Teaching Practices in the Age of a Pandemic

by Dr. Mahmoud Al-Odeh

The COVID-19 pandemic affected many areas of our life, including the education sector. Colleges and universities in Minnesota were required to switch overnight to "emergency remote" (fully online education) as a safe option for students and faculty when everything was shut down. During this challenging time, many opportunities were used to remove difficulties from online learning to ensure student success. Here are six working practices used in my classes.

1. Understand students' needs and readiness

To understand students' needs and readiness, I use an online survey about virtual education and the available technology tools to evaluate the number of students who have the needed technologies to study online and those who don't have laptops or cameras to connect to the virtual classroom. I connect the students in need with university offices that support the students by offering grants to buy laptops and other technologies. This ensures that the students are ready to participate in the virtual classes. During the first week of the semester students are asked to watch videos and view training resources to prepare them to use virtual classroom technologies.

2. Offer the opportunity for students to socialize with their peers

In virtual classes, students don't have the chance to meet, socialize, and talk to each other before or after the class. To encourage the students to socialize and talk, I open the virtual classroom 15 minutes before instruction begins, mute myself with no video, and inform the students that the non-instructional sessions are not recorded. This encourages and allows the students to socialize and create a sense of community.

3. Endeavor to meet all needs

Students have different needs; some like to work in teams, and others want to work individually. I redesigned some of the course activities to allow students to work individually or in a group to make it work for everyone. To make information more accessible to students, I record the lectures for those students who can't attend the live class so they can view the lessons later. Making my classes flexible will result in more successful students by helping support their education and avoid difficulties.

4. Develop interactive activities

Keeping students engaged in the class is vital to their success. Using pictures of a real classroom as a virtual background helps students feel that they are in an actual classroom. I use Kapwing.com, bitmoji.com, and google documents to bring the virtual classroom closer to a real classroom. Engaging students with games to review the lectures' concepts is another way to connect with them. There are many websites that helped me design my own game to engage the students. Kahoot and Socrative allow students to compete in groups against each other, and the group who responds quickly and correctly is considered the winner. Using virtual breakout rooms is a beneficial technique to ensure that students are engaged. I divide students into four or five groups to work on a discussion. At the end of the breakout session, I bring them back to the main classroom to share a summary of their results with the class. Using simulation software is another valuable engagement technique. For example, I teach control charts and the cost of quality in my quality assurance course. After practicing the concepts in a lecture, students use a simulation case study from Harvard Business to construct charts and calculate the cost of quality.

5. Weekly theme for camera face time

I encourage students to turn their cameras on because they will dedicate their time to focus on the class and the knowledge that is shared. However, requiring them turn their cameras on is a challenge, and not everybody likes to do so. To entice students to use their cameras, I hide items in my background and ask the students to find them for an award. Another practice is using a weekly theme that is based on holidays and seasons. For example, in the Halloween season, I encourage my students to virtually share their Halloween customs with others. They love it! Other ideas are to ask students to show their pets or share a picture of their favorite food or cultural activity.

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Teaching Practices in the Age of a Pandemic *(continued)*

6. Support students through office hours, review sessions, and answering questions

Offering support is key to student success. I encourage students to attend my virtual office hours to review some of the difficult, challenging topics. Because some students are shy to ask questions in front of the class, I give them the opportunity to ask questions after class, staying in my virtual lecture for an additional 10 to 15 minutes after class to answer any questions students may have. I encourage them to use private chat during class if they do not want to speak or use the public chat. Another practice is to make an online review session to go over the concepts and provide them with practice questions to prepare for the exam. These sessions are recorded for other students who could not attend the review sessions.

In conclusion, this is a challenging time for everyone, and I encourage my colleagues and students to be patient during this difficult time. Patience and effective communication are two critical practices that we all need to ensure students' success.

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CALCULATING RETURN ON INVESTMENT FOR CONTINUOUS IMPROVEMENT ACTIVITIES: A MODEL AND A CASE STUDY

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ABSTRACT

Calculating the Rate on Investment (ROI) could be a challenge in an ever-changing environment. There is no existing model in the literature studies that measure the financial effectiveness of continuous improvement (CI) activities. This research aims to explain a framework model to link financial measures with performance measures. The model can be used to determine the financial impact of continuous improvement (CI) activities. By following the proposed framework, managers can calculate return on investment (ROI) of CI activities. This paper highlighted the equations and parameters that are needed to conduct the analysis process. The proposed framework is tested using a real case study from the bearing industry to demonstrate its usefulness. It is proven that this framework is useful for organizations to support their CI efforts and to evaluate their achievements.

Key words: Rate of Investment, Continuous Improvement.

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1. INTRODUCTION

Organizations improve their performance by using several strategies such as train their employees to gain new skills, maintain their current equipment, buy new machines, move to a bigger facility, improve documentation process, invest in digital marketing, reduce non-value added activities, and many others. These continues improvement (CI) efforts require from management spending money to achieve the desired goals and with a hope of bringing this money back through enhancing quality, improving market reputation, and increase customer satisfaction of their products or services.

Knowing whether management should invest in future CI initiatives could be a challenge due to the difficulty of tracking the financial aspects of new initiatives. One of the financial analysis that managers make decisions based on is the return on investment (ROI). Therefore,

this research provides a roadmap for managers to be able to link performance measures with financial factors. A framework model has been developed along with tools to measure the ROI for CI initiatives. The framework model consists of several strategies to help managers answer two questions: “which CI activity should we invest in?” “which CI activity will yield a higher ROI rate?”

2. RESEARCH GAP

In spite of the efforts stated in the literature review, the relationships of KPIs for CI activities and financial factors are still not understood. There is no generic model found in the literature to measure the financial effectiveness of CI activities. Therefore, this study could be the solution that will overcome the shortcomings and close the gap in the previous studies in the field of financial performance. This paper is intended to contribute to this end by developing a model to connect CI activities with KPIs and then convert these KPIs into financial factors to calculate the ROI.

3. LITERATURE REVIEW

Previous studies investigated and summarized to provide an overview of the efforts that have been done in this field. First, it is discussed continuous improvement using Deming Cycle, then, followed by performance management. Then, section included on the Key Performance Indicators (KPIs), followed by business strategy and connecting it to organizations activities.

3.1 Continuous Improvement

The American Society for Quality (ASQ) defines continuous improvement as “the ongoing improvement of products, services or processes through incremental and breakthrough improvements” (ASQ, 2020). Most management use the “incremental” improvement over time to avoid any resistance to change from employees. However, some management strategies use “breakthrough” improvement all at once to rebuild their brands or establish new era for the company. Managers should assess their environment before making a decision on which approach should be used in their organizations.

Continuous improvement can be implemented by considering several techniques. One common practice is using Deming Cycle the plan-do-check-act (PDCA) to implement improvements in a process. This is a cycle of incremental process improvement, can benefit organizations of being more efficient and achieve their goals. The PDCA cycle is a valuable tool to assess companies performance as the third phase is specified for checking on the performance progress of phase one and two: Plan and Do (Sokovic, Pavletic, & Pipan, 2010).

Most managers are interested in financial factors rather than using performance measures (Oakland J. , 2012). The financial factors cannot be used as a comprehensive and effective tool to assess unless we connect these factors with performance indicators as it is explained in this research. Hafeez et al., 2006 indicated that managers should use quantitative performance indicators (e.g. cost, time) and qualitative indicators (e.g. customer satisfaction, innovation) to accurately measure organizations achievements.

Researchers such as (Pimentel & Major, 2014); (Oakland J. S., 2003); (Neyestani & Juanzon, 2016) believe that “well-structured performance measurement process generates a proper linkage between objectives and real works”. Therefore, in order to connect CI factors to financial factors, a set of KPIs is organized and connected in a framework (e.g. model) to monitor the input and the output of a process. The proposed model consists of set of a KPIs and acts as a management tool for connecting continuous improvements with financial measures such as Return on Investment (ROI). ROI analysis compares profits to cost of investment on a project and can be calculated using this equation

ROI= Profit/ Cost of investment * 100% …… (1) (Al-Odeh, 2020)

Another strategy that contributed to this research is the balanced scorecard (BSC). BSC is developed by Kaplan and Norton (1992) and it is considered as the most practical tool to combine financial and non-financial factors together (Neyestani & Juanzon, 2017). Using the BSC can help managers to evaluate strategic objectives and performance in four areas: financial performance, customer perspectives, internal business processes, and innovation and growth (Oakland J. S., 2003); (Neyestani & Juanzon, 2017); (Talavera, 2005); (Pimentel & Major, 2014); (Parmenter, 2007); Hafeez et al., 2006; (Zizlavsky, 2014). To use BSC technique, companies should identify the most significant KPIs to achieve their strategic goals, and then connect the financial and non-financial factors.

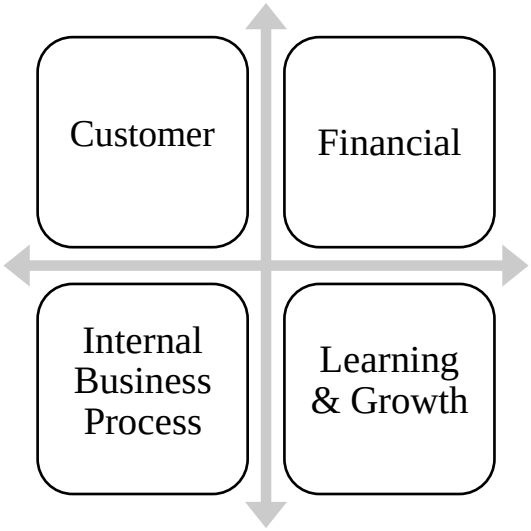


Figure 1 Balanced Scorecard (BSC)

3.2 Performance Management

Performance is the results of a company's work and it's progress in achieving organizational plans and goals (Mahmood, Qadeer, & Ahmad, 2015). According to Omachonu and Ross (2004), there is an old maxim in management that says, "If you can't measure it, you cannot manage it". Using performance management, managers can establish guidelines and policies that would enable companies to measure their progress in achieving their goals and plans.

Performance management is a strategy used by organizations to measure and maintain adherence to objectives, whether on a macro scale or down to the individual (Society for Human Resource Management, 2017). The performance of an organization can be measured using key performance indicators (KPIs) such as profitability, shareholder return, dividend rates, market-share, costs/overhead, compensation, depreciation, asset efficiency, asset utilization, inventory value trend, inventory days stock on hand, etc. The key to performance management is to prioritize plans to meet the defined goals. Figure 2 shows the relationship between performance management and continuous improvement activities at different levels in an organization. This research will focus on the KPIs of organization level not personal or employee performance level.

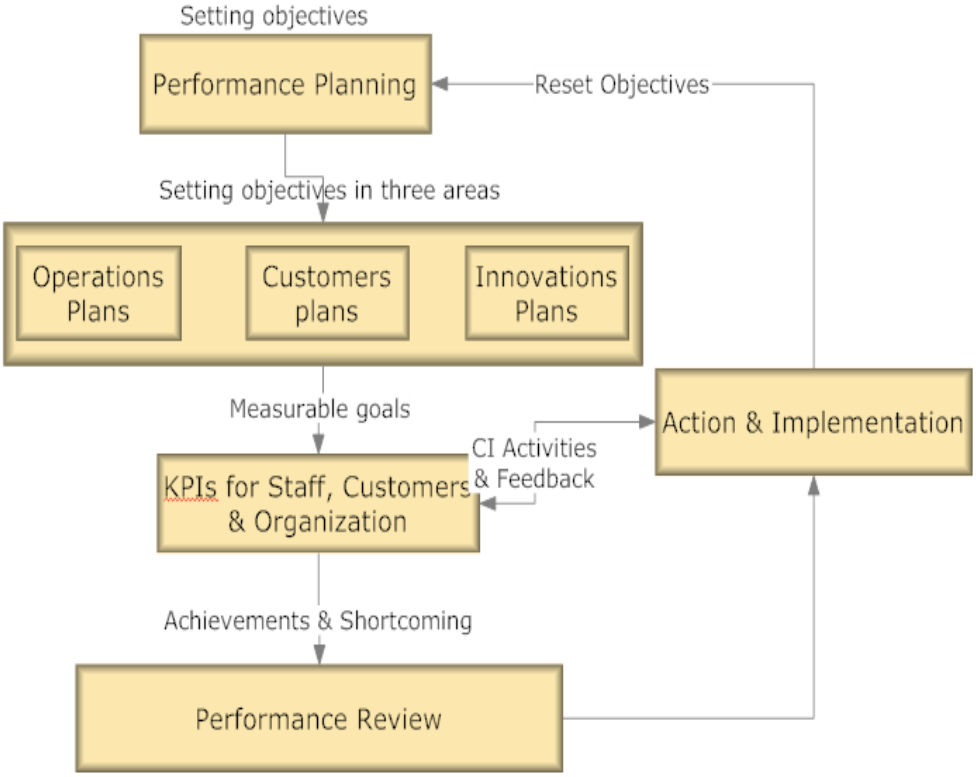


Figure 2 High-level organizational performance management

Monitoring organizations performance benefit organizations, through pointing out potential issues to be corrected at the onset, while correction is manageable. Managing and assessing performance requires data to be collected to accurately measure and improve the output over time and to reduce waste. Effective performance management ultimately leads to increased profitability, by getting more output for the same input in transactional terms. One of the factors that can be used in performance management is the return on investment (ROI). Most managers prefer to calculate ROI prior to investment. However, calculating the ROI on continues improvement activities is a challenge and not straightforward. This research will help guide managers calculate the ROI on CI activities.

