

What were the managerial problems during or after ERP implementation?	What has been or will be the area of your business that most benefits from ERP?
It take 2-3 weeks to migrate to any erp system(to update data into the erp tool)	Day-day production
Integrated to others tool must use additional integrated system.	Forecasting
Give the project resources and training needed	MRP
Good architects are requred.Also need management support	Engineering,Materials control and sales.
Some process wouldn't fit so need to customize the system or need to tweak the process	SAP SCM which includes MM WM PP
This is one kind of culture change.Whatevers doing for many years, all are just to that though those are not good,But after implementing ERP or good behavior tools, i think so all are happy with this.	Supply Chain

Table 8 Survey Section 3 Data

What type of ERP solution did you adopt?	How many modules did you implement?	What were the technical problems faced during implementation, if any?	What were the integration problems you faced, if any?
omega	3	n/a	n/a
EBSS	30	Knowledge to maximize function of ERP	Integrated from Excel file to ERP System
SAP	2	Wrong mindset , everyone should understand that the project will affect the whole company not only the project team	
Was trying to implement SAP.	Part configuration,Rules base logic etc.	Management support.	When we run thrid stress test and it was passed.But Management did not support.
SAP	MM/WM/PP/SD	Master data, training, Any Interfaces with ERP system	Engineering design data to create master data automatically in ERP
Accounting, supply chain operation	2	lack of support	data duplication

7.1 Numerical Results

The numerical results for this study come from the results of survey section 4. The mean, standard deviation (SD), and associated regression results can be seen in Table 9. Before the results of the survey were finalized, an expected mean table was created based on past research looked into why completing this study. The expected means can be seen in Table 10. After the survey results were finalized, the variance was found for each of the statements. The statement that showed the highest variance was statement 7, We will/have not reduce our costs by using ERP systems. This table shows that, for the most part, the survey results matched what was expected for it.

Table 9 Section 4 Results

Statement	Mean	SD	Regression
1. ERP system will/has greatly improve(d) our supply chain management	4.67	0.816	
2. ERP system will/has greatly improve(d) communication and co-operation within our business	4.5	0.837	0.77
3. ERP systems require too many components	4.33	0.816	0.64
4. ERP systems are too new for our current analysis	2.5	0.548	0.17
5. An ERP system will/does offer us competitive advantage	4.33	0.816	0.64

6. ERP systems are complex to implement	4.17	1.33	0.63
7. We will/have not reduce our costs by using ERP systems	3.17	1.17	0.71
8. ERP systems have no real advantages	1.5	0.548	0.17

Table 10 Expected Survey Results

Question	Expected Mean
1. ERP system will/has greatly improve(d) our supply chain management	4.5
2. ERP system will/has greatly improve(d) communication and co-operation within our business	3
3. ERP systems require too many components	5
4. ERP systems are too new for our current analysis	2.5
5. An ERP system will/does offer us competitive advantage	4.5
6. ERP systems are complex to implement	4
7. We will/have not reduce our costs by using ERP systems	4
8. ERP systems have no real advantages	1

Section four of the survey came from a subsection of a survey conducted by Mwanyota (2004). Table 12 are the results gathered by that study. This study was sent to 50 respondents and answered by 36. A variance table, Table 13, was created to compare these results and the results from this study. This comparison showed a much greater variance but upholds previous statements regarding how a greater number of respondents can greatly change the outcome of the results. There still was an overall level of agreement in both studies.

Table 11 Expected vs Actual Variance

Question	Variance	% Variance
1. ERP system will/has greatly improve(d) our supply chain management	0.17	103.78%
2. ERP system will/has greatly improve(d) communication and co-operation within our business	1.5	150.00%

3. ERP systems require too many components	-0.67	86.60%
4. ERP systems are too new for our current analysis	0	100.00%
5. An ERP system will/does offer us competitive advantage	-0.17	96.22%
6. ERP systems are complex to implement	0.17	104.25%
7. We will/have not reduce our costs by using ERP systems	-0.83	79.25%
8. ERP systems have no real advantages	0.5	150.00%

Table 12 Level of Agreement and Statements on ERP Systems (Mwanyota 2004)

Statement	Mean
1. ERP system will/has greatly improve(d) our supply chain management	2.1
2. ERP system will/has greatly improve(d) communication and co-operation within our business	2.2
3. ERP systems require too many components	2.3
4. ERP systems are too new for our current analysis	2.4
5. An ERP system will/does offer us competitive advantage	2.7
6. ERP systems are complex to implement	2.9
7. We will/have not reduce our costs by using ERP systems	3.1
8. ERP systems have no real advantages	3.4

Table 13 Mwanyota vs Actual Variance

Question	Variance	% Variance

1. ERP system will/has greatly improve(d) our supply chain management	2.57	222.38%
2. ERP system will/has greatly improve(d) communication and co-operation within our business	2.3	204.55%
3. ERP systems require too many components	2.03	188.26%
4. ERP systems are too new for our current analysis	0.1	104.17%
5. An ERP system will/does offer us competitive advantage	1.63	160.37%
6. ERP systems are complex to implement	1.27	143.79%
7. We will/have not reduce our costs by using ERP systems	0.07	102.26%
8. ERP systems have no real advantages	-1.9	44.12%

7.2 Graphical Results

The results in Image 2 show the survey responses for statement 1, ERP system will/has greatly improve(d) our supply chain management. This had an expected mean of 5 and an actual mean of 4.33.