3.3 Key Performance Indicators (KPIs)

KPIs are identified using several models some researchers use statistical approaches and data-based methods. For example, Rodriguez (2009) investigates the relationships of KPIs in a performance measurement system. Suwignjo, Bititci, & Carrie (2000) develop models for performance measurement systems to identify KPIs and their relationships using methodology of intellectual maps is used. Sarkis (1997) focused on investigating the relationship of productivity performance measures of flexible manufacturing systems using data analysis and cross-efficiency techniques. Other researchers e.g. (Jacobs & Meerkov, 1995), (Biller, Marin, Meerkov, & Zhang, 2010), (Meerkov & Zhang, 2011), & (Ju, Li, Xiao, Huang, & Biller, 2014) used mathematical models for productivity and quality improvement.

Kang et al. (2016) categorize KPIs based on their functions or attributes and dividing the KPIs into time and/ or quantity supporting elements. In addition, their model indicates the relationships between different levels of the KPIs.

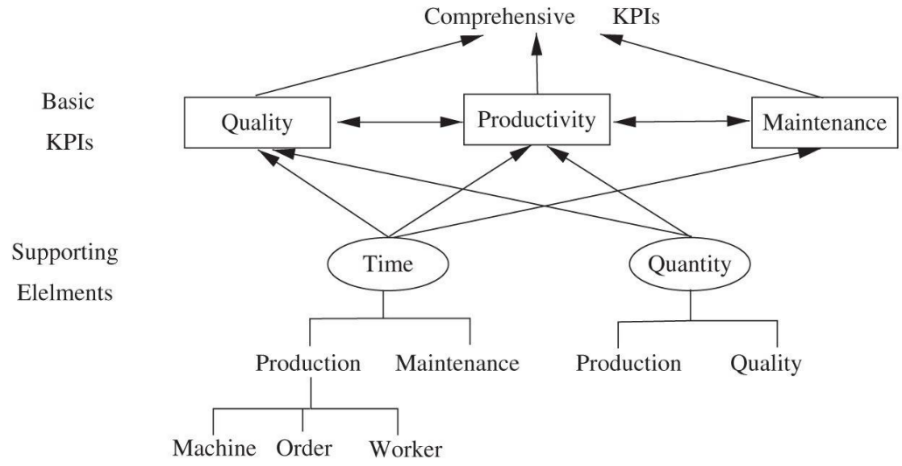


Figure 3 KPIs based on their functions or attributes Kang et al. (2016)

The author highlighted some of the important KPIs as identified in the literature review in Table 1

Table 1 KPIs from the literature review

Article	KPIs
Dingley (2020) explained the importance of knowing how production line is performing and what measurements are affecting the overall effectiveness of a company and its product. The measurements are summarized on the right.	Manufacturing cycle time, Time to make Change Overs, Throughput, Capacity utilization, Overall Equipment Effectiveness (OEE), Schedule or production attainment, Percentage planned vs emergency maintenance work orders, Availability, Yield, Customer rejects/returns, Supplier quality incoming, Customer fill rate, on-time delivery, perfect order percentage.
IQMS (2017) provided five key metrics that measure effectiveness for building medical devices. The medical device industry is very regulated to the point that they have to document how product is being built and they can not change the process without going back through the lengthy approval process. This article is focusing on more of the process of how engineering is affecting the overall quality of the process and output of the product. The five metrics that are summarized on the right.	Corrective Action/Preventative Action (CAPA) events, Engineering Change Order (ECO) Tracking, Overall Equipment Effectiveness (OEE), Perfect Order Performance, and Return Material Authorizations (RMAs), and Returns.
Williams (2017) belives that in order to evaluate business, companies can use measures that can fit into three categories: Financials, Marketing Outcomes, and Employee Performance. These measures are summarized on the right.	Financials include: Gross Profit Margin, Net Profit, Net Profit Margin, and Debt/Asset Ratio. In the Marketing Return on Advertising Spend, Customer Acquisition Cost, Time to Payback, Marketing Originated Customer Percentage. In the Employee area: Performance, Employee Efficiency, Quality of Work, and Adherence to Values

Davidson (2013) highlited the most important metrics that can be used to monitor the effectivmess of an organizton. He found 28 metrics that are organized in eight groups as summarized on the right.	Improving Customer Experience & Responsiveness, Improving Quality, Improving Efficiency, Reducing Inventory, Ensuring compliance, Reducing Maintenance, Increasing Flexibility & Innovation, and Reducing Costs & Increasing Profitability.
Research Team (2012) from LNS Research explained five quality measures that can be used by managers to better understand the effectiveness of quality practices in their organizations.	Yield, Scrap Rate, and Customer Complaints. The two that are unique are Supplier Defect Rate and Supplier Chargebacks.
Vasilev (2015) explain the importance of using a metric-driven approach of Management in Software Industry. The author utilized the mertics that are used in the manufactrung industry to serve the needs of Software Industry.	Time to accept PO for planning (TAPO), Time to schedule a PO (SPO), Planned Order duration PO (POT), Execution time (TPT) time span for execution, PO Standard Busy Time (pBT), PO Busy Time (eBT), *Process Time (PCT, BAZ)*, Delay Time (DeT, SU) Down Time (DoT, SZ), Work Order Standard Busy Time (pBT), WO Busy Time (eBT), WO Transport and Waiting Time (TT), Process Time (PCT, BAZ), WO Delay Time (DeT, SU), WO Down Time (DoT, SZ), Efficiency, Reworks, PO Allocation Degree, PO Throughput, Operational Time (OT), Planned Allocation Time (PBT), Busy Time (BT) Processing Time, Main Usage Time (PDT) SetUpTimes (DeT), Allocation Efficiency Availability, Effectiveness, Quality Rate OEE index, Reworking Ratio, Time Utilization, Standard Time Utilization

3.4 Implementing Business Strategy

Business strategy is formulated at the highest levels of an organization to serve as a guide for the direction of all elements of the organization. With defined specific, measurable, attainable goals, tasks can be executed to achieve these goals. For the purpose of this research, the researcher defines the process for developing performance metrics following three steps:

- Understand the business strategy
- Define organizational goals
- Align the organization through annual objectives.

This process is demonstrated in Figure 4. The leap from step 2 to step 3 is the key to meeting the goals.

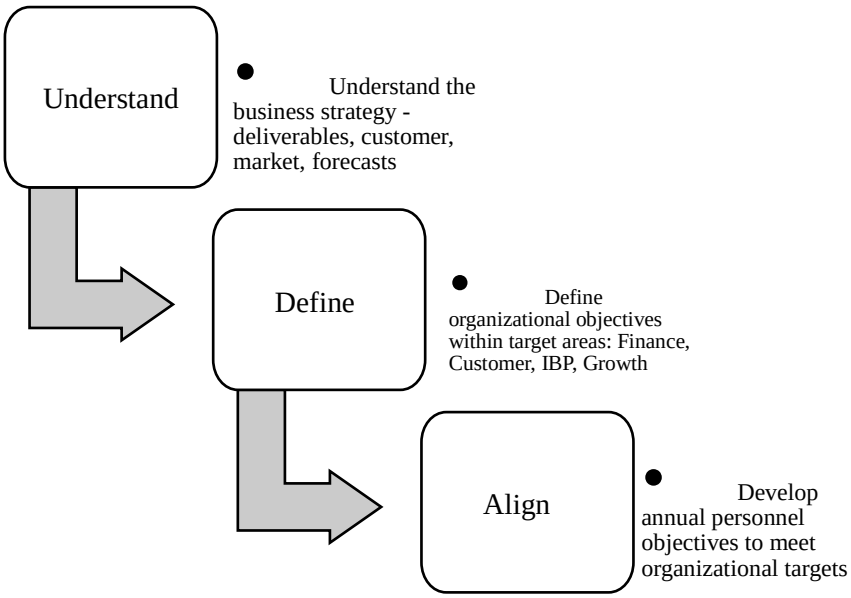


Figure 4 Development of performance metrics

Effective strategic operations planning must continually and systematically perform the following two tasks for continuous improvement:

- Re-evaluate the current strategies, objectives, action plans and performance measurements, and examine how well they are reflected in the company's overall strategic plan.
- Develop new or modified objectives, action plans and performance measurements that are well-connected to the overall strategic plan.

Like any continuous improvement efforts, effective operational strategy planning must always be asking:

- "Where do we want and need to go?" and,
- "How are we going to get there?"

Once these questions are defined, managers should connect business strategy with operations strategy to form a competitive strategy with four essential components and tactical actions:

- Strategic goals: which are brief statements of what top management wants to achieve in terms of growth, products, markets, and profits.
- Improvement objectives: which are specific and measurable performance improvements set within certain timeframes and tied to specific strategic goals.
- Action plans: which translate objectives into a specific set of steps, responsibilities, schedules and cross-functional teams for implementing the plans to achieve the objectives.
- Performance measures: providing quantitative means of reviewing, evaluating and updating actions, improvement objectives, strategic goals, and process performance.

These four components help managers to formulate objectives and action plans that mesh with strategic goals and to continually measure and evaluate process performance results. Then, these measures should be connected to financial factors to calculate the ROI for CI activities. If a strategic plan is not translated and executed in this way, a company misses the

opportunity to focus its entire organization on specific objectives and actions and to develop common values and beliefs.

To begin a performance management program, organizational goals should be translated into measurable objectives across the organization. The Balanced Scorecard approach to organizational performance management suggests four areas of performance requirements as explained in Figure 1: customer, financial, internal business process, learning and growth (Ferreira & Otley, 2009). Organizational goals and objectives should be set to align with the four core areas of performance. In this way, the performance requirements will be aligned to the business strategy. Figure 4 illustrates the alignment relationship between Performance planning, setting objectives, and measuring goals.

4. THE PROPOSED MODEL

In order to connect CI activities with financial activities, managers should identify the improvement initiatives in three areas: Operations, Customers, and Innovations. These areas are recognized as the most critical areas in any organization and these contribute to the financial capability of a company. Measuring the financial effectiveness, managers need to study the factors in these areas and their financial impact. The plan below shows the connections between the strategic plan with one financial factor: Return on investment (ROI).

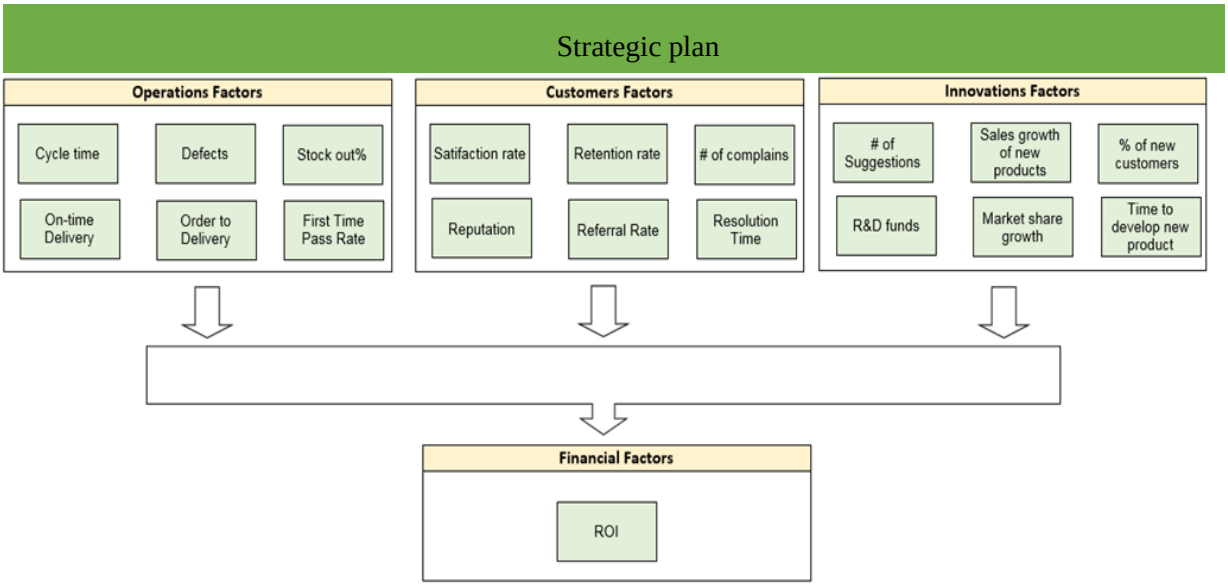


Figure 5 Model to connect strategy with financial factor

Managers can follow these steps to be able to connect the strategic plan for the financial factors and calculate the ROI.

Step 1: Identify 3-5 Goals in Each Area

The first step in this strategy is to identify 3-5 goals in each area. Answer the following questions:

- What are the three-five goals that we need to work on this year?
- What is the current measure and future target for each goal?
- How we could measure this goal?
- What is the timeline needed to reach the target?

Once goals are identified, managers should think of KPIs that can be used. In the operations area, the following PKIs can be used: cycle time, Defects, stock out%, On-time delivery, Order to delivery, and first-time pass rate. The following can be used as customers factors: satisfaction rate, retention rate, # of complains, Reputation, referral rate, and resolution time. The innovations factors are #of suggestions, Sales growth of new product, % of new customers, R&D funds, market share growth, and time to develop new product. Defining any measure should include all the details related to the measure. The following template, Figure 6, can be used to define the measure and include all details needed.

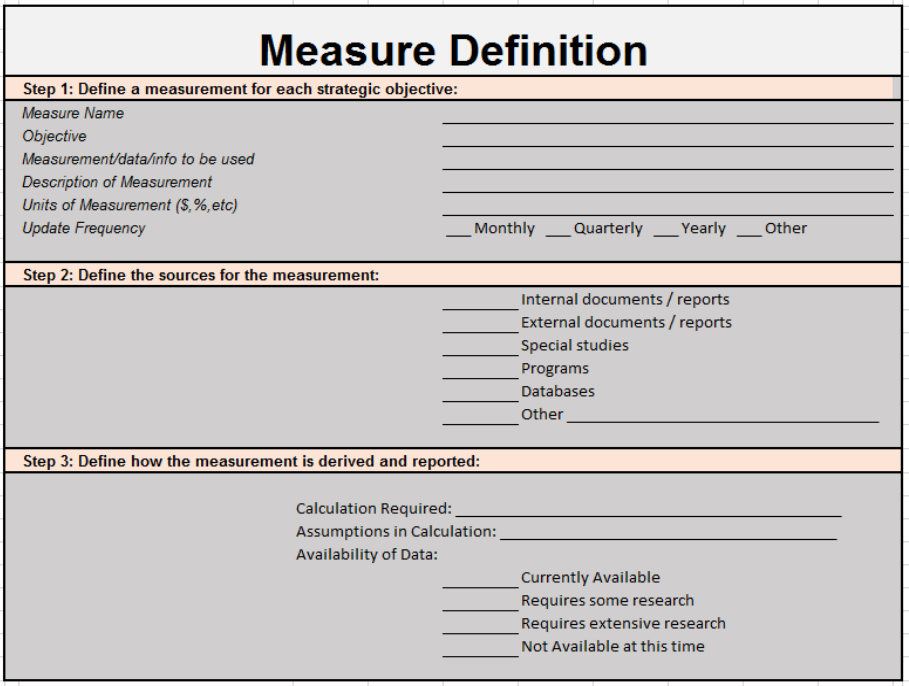


Figure 6 Template to define measures

Step 2: Track the Progress

Monitor the progress for each measure is important to achieve the desired goal. There are several techniques that can be used to track the progress of implementing CI activities. Gantt chart, Figure 7, can be used to track the timeline of the tasks to accomplish these tasks on time.

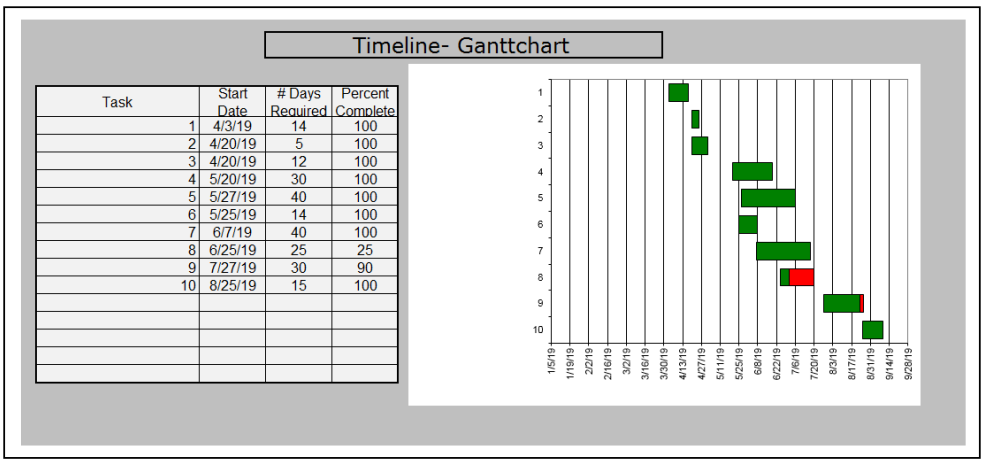


Figure 7 Gantt chart to keep track of goals progress

Also, scorecard dashboard is a technique that utilizes visual management and compare the results with the targets. In figure 8, the color scheme that is used: Green to show that the results of these efforts have been achieved, Yellow color indicate the team are missing the target but within a sight. The red color to indicate that the team is missing target by substantial margin.

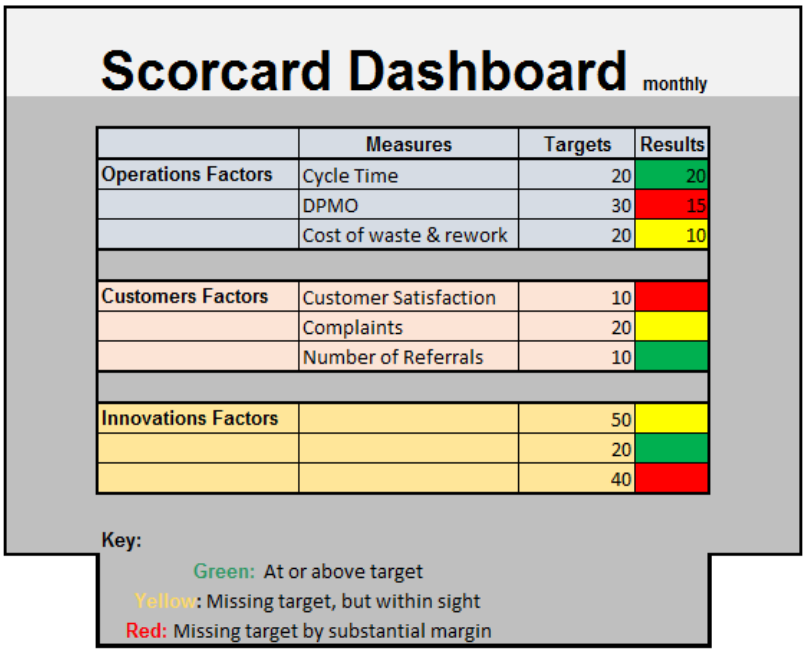
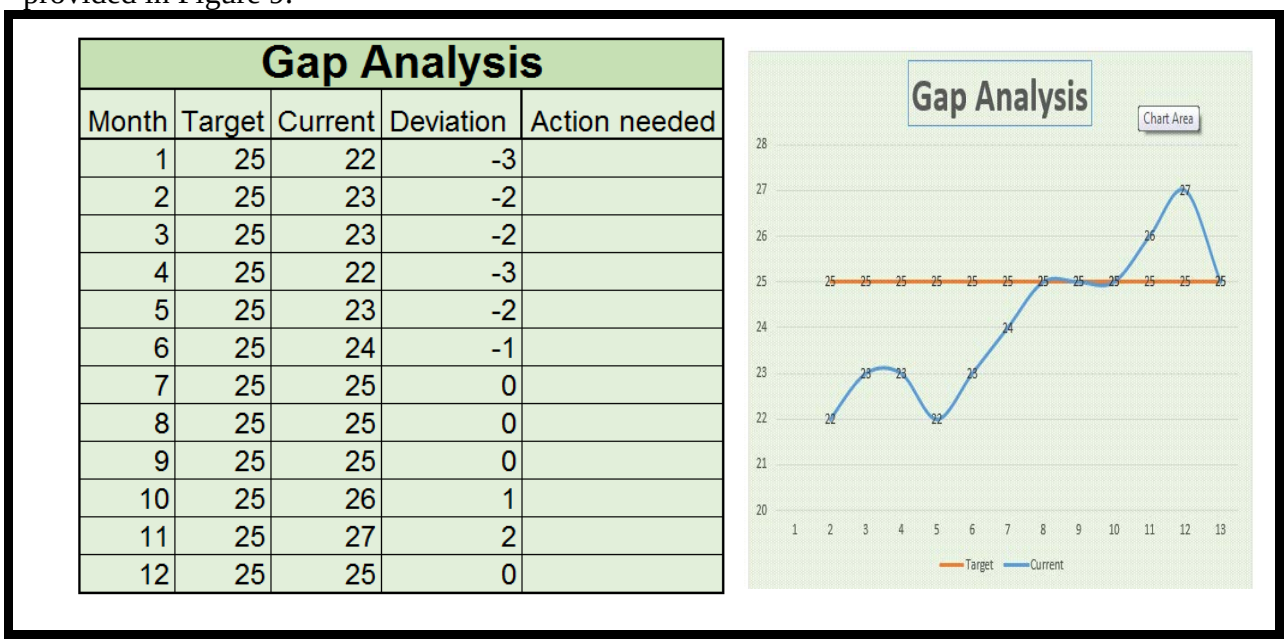


Figure 8 Compare results with the targets using dashboard

Step 3: Gap Analysis

Gap analysis techniques can be utilized to provide graphical data visualization and to indicate correction and actions needed to get back on track and to achieve the target. Example is provided in Figure 9.



Gap Analysis

Month	Target	Current	Deviation	Action needed
1	25	22	-3	
2	25	23	-2	
3	25	23	-2	
4	25	22	-3	
5	25	23	-2	
6	25	24	-1	
7	25	25	0	
8	25	25	0	
9	25	25	0	
10	25	26	1	
11	25	27	2	
12	25	25	0	

Figure 9 Gap Analysis and list of actions needed to achieve goals

Step 4: Calculate the Savings Due To Ci Activities

Once CI activities implemented, managers can calculate the savings. Managers can look into improvement in the KPIs that are used and then look at the KPIs in terms of time, cost of material, labor cost, impact of the new process, and then managers can find total cost/savings. For example, in the operations factors, a manger may select defect, cycle time, and stock out as KPIs to measure the improvements. Figure 10 shows an example of a scorecard with four sections: A,B,C, and D to help managers track the ROI for improvement initiatives.