The results in Image 3 show the survey responses for statement 2, ERP system will/has greatly improve(d) communication and co-operation within our business. This had an expected mean of 3 and an actual mean of 4.5.

The results in Image 4 show the survey responses for statement 3, ERP systems require too many components. This had an expected mean of 5 and an actual mean of 4.33.

The results in Image 5 show the survey responses for statement 4, ERP systems are too new for our current analysis. This had an expected mean of 2.5 and an actual mean of 2.5.

The results in Image 6 show the survey responses for statement 5, An ERP system will/does offer us competitive advantage. This had an expected mean of 4.5 and an actual mean of 4.33.
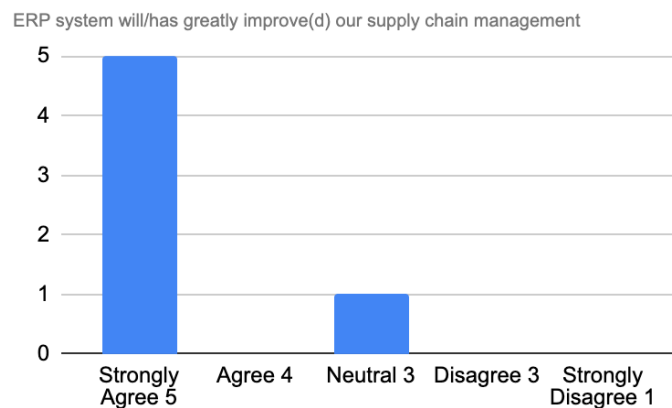

Image 2 Improved Supply Chain Results

ERP system will/has greatly improve(d) communication and co-operation within our business
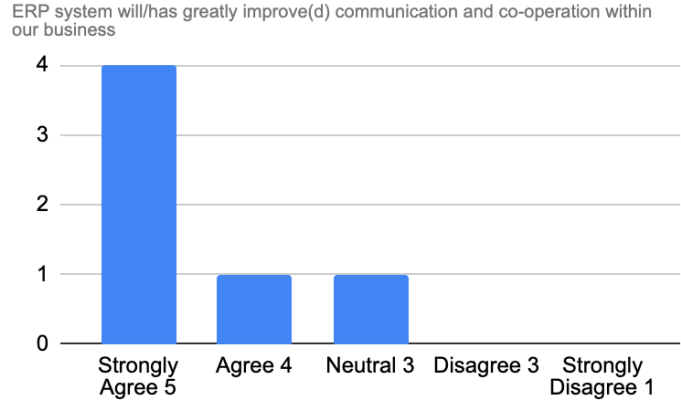
Image 3 Improved Communication Results

The results in Image 7 show the survey responses for statement 6, ERP systems are complex to implement. This had an expected mean of 4 and an actual mean of 4.17.

The results in Image 8 show the survey responses for statement 7, 1. We will/have not reduce our costs by using ERP systems. This had an expected mean of 4 and an actual mean of 3.17.
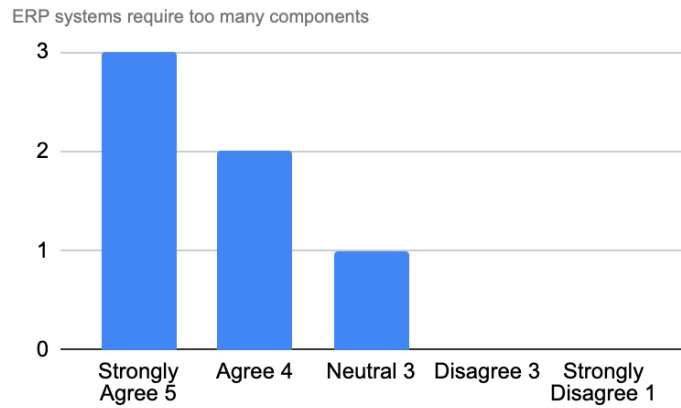