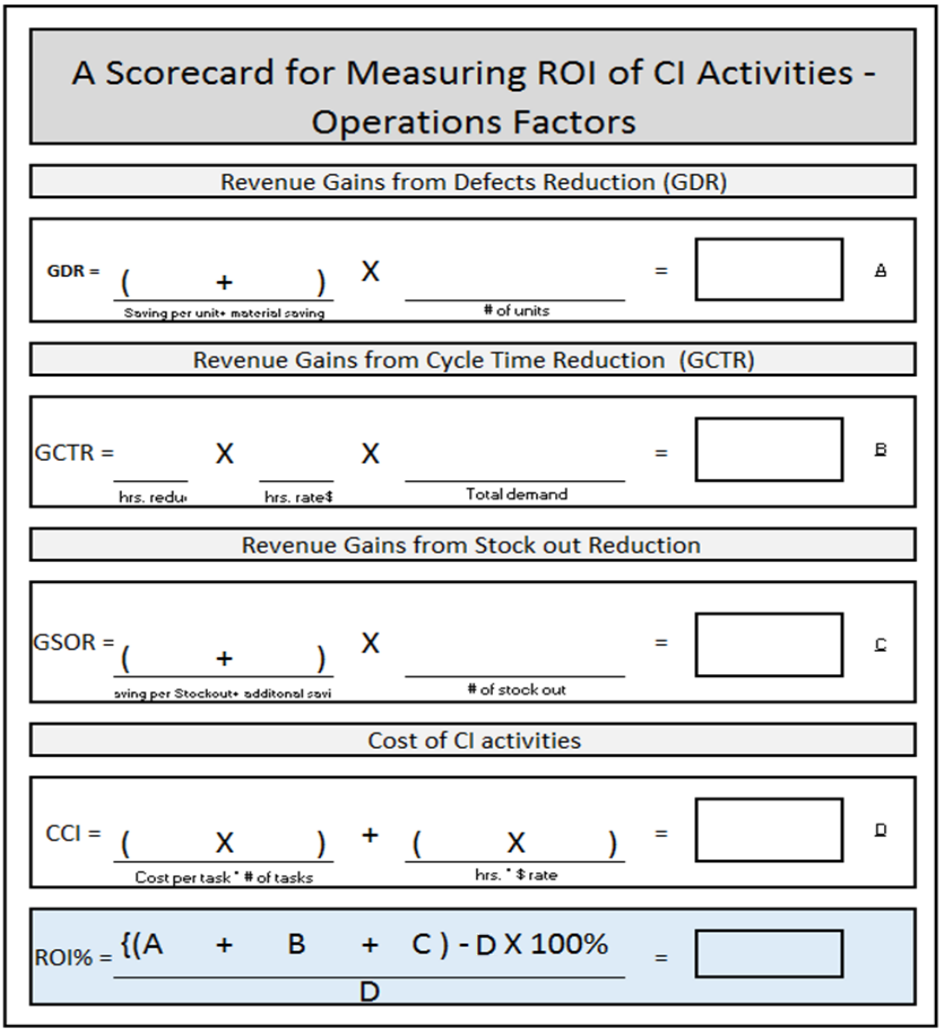


Figure 10 Measure the ROI of CI activities using scorecard

Step 5: Calculating the Saving Due To Reducing Defects Rate

In order to calculate the saving from reducing defects after implementing continuous improvement (CI) activities, managers should list all tasks that are affected by the improvement and estimate time reduction per item due to not working on correcting the items in each tasks. Then, these savings can be multiplied by the labor hourly cost to find the total saving for the task and then adding all these savings to find the total saving due to reducing defects rate. For example, implementing new technique (e.g. 5S) would help an organization to reduce the cleaning time by one hour for each item produced. If it is assumed that the labor cost is $25 and yearly demand is 160 unit, the total saving in this activity is $25*160 unit/ year *1 hour= $ 4000 per year. Figure 11 shows example of activities that can considered when calculating the savings due to reducing defects.

Saving due Defects Reduction						
Description: (Grinding Variation based on 160 units)						
Specific Tasks	Hours for Task	Hourly Rate	Cost of Task	Material Costs	# of units	Total Cost o
Document Nonconformance Report	0.5	$25	$12.50	$0.00	160.00	$2,000.00
Engineering Disposition	0.5	$45	$22.50	$0.00	160.00	$3,600.00
Grinding	0.3	$25	$6.25	$2.00	160.00	$1,320.00
Cleaning	1.0	$25	$25.00	$0.00	160.00	$4,000.00
Inspection	0.5	$25	$12.50	$0.00	160.00	$2,000.00
Total Saving	2.80		$78.75	$2.00		**$12,920.00**

Figure 11 Calculate savings due to defects reduction

Step 6: Calculating the Saving Due To Reduction In Cycle Time

The total saving due to improving the cycle time of a process can be simply calculated by finding the time reduction per unit after implementing the CI and then multiply the time by the number of units (or the yearly demand) by labor cost/ hour. For example, if a company implemented lean and VSM technique and was able to reduce the cycle time from 568.05 min to 517.6 min. This would result in reduction by 0.841 hour per item. The total saving for 160 unit (the yearly demand) would be 0.841*$25*160= $3,364. Figure 12 shows the total savings.

Saving due to Cycle Time Reduction					
Description: (Cycle Time based on 160 units demand)					
Specific Tasks	Hours for Task	Hourly Rate	Cost of Task	# of units	Total savings
Cycle Time Saving (568.05 min-517.6 min	0.8408	$25	$21.02	160.00	$3,363.33
Total Saving	0.84		$21.02	160.00	**$3,363.33**

Figure 12 Calculate savings in cycle time reduction

Step 7: Calculating the Saving Due To Reducing Stock out Rate

Calculating the savings in this area requires the monetary values for four parameters: backordering, cancelled orders, losing customers, and discount value. The backordering is the inability to fulfil the market demand and customers orders. Having this issue will require time to communicate with the customers and reschedule their orders. This issue can be reduced by using an advanced prediction software to give a company more accurate to estimate future demands. The saving can be calculated by estimating the time reduced per order by the labor hourly cost by number of orders per year. For example, if a company had 10 backorders per year and each order will take the employee 9 min to be corrected and rescheduled and the hourly rate for the employee is $25/ hour. The total saving would be $25*0.15*10= $37.5 per year.

The second parameter is cancelled orders, which there are some costs associated to it and it would require some labor work to get the orders canceled and rebalance the current inventories. The savings that can be gained from implementing CI in this area would be calculated by multiplying labor time required to work on one cancelled order by the labor cost by the number of cancelled orders. For example, if a company had 10 cancelled orders per year and each order requires 9 min to be cancelled by an employee in the company, the total saving, assuming the labor cost is $25, the cost would be 0.15*$25*10= $37.5 per year.

The third parameter is the cost of losing customers. This should be estimated by the company, assuming losing one customer will cost $50, the cost for losing 5 customers per year is $50*5=$250 per year.

The last factor is cost for discounts that are given to the customer if they did not get their orders in time. Discount is determined by the company and included on their internal policies. Also, the time needed to process this discount should be considered. If a company gives $50 discount on delayed orders and will take 9 min to process the discount, the savings would be time needed to process the discount for one item times the labor cost times the number of discounts plus the number of discount times the total discount per order. If the company used to process 7 discounts for 5 customers but after implementing the CI solution this number reduced to 2 discounts for 2 customers, the savings would be 0.15*5*$25+5*$50= $268.75 per year. Figure 13 provides examples of these four parameters and the savings.

Saving due to Stock out Reduction

Description: (Stock out based on 10 stock out)

Specific Tasks	Hours for Task	Hourly Rate	Cost of Task	Additional Costs	# of units	Total Cost
Back Ordering	0.15	$20	$3.00	$0.00	10.00	$30.00
Cancelled Orders	0.15	$20	$3.00	$0.00	10.00	$30.00
Losing a Customer				$150.00	5.00	$750.00
Discount Customer agrees to wait	0.15	$25	$3.75	$50.00	5.00	$268.75
Total Saving	0.45		$9.75	$200.00		**$1,078.75**

Figure 13 Calculate savings due to stock out reduction

Step 8: Calculate the Cost of Ci Activities

Four factors should be considered to calculate the cost of the CI activities. These are: training cost, new equipment and installation costs, documentations for the new process, and labor time spent during the training. The cost of training considering the fees that are charged by the companies offered the training. For example, if a company charged $550 per training per employee, the cost for training 50 employees is 50*$550= $27,500.00.

The second parameter is the cost of installing new tool or equipment. For example, a company would like to improve their productivity by buying new machine with a cost of $75,000. The next parameter is the time required to document the new changes. This can be estimated by multiplying time needed to write new instructions by the hourly cost. For example, documenting the new process would require one employee for one week. The cost would be 5 days* 8 hours * $20= $800

The time spent during the training should be considered as companies still have to pay for their employees during training sessions. For example, if a 5-day lean six sigma training offered in a company, the cost for labor time would be 5 days * 8 hours/ day * $20= $800/ employee. If there are 50 employees attended the training, the cost would be 50*800=$40,000.

The total cost for the CI activities= training cost+ installing new tools costs + documentations costs+ labor time

Total cost for the CI activities in the example above= 27,500+75,000+800+40,000 = $143,300. Figure 14 shows example of four costs as related to CI.

Cost of CI activities

Description: (Cost of CI activity)

Specific Tasks	Hours for Task	Hourly Rate	Cost of Task	# of units	Total savings
Training			$550.00	50.00	$27,500.00
Equipment			$75,000.00	1.00	$75,000.00
Documentations	160.0	$20	$3,200.00	2.00	$6,400.00
Other					
Total Cost	160.00		$78,750.00	53.00	**$108,900.00**

Figure 14 Calculate the total cost of CI activities

Step 9: Calculate the Roi

After preparing the numbers in the sections above, now ROI can be calculated by the following equation:

ROI %= (Total gains - Cost of CI Investment)*100%/Cost of CI Investment

Figure 15 shows an example for calculating the ROI for CI activities.

ROI for CI					
Description: (ROI)					
Specific Tasks					**Total savings**
Total cost					$108,900.00
Total Saving					$117,362.08
ROI% = Total Gains- Cost of CI Investment)*100%/Cost of CI Investment					7.77%

Figure 15 Calculate ROI of CI activities

5. CASE STUDY: ROI IN THE BEARING INDUSTRY

5.1 Overview

In order to verify the model, the model is applied in a real case study from a local small manufacturing company. This case study is used to apply and demonstrate the process of calculating the return on investment for continues improvement activity. Mahi is a small manufacturing company located in the USA specialized with producing UC208 bearing. The management of the company developed three goals to be achieved over the next 3 years: improving customer satisfactions, improve availability of bearing UC208, and reducing defects. The management found these goals can be monitored using three KPIs: cycle time, % of defects, and % of stock out. In order to achieve these goals, the company decided to offer lean training to five of their employees with a focus on using the value stream mapping tool.

5.2 Demand and part information

The following information is the details used to conduct the study.

Demand = 100 units per year

Stock out = 9 per year

Discount for late shipments = $50 discount

Defects = 7 per year

1-day lean training = $350/ employee for 5 employees.

Average labor cost = $20 / hour

1 shift = 12 hours

Dimensions

Inner diameter (d): 40mm

Outer diameter (D): 80mm

Thinkness (B): 49.2mm

s: 19 mm

C: 21mm

5.3 Improvement inititives

After the training, the team were able to develop current and future value stream map. They implemented several improvement techniques include using buffer, supermarket, buying a second annealing machine (this is the bottelneck in the process), and combining activities togather in one cell (e.g.bar cutting, upsetting, and piercing combined in one cell). These improvements helped the team reduce the lead time from 25.64 days to 21.57 days. Also, the stock out reduced to 2 per year and the defects reduced to 1 defected part per year. The improvements for the before and after are explained in the value stream maps Figure 14 & Figure 15.

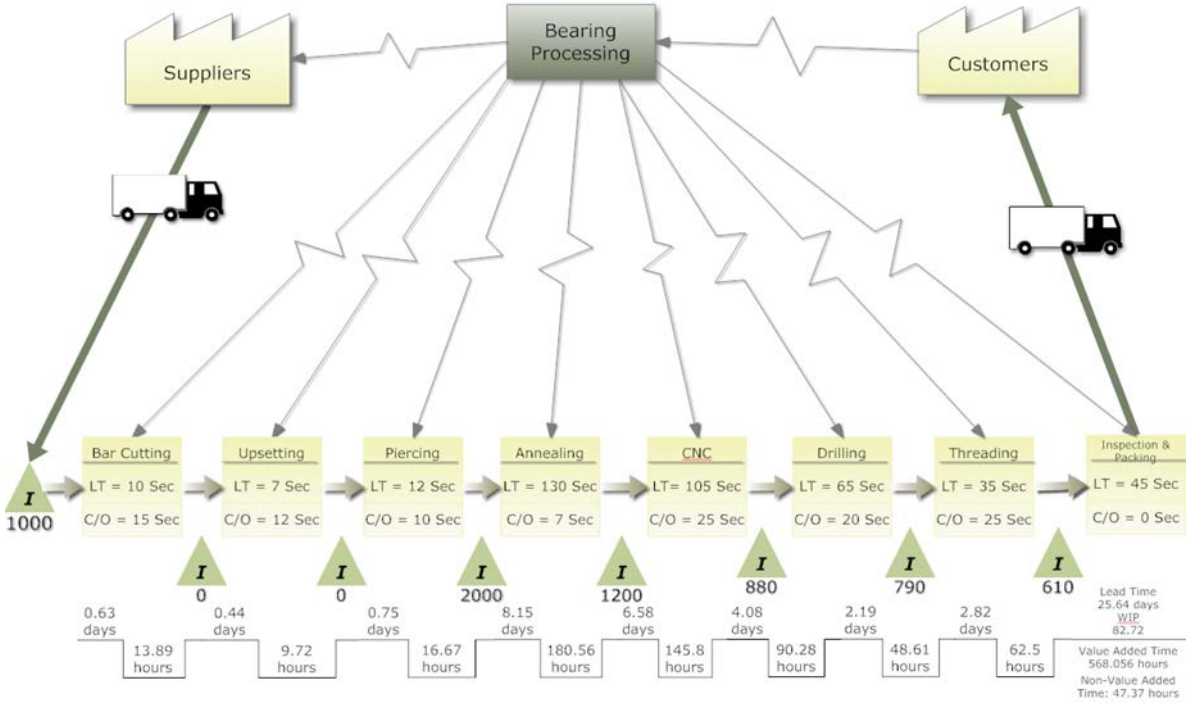


Figure 16 Value Stream Map – Before implementing the improvement

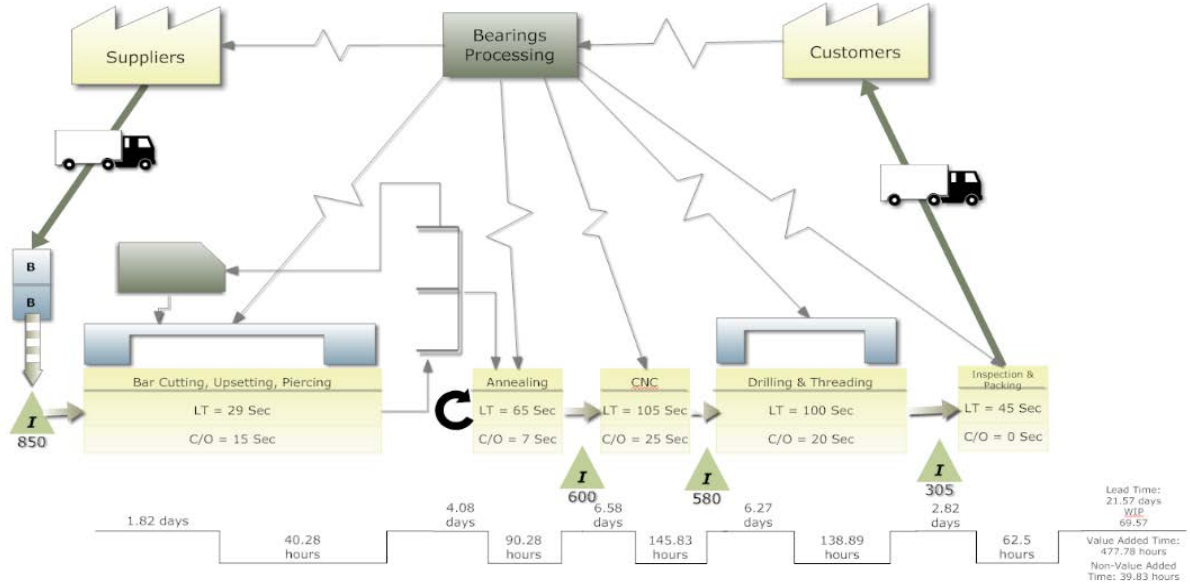


Figure 17 Value Stream Map – After implementing the improvement

5.4 Calculating the ROI for CI

The process for calculating the ROI as the following:

A. Calculating the Revenue Gains from Defects Reduction (GDR) :

The team reduced the defects by 18 units over the three years plan.

The raw material cost is $ 0.36 / unit. This would be $6.48 saving in material.

The savings in labor cost is calculated by finding that each part will need 423 seconds (7.05 minutes) to be reworked. This will be equivalent to $42.3. The total savings from defects reduction is $48.78 over three-year period.

B. Calculating the Revenue Gains from Cycle Time Reduction (GCTR):

The new process resulted in reducing the production time. The lead-time reduced from 25.64 days to 21.57 days for a lot size of 100 units. This equal to 4.07 days or 48.84 hours. The total savings is:

48.84 hours/ lot *$20/ hour*3 lots= $2,930.4 in three years.

C. Calculating the Revenue Gains from Stock out Reduction:

After implementing the new changes, the team now more able to meet the market demand. The stock out reduced from 9 to 2 units per year. It is estmated that stock out will cost the company $100 per unit and additional $50 will be given to the customer as discount on their next order. Since the ordering process is computerized, it is assumed that there is no additional labor time required to process stock out and back orders. Over three-year period, the saving calculated as the following:

($100+$50)* 21 units= $3,150

All the cost savings and gains are calculated in points above: A, B, & C. The next step is to calculate the costs of the CI activities. In this case, the company has two main improvement activities: the training cost and the cost of buying new annealing machine.

D. Calculating the cost of CI activities:

The training costs the company $350 per employee for 5 team leaders in addition to that cost labor cost should be included as this is a payed training. The cost for the training can be calculated as:

$350*5 employee + 1 days *12 hours *5 employees *$20 / hour= $2,950.

The cost of buying new annealing machine of $2,880 should be considered.

The total cost for CI activities= $2,950+$2,880 = $5,830

Now, the ROI can be calculated using the following equation:

ROI%= (Total cost gains – CI activities Cost)/ CI activities Cost

ROI%= {($48.78+$2,930.4+$3,150)- $5,830}/$5,830 = 0.04988 = 4.988%

5.5 Case Study Results

For this study, it is found that investing in the CI activities (e.g. 1-day lean training and buying new annealing machine) is economically justified and managers can achieve their desired goals and return their money at rate of 4.98% over three-year period. Managers should look for other opportunities that their company could invest in for the future.

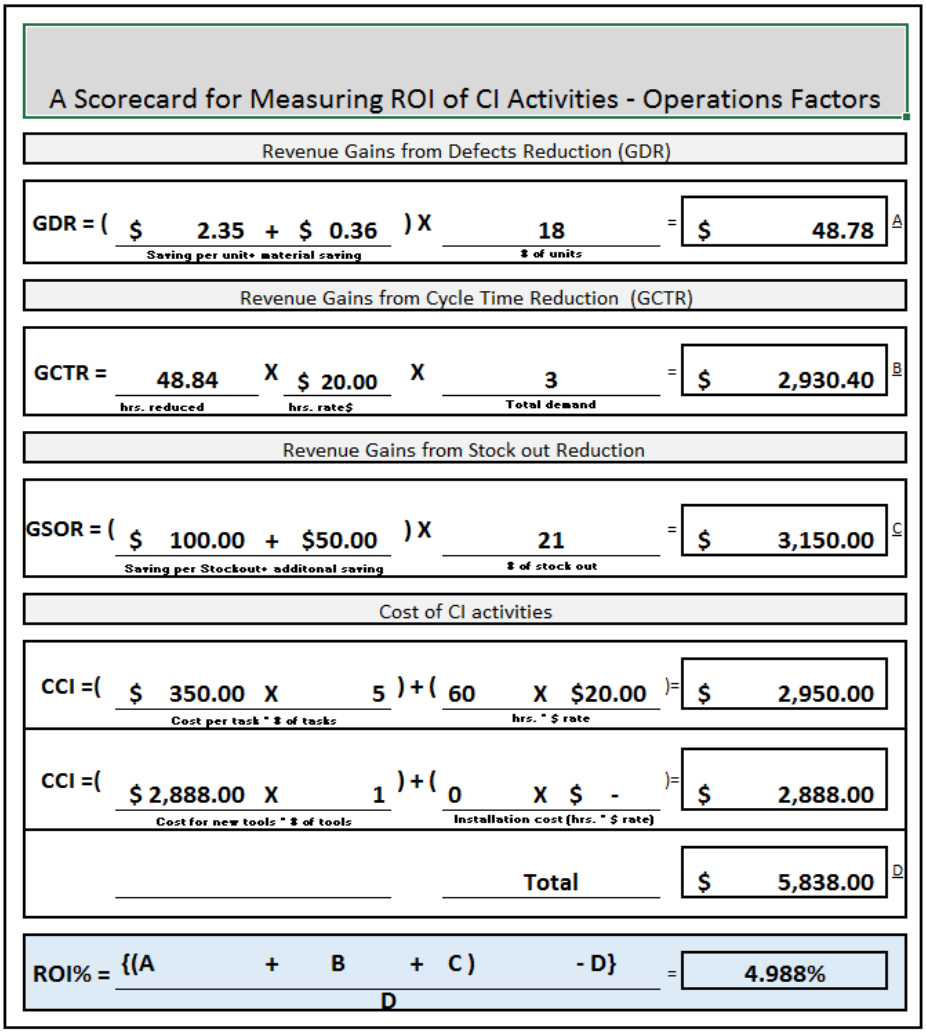


Figure 18 ROI of CI

6. CONCLUSION AND RECOMMENDATION

ROI tools is a valuable technique to show the economic impact of continuous improvement. In order to calculate ROI for CI activities, managers need focus on 3-5 goals in one of the following areas: Operations, Customers, & innovations. Managers should identify the KPIs that will help in monitoring their performance. Then, they should develop a plan and timeline. Gap analysis can be used to check if they reached the target. Last, find the ROI using the scorecard strategy explained in this paper. The model has been implemented in real industry example, which managers were able to calculate the ROI for the improvement activities that have implemented. It is recommended to apply the model at a real-life example from the service industry to verify its applicability.