ERP systems require too many components

Image 4 Components Results

ERP systems are too new for our current analysis

Image 5 Too New Results

The results in Image 9 show the survey responses for statement 8, 1ERP systems have no real advantages. This had an expected mean of 1 and an actual mean of 1.5.
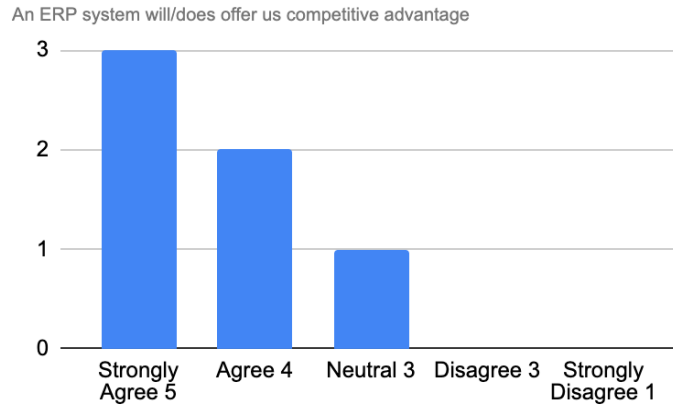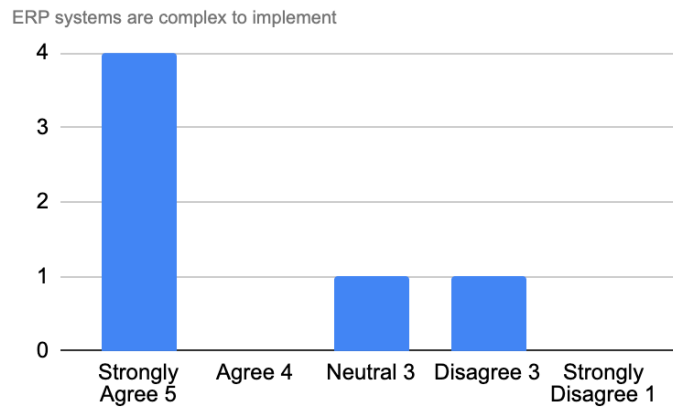
An ERP system will/does offer us competitive advantage

Image 6 Competitive Advantage Results

ERP systems are complex to implement

Image 7 Complex Results

We will/have reduce our costs by using ERP systems

Image 8 Cost Results

ERP systems have no real advantages
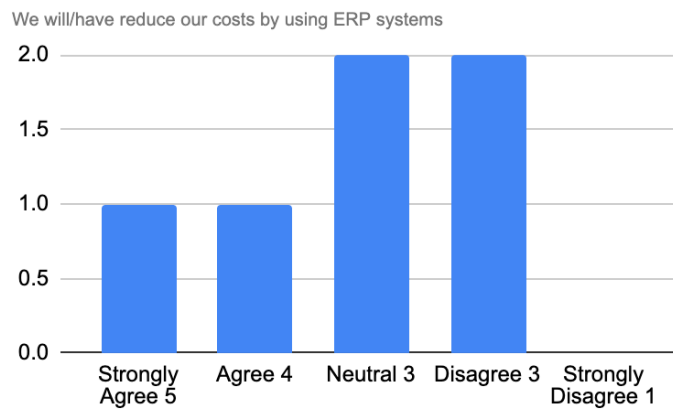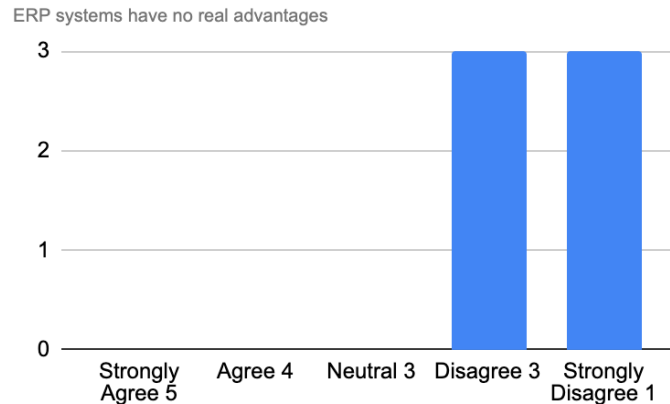

Image 9 Advantage Results

8. Conclusion

Supply Chain Management (SCM) manages the flow of goods and services. SCM can function on its own effectively but with the rise of new technologies, it became apparent that there were ways to improve upon a supply chain but adding a computer system and automation. Enterprise Resource Planning (ERP) is a set of processes that can either stand alone or integrate with another system to make management more efficient and transparent. SCM and ERP have been working together for years but with the uniqueness and complexity of both, it does not come without issues. This study looked into the effect of ERP on SCM to see by using survey data, could the benefits prove to show the same as it has in the past. It also looked to see the effects on cost, communication, and competitive advantage.

The survey results upheld the expected results made based on past research reviewed. ERP has a positive effect on the cost, communication, and competitive advantage with communication relating the most to the effect on ERP's effect on SCM. Issues found through the survey were related to the general complexity of ERP systems and lack of managerial support. It is critical that when implementing an ERP system that the SCM company vets all possible ERP systems before selecting the right one for them and for the ERP company to be wiling to be moldable and accessible to match the SCM as best possible and make the implementation process as simple as possible.

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Biography

Kayla Akey is a master's student in the Mechanical Engineering Department at Lawerence Technological University. Her experience is many in Enterprise Resource Planning software specifically in the Public Sector. Her expert areas are mainly in software engineering. She has a BS in Computer Engineering from Michigan State University and is pursuing her Master's in Engineering Management from Lawerence Technological University.