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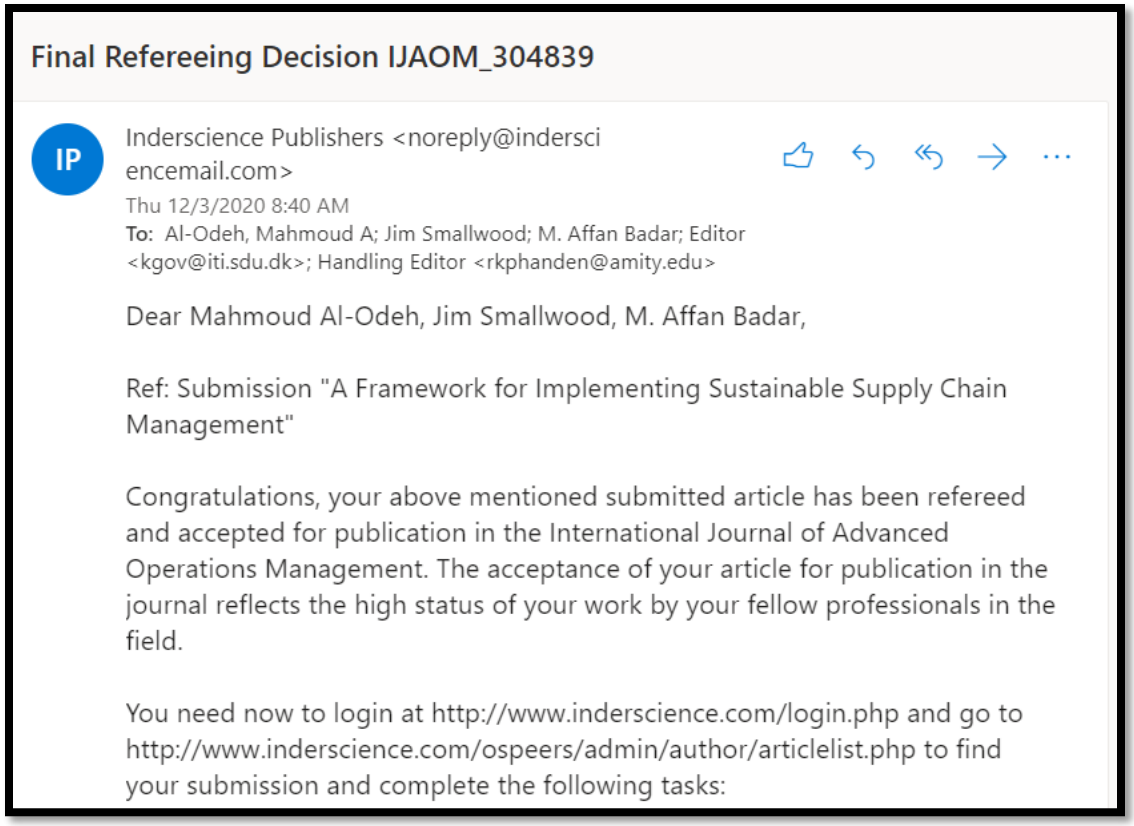

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A Framework for Implementing Sustainable Supply Chain Management

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Abstract

Considering environment friendly practices in a supply chain management (SCM) is known as Sustainable Supply Chain Management (SSCM). SSCM is an important strategy not only to reduce the harm on the environment but also it supports organizations in becoming more efficient and this impacts their overall performance. This article provides a framework strategy to help managers apply SSCM to their organizations and partners. The methodology employed in this study is based on the literature search and on the current status, best practices, and needs of regional large, medium and small manufacturing companies regarding SSCM. For the first part of the methodology, a brief background of the SSCM practices and strategies from the literature has been presented. For the second part, companies located in and around the city of Terre Haute, Indiana, USA were visited to observe their sustainable initiatives as well as employees responsible for supply chain management were interviewed. The companies included large size companies: company S (950 employees) and company B (710 employees); medium size companies: company T (425 employees) and company TKP (439 employees); and small size companies: Company J (250 employees), Company CG (165 employees) and Company Tr (135 employees). As a result of the literature survey and the observations and interviews of the

companies, a framework has been developed for SSCM implementation. The practical implication of this research is that this framework can be used in any manufacturing company regardless of their size with some adjustment due to the regional consideration.

Keywords: Supply Chain, Sustainability, Operations Management, Trends, Framework, Industry Practices

1. Introduction

A supply chain integrates, coordinates, and controls the flow of goods, materials, and information from a supplier to a manufacturing company, and to the final consumer sometimes through a distributor/retailer in between (Badar et al., 2013). Therefore, supply chain involves activities like buying, making, moving, and selling (Emmett, 2005). Supply chain activities begin with a customer order and end when a satisfied customer who has paid for the purchase (Chopra & Meindl, 2004) (Al-Odeh, 2016). An effective supply chain management maintains satisfied customers in addition to constant growth in the company market share and revenue (Badar et al., 2013).

With the public becoming more aware of environmental issues and climate change, consumers have begun asking more questions about the products they purchase in terms of their effect on the environment. Entrepreneurship for sustainable development is a multilevel phenomenon connecting social, environmental and economic dimensions between entrepreneurial processes, market transformations, as well as large-scale societal developments. While previous articles on social, environmental, and sustainable entrepreneurship have advanced our understanding on processes of discovery, creation, and exploitation of sustainability-oriented opportunities, the links between contextual influences on venture development and transformational outcomes at multiple levels are only partially captured in extant frameworks. Drawing out causal mechanisms with a systematic review, this article proposes a multilevel framework for linking mechanisms in existing literature and proposing future research on entrepreneurship for sustainable development

In this regard, the concept of Sustainable Supply Chain Management (SSCM) is an effective way to provide customers what they need: a product that has the smallest carbon footprint. Some SSCM practices require limited investment, are low risk, and offer short term return on investment periods allowing almost any business to engage in these activities. Despite these benefits, the number of businesses that engage in such activities is still low (Supply Chain and Logistics Association of Canada, 2015). SSCM is the environmentally friendly adaptation of the typical SCM, which is the movement of

materials from the source (raw material) through the manufacturing process, and ending in the customer's hands. The environment concerns that are considered for SCM activities are: rising fuel and energy prices, increasing concern over carbon emissions, resource scarcity, climate change, and waste generation. By reducing these concerns, organizations may advertise their products as more sustainable than their competition. SSCM practices can help organizations keep costs down by producing less waste and having a more efficient production process.

Koberg & Longoni (2019) have reviewed articles related to SSCM in companies with global supply chains. They have identified configurations and governance mechanisms as main elements that can improve sustainability outcomes in their supply chains. Saeed & Kersten (2019) listed drivers that can help organizations to implement SSCM in their supply chains. Narimissa, Kangarani-Farahani, & Molla-Alizadeh-Zavardehi (2020) have presented a conceptual framework summarizing key drivers and barriers to improve sustainability in Iranian oil companies. Jilani, Ali, & Khan (2018) studied how to make humanitarian supply chain, particularly logistics, due to natural disaster, sustainable to decrease carbon emissions. They proposed that reduction in the vehicle load volume would result in less damage to the environment. Sheel, Singh, & Nath (in press) have described main issues concerning supply chains of biodiesel in India. Samizadeh, Aghagoli, & Vatankhah (2019) investigated the influence of IT integration on improving agility and integration on the performance of supply chain.

The current work is aimed to fulfill a gap in the literature review of the Supply Chain Management (SCM) field as there is no model or framework that is validated by industry and specific to the SCM field. The previous studies and literature review provided frameworks serving general purpose models that can be applied in the operations management field, but no research specifically addressed the sustainability practices in supply chain. For example, Caiado et al. (2018) and Magraner (2019) provided broad models to align Lean and Six Sigma tools with green and sustainable practices. There is also a lack of industrial practices in SSCM. For example, based on interviews with a sample of 64 out of 170 small-to-medium enterprises (SMEs), Al-Odeh & Altarazi (2019) found a high deficiency in the Green Supply Chain Management (GSCM) field and concluded that surveyed companies have minimal attention towards the environment. Shah (2020) has reported there is a gap in the GSCM practices overall and in India, in specific, therefore, 180 companies are surveyed to develop a framework that fits the chemical companies in India.

This research aims to provide a more specific framework for implementing sustainability into supply chain practices. Besides the literature search, for this study, large, medium and small manufacturing

companies located in the region of Terre Haute, Indiana, USA were visited to observe sustainable initiatives in their SCM. In addition to the visits, interviews with professionals who are responsible for supply chain management in the companies were conducted to identify the best practices in SSCM.

After the introduction section, the article has been organized as follows. The research gap has been mentioned in the introduction section. Section 2 discusses the research methodology. The methodology employs literature search and visiting local companies and interviewing employees. The literature review hasn't been covered as a stand-alone section. Instead, the literature survey has been detailed in Section 3 and Section 4 corresponding to the topic. Section 3 defines SSCM and describes various activities related to SSCM found in the literature as well as simplified and summarized by the current authors. Section 4 explains how a new framework for SSCM has been developed. Section 4.1 summarizes the findings of the literature search as well as the company visits and employee interviews. It also highlights SSCM importance and barriers, and impacts of technology on SSCM. Section 4.2 discusses the new framework proposed in this study. In other words, this is the result of the current work. Section 5 is the conclusion.

2. Research Goals and Methodology

This paper is constructed based on a combination of reviewing best practices in previously published articles and visiting companies and interviewing professionals in the field of SCM. Systematic literature review is a valuable research methodology to improve the understanding of new concepts and suggest new proposals that would help develop a future roadmap for the concept and make it more valuable (Carter & Rogers, 2008) (Meredith, 1993) (Sreedharan & Raju, 2016). This method is used to achieve the following two research objectives (RO):

- RO 1- Review definitions, activities, and practices for SSCM,
- RO 2- Suggest a strategy to help organizations and business implement SSCM.

In order to achieve these goals, the authors searched articles using two broader fields "Supply Chain Management" and "Sustainability" published in the last 20 years, between 2000 up to this year 2020. The articles were searched in databases like SCOPUS, Web of Science, ProQuest, Google Scholar, ResearchGate, and Mendeley in the areas of operations management, sustainability, green supply, purchasing management, and ethics.

The coding strategy that is used in this research has been adopted from Abbasi and Nilsson (2012) & Aarseth et al. (2017) . The authors analyzed the articles and ranked their relevancy to the research

objectives by color coding: green for relevant articles, yellow for semi-relevant articles, and red for not relevant articles. Then, articles were selected to meet each of the research objectives (Panayiotou & Stergiou, 2020) (Caiado, Dias, Mattos, Quelhas, & Filho, 2017). The initial searches resulted in a total of 69 results. Abstracts of these articles were read and categorized based on their relevancy to the research objectives. The irrelevant articles were highlighted in red and removed (30) from the list. The final list consisted of 39 relevant articles as the following: 6 books, 2 conference paper, 9 online reports from state departments and organizations, 22 peer reviewed articles. Figure 1 summarizes the research methodology.

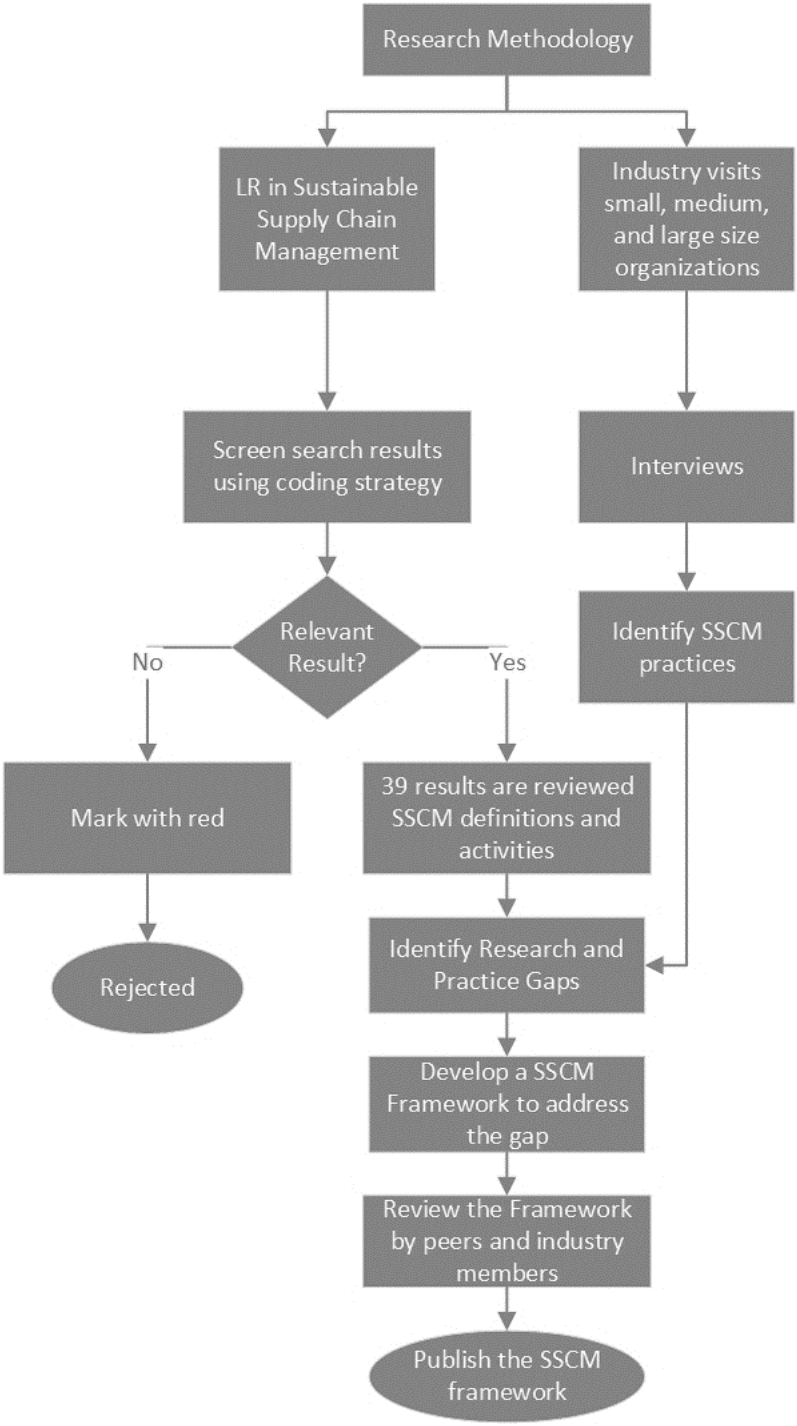

Figure 1: The Research Methodology

3. SSCM Definition and Activities

The concept SSCM can be defined as the process of managing the traditional activities of a SCM with consideration for environmental, economic, and social issues to achieve long-term goals of individuals,

communities, and organizations. This definition is the most agreed upon by multiple scholars such as (Zanjirani Farahani, Asgari, & Davarzani, 2009) (Peters, 2010) (Carter & Rogers, 2008) (Schwartz, Tapper, & Font, 2008), (Ahi & Searcy, 2013).

After reviewing the literature review, the authors simplified the SSCM activities using Fig. 2. This chart summarizes the main activities for the SSCM as it is reflected. An explanation of each activity as it is related to sustainability has been provided in the following section.

Figure 2: SSCM activities

3.1 Sustainable Design and Packaging:

In order to offer an environmentally friendly product, the first activity companies can do to implement SSCM is creating a sustainable product design. Sustainable design is considered when organizations design a product that has no harm to the environment and provide flexible options to get the product recycled or remanufactured at the end of its useful life (Eppinger & Ulrich, 2011) (Keoleian & Menerey, 2012). Sustainable design will lead to a higher quality, less waste, and a successful recycling process. Considering the environment while designing a product helps organizations to earn customers' respect, save money and lead to better products (Toupin, 2001) (Santucci, 2012).

Sustainable packaging is part of the design phase where it becomes an essential business strategy these days. Businesses and organizations started paying attention to environmental packaging in the 70's during the environmental movement (Buclet, 2002). Authors such as Baojuan (Baojuan, 2009) and Toupin (Toupin, 2001) believe that sustainable packaging can be achieved using sustainable design to reduce package materials. In a more simplistic way to achieve sustainable packaging, Wal-Mart identified the strategy of the 7 R's scorecard to reducing packaging across its global supply chain. The 7 R's that were announced at the Clinton Global Initiative in New York City in September 2006:

1. Remove Packaging: Provide the package without extra packaging components.

2. Reduce Packaging: Provide a maximum protection for products with minimal packaging material.
3. Reuse Packaging: the ability of returning and reusing a package in a closed-loop system.
4. Renew(able) Resources in Packaging: the use and reuse resources used in a packaging process e.g. using same water or energy in several steps in the process
5. Recycle(able) Packaging: the package is made from recycled material (e.g. 80% post-consumer waste) and the material can be 100% recyclable.
6. Revenue (economic benefits): use a friendly environment package that will be cost-effective because of reducing fuel consumption and having a more efficient shipping.
7. Read (education): use the package to educate customers about the benefits being delivered.

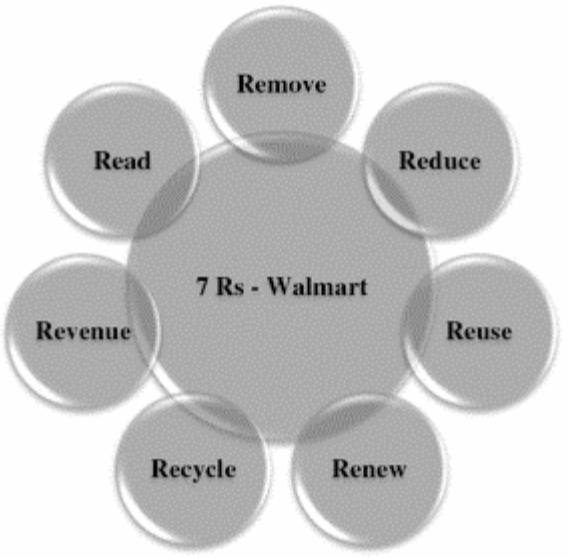

Figure 3: The seven R's at Walmart's Packaging Scorecard (Wal-Mart, 2006)

3.2 Sustainable Purchasing:

Sustainable purchasing is fulfilling the responsibility of buying environmental friendly raw material in order to reduce gas emissions. This step is important to be implemented to reach SSCM practices because it assists organizations in reducing pollutions, ensuring high quality, meeting price requirements, and eliminating waste (Liang & Chang, 2008). Efficient and sustainable purchasing can be achieved by using strategies such as recycling of extra material, using scrap for making another product, sorting raw material by its environmental impact, and using biodegradable packaging (Johnson P. F., 1998) (Min & Galle, 1997).

3.3 Sustainable Production:

In order to develop a SSCM, organizations need to implement production processes that reduce harm to the environment. Environmental production can be achieved by using an efficient production method. Organizations can use new and advanced technologies to become more efficient and reduce raw materials resulting in lower pollution. Just-in-time or the Toyota production system technique is the first environmental production effort. New emerging management strategies such as lean manufacturing, six sigma, and agile manufacturing can also contribute to efficient and environment friendly production (Bortolini, Galizia, Gamberi, Mora, & Pilati, 2019) (Suifan, Alazab, & Alhyari, 2019). Several studies discussed lean manufacturing as an environment friendly production process. For example, Srivastava (2007) mentions that "lean manufacturing is an important consideration in reducing the environmental impact of the production phase". Liang & Chang (2008) believe that lean production is helpful in improving environmental performance of manufacturers through activities such as waste reduction and minimizing hazardous wastes. King & Lenox (2001) affirm that lean production leads to improvements in environmental implementation and it assists organizations in reducing the marginal cost of pollution. Rothenberg, Pil, & Maxwell (2001), Hartini & Ciptomulyono (2014), and Srivastava (2007) identify that lean plants aim to minimize waste products and buffers in environmental technology and management. Chowdary & Fullerton (2019) define waste as activities or efforts that do not add value to the process and customers are not willing to pay for. Cherrafi et al. (2016) found that implementing Lean Six Sigma helped organizations reduce resources consumption from 20% to 40% and 7-12% reduction in the cost of energy. The most noticeable work on lean and six sigma done by Kaswan & Rathi (2020a), where they developed a three dimensional Green Lean Six Sigma (GLS) model that represents: Green for reducing emissions, Lean for waste reduction, and the third dimension is for Six Sigma and process variation reduction. In another study, Kaswan & Rathi (2020b) found that the three main enablers for GLS are: preparedness of the organization and their knowledge with green product and process, senior-level management commitment and embedding GLS into business objectives.

Recycling is another production activity that helps in developing SSCM. The strategy is to implement sustainable production by accepting products for remanufacturing and recycling purposes. This is also called reverse logistics. Reverse logistics as shown in Fig. 4 involve moving products and material from the disposal location (e.g. customers) to the manufacturers to achieve a goal of producing a valuable product out of the surplus.

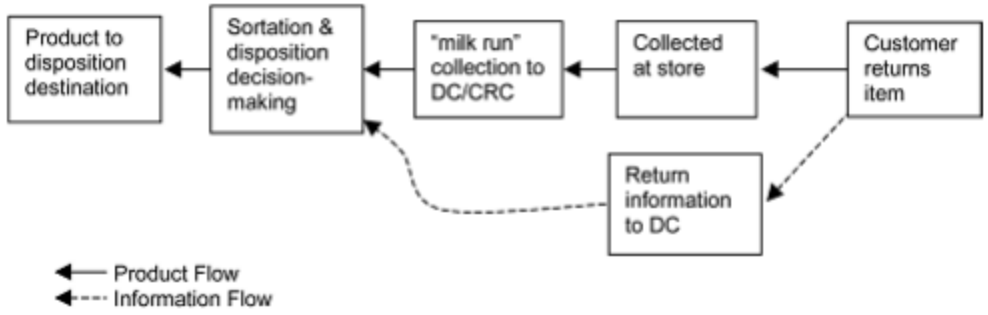

Figure 4: Reverse logistics (Robinson, 2020)

3.4 Sustainable Marketing:

Sustainable marketing has many dimensions that are important to implement SSCM. Sustainable development can grow with entrepreneurship mind-set (Johnson & Schaltegger, 2019). Sustainable marketing is promoting the environmental and social responsibility of an organization' products, services, or practices. Sustainable marketing involves communicating to customers about the organization goal of meeting the environment, society, human, and cultural responsibilities and to ensure a better life for future generations. Fig. 5 summarizes the four dimensions of sustainable marketing with examples for one of these dimensions. Sustainable marketing improves organizations' relationship with their customers, suppliers, and other partners (Trivedi, Trivedi, & Goswami, 2018). McDonald's is a good example for a company that was successful of using sustainable marketing to maintain ethical, social, and environmental responsibilities. Strategies such as finding sustainable ingredients for its foods, using healthier cooking oil, launching education health campaign (Kotler, 2013), and having a playground in their restaurants are used which are powerful, effective, and profitable. Another company that uses sustainable marketing is Starbucks by setting environmentally friendly goals such as eliminating plastic straws from their stores by 2020 and opening 10,000 environmentally friendly stores by 2025 (Rogers, 2018) (Starbucks , 2018).

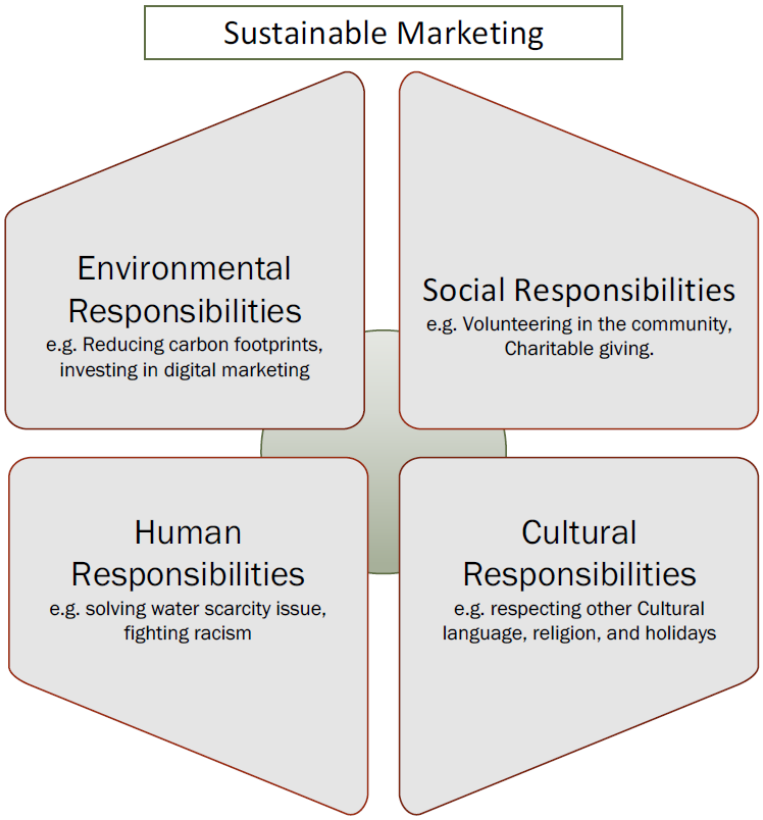

Figure 5: Dimensions of the Sustainable Marketing

3.5 Sustainable Transportation:

Reducing the gas emissions require organizations redesigning their transportation practices and develop new plans and strategies. Factors such as fuel sources, type of transport, and infrastructure should be considered when developing environment friendly supply chain systems. Kam, Christopherson, Smyrnios, & Walker (2006) believe that these factors and the dynamics that connect them, "determine the environmental impact generated in the transportation logistics phase of the supply chain." Sustainable transportation can be achieved by designing an efficient delivery routes and methods, partnering with third parties, and providing an efficient packaging design. Deakin (2001) provides a comprehensive list of transportation strategies for sustainable development. These strategies are grouped into several categories based on the component of the transport system: vehicles (e.g. new vehicle technologies, new fuels), guideways and operations (e.g. traffic signal timing, bottleneck removal, smart highways), and demand (e.g. gas tax increases, bike friendly development, fees based on use, information technology-enhanced routing and scheduling). Government has a great impact on developing sustainable transportation. For example, in the state of California in the US, the department of transportation developed 13 long-term policies to implement sustainable transportation by 2025 as

shown in Fig. 6. These policies would enhance the economy, support communities, and safeguard the environment. To support these policies, strategies and partners are identified to ensure the implementation by 2025. The policies are as follows:

- Increase system capacity (e.g. additional roadways, improve transit services, use technology).
- Preserve and maintain the system (e.g. Increase private sector participation, Support training programs) .
- Enhance goods movement (e.g. Research, develop, demonstrate, and deploy cost-effective technologies, Gather, develop, and refine data, tools, and techniques needed for assessing goods movement).
- Support research to advance mobility and accessibility.
- Provide viable transportation choices.
- Manage and operate an efficient intermodal system.
- Provide additional and flexible funding (e.g. valuate past transportation financing initiatives, developing long-range financing).
- Improve system and system user safety (e.g. Increase education and outreach programs, Deploy and promote the use of advanced systems, Increase patrols to enforce speed restrictions).
- Expand collaboration in planning and decision-making (e.g. implement public information and involvement programs, Involve businesses, communities, and community-based organization in transportation decision-making).
- Provide for system security (e.g. Work closely with federal agencies, including TSA, Customs, and the Coast Guard).
- Manage growth (Protect environmental and agricultural resources, Encourage efficient development patterns, Provide incentives for collaborative linked to sustainable development).
- Conserve natural resources (e.g. preserve wildlife corridors, promote a greater understanding of the relationship between the natural environment and transportation, provide incentives to promote the use of recycled materials.).
- Commit to a clean and energy efficient system (e.g. expand market share of cleaner vehicles and supporting fuel infrastructure, Implement measures to lower emissions of GHGs and air pollutants in transportation options).

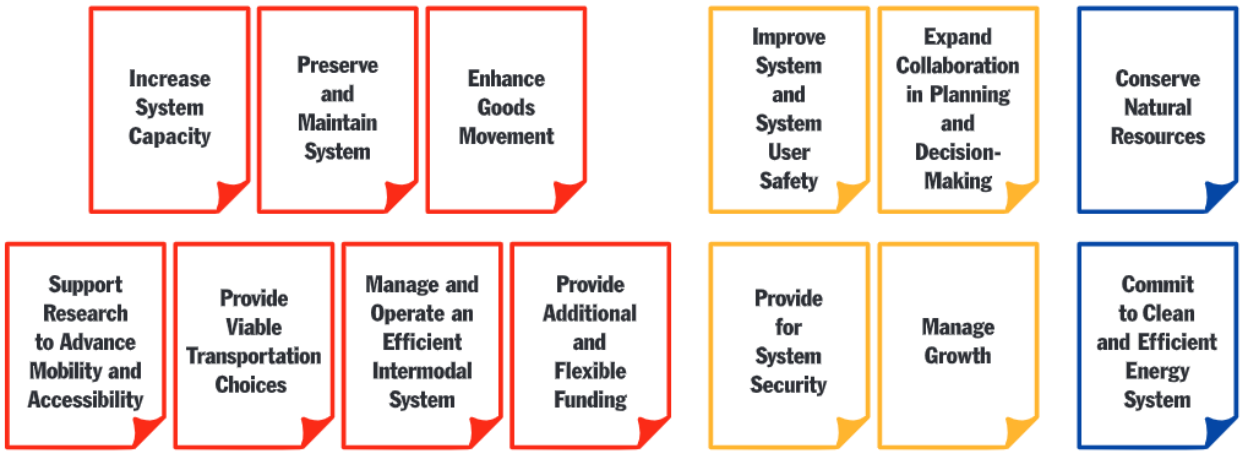

Figure 6: California Transportation Plan 2025 (State of California, 2006)

4. Development of a framework for SSCM

In this section, the authors present a background on SSCM and then propose a framework.

4.1 Background

Before discussing the proposed framework, background information about the SSCM is provided.

4.1.1 History and the timeline for SSCM strategies and practices 1970's - 2000's

Environmental auditing and assessing programs began in the USA in the early 1970s. At that time, a few companies worked independently and developed environmental auditing programs. These efforts resulted in creating tools to help manage, review, and evaluate their environment impact. During the environmental movement in the 1970s, sustainable packaging and recycling gained a lot of popularity in the USA and more efforts spent toward this direction. In 1984, the Toyota production system (TPS) was considered as the beginning of sustainable production. TPS helps reduce waste and improve efficiency. In 1987, sustainable design gained poignant meaning after the Brundtland UN-commissioned study. In 1992, people's awareness with government rules and regulations (e.g. ISO 14000 established) was the next stage of evolving SSCM. Reverse logistics and remanufacturing were initially mentioned in 1992 in a white paper published by the Council of Logistics Management. In the early 2000's, more global environmental efforts focused on improving the customers' awareness toward the environmental friendly practices. Increasing customers awareness put pressure on organizations to fulfill their customer needs and encouraged them to adopt sustainable manufacturing and implement a more effective SSCM. Government agencies established strict environmental policies to guide organizations implementing environmental friendly practices. As a part of commitment to environmental practices,

organizations started awareness campaigns, seminars, and education programs for employees, suppliers, vendors, and customers to improve the awareness level. Finally, between now and 2030, customers are expecting sustainable concerns to be built into any business or organization practices. The timeline is shown in Fig. 7.

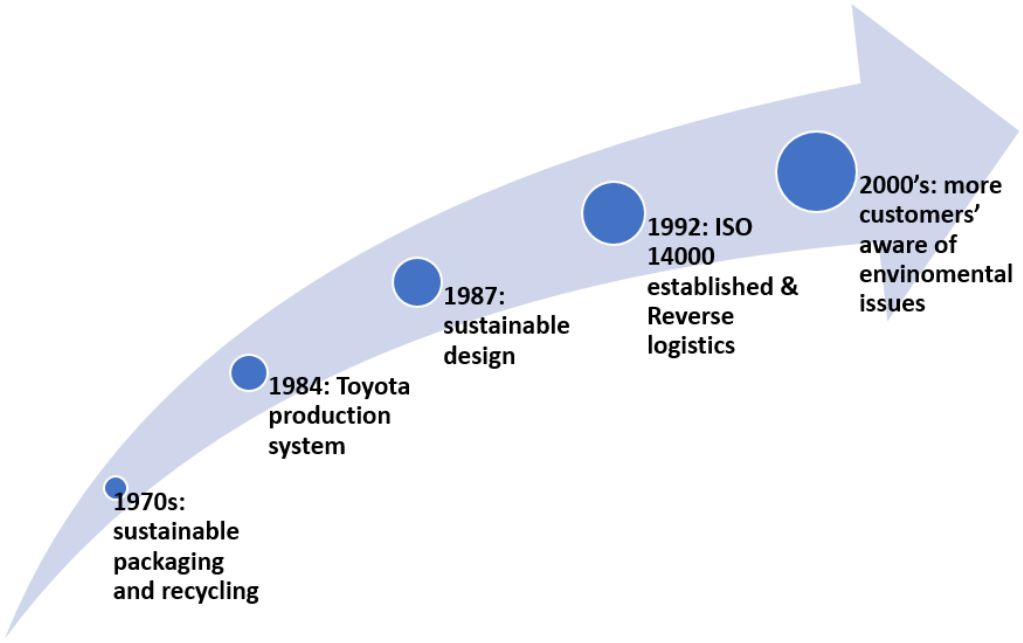

Figure 7: SSCM history and timeline

4.1.2 An overview of Regional manufacturing companies regarding SSCM

In order to determine the current status, best practices and needs of large, medium and small manufacturing companies of SSCM, such companies were visited in the Terre Haute region of Indiana (USA). A list of manufacturing companies in the Terre Haute region was secured from the Chamber of Commerce. The researchers knew it was important to interview manufacturing professionals who were involved in the day to day operations of supply chain management. Initial contact was made with the human resource department of several of the companies to help identify the manufacturing professionals to be interviewed. They were informed ahead of time the researchers were particularly interested in the sustainability of SCM. The professionals interviewed were all responsible for supply chain management in their respective company and had position titles such as: Head of Supply Chain – Americas, Director Procurement, Purchasing Manager, Supply Chain Manager, Logistics Support and/or Technology Managers. Personal visits and observations of sustainable initiatives took place in these companies: large size companies - Company S (950 employees) and company B (710 employees);

medium size companies - Company T (425 employees) and company TKP (439 employees); small size companies -Company J (250 employees), Company CG (165 employees) and Company Tr (135 employees). The observation and interviews helped in developing the proposed framework.

List of interview questions that were asked during the interview are as follows:

- Q1 Tell me a little about your position.
- Q2 How would you describe the current status of Sustainable Supply Chain Management (SSCM) in your company?
- Q3 Do you have a company strategy regrading SSCM?
- Q4 How does your company manage the system?
- Q5 How do you monitor progress, organize and report data to know if you are successful?
- Q6 Do you use computer software to develop better supply plans for purchasing, manufacturing, distribution and transportation?
- Q7 What kind of activities have you done up and down the supply chain to reduce environmental impacts?
- Q8 What are some of your sustainable purchasing practices?
- Q9 Have you identified a list of best practices in SSCM for your company? Some practices that are kind of standard and possibly used by other mfg. companies?
- Q10 Can you discuss some of the practical things your company is doing regarding SCM and are you addressing the sustainability issue?
- Q11 Would I be able to see some of these practical applications in action?
- Q12 Are there things you would like to be doing re: SSCM but currently are not?
- Q13 What are some of your greatest successes/failures re: SSCM?
- Q14 What are some of your biggest obstacles/barriers re: SSCM?
- Q15 Do you have any particular needs in your company that would help move this sustainability effort re: SSCM forward?
- Q16 How does this benefit your company? Is there any downside?
- Q17 What have you done to increase cooperation and partnerships with customers, suppliers, governments and non-gov't organizations to achieve greater sustainability goals?

Based on the visits and interviews of manufacturing professionals, it was found that all of these companies are making an effort to achieve sustainability up and down the supply chain as well as within their own facility. The current status is that the large and medium size companies have dedicated

supply chain management professionals working toward sustainability. The smaller companies have their procurement or purchasing directors working with SSCM initiatives.

As for best practices, there are many things all of these companies are doing and some things specific to each company. The professionals in each of these companies realize if you cut down on your waste (reduce), reuse materials whenever possible and recycle materials that can't be reused, the company will save money. If you implement activities that help you do these things not only will you save money, but you will be helping the environment. Some of the best practices for these companies are 1) recycling, 2) reducing waste, 3) reusing materials whenever possible, 4) energy usage, 5) air emission, 6) water usage, 7) hazardous waste, 8) use of raw materials, 9) use of natural resources and 10) sending as little as possible to the landfill. Most of these practices involve working with partners to be successful. Communication is key in creating a sustainable supply chain.

The needs are different depending on the size of the company. The large and medium size companies are part of a larger corporation that have facilities around the world and more resources from which to draw. They still have needs but are better positioned for SSCM. These companies have access to more research and development. They can afford the expensive computer software packages such as SAP (a German product) to help monitor, organize and report their data. They also have the expertise to implement their own Operational Excellence Programs.

It is more difficult for the smaller companies with limited resources nonetheless the professionals in these companies are creative in their effort to achieve a more sustainable supply chain. These companies can do many of the things mentioned earlier by partnering with other companies. For example, they can reduce their energy usage (power and lighting) by working with their energy provider (Duke Energy) to reduce energy consumption. They can also work with the company (Jadcore) that handles their waste to reduce the amount of material they send to the landfill. There are plenty of opportunities and part of the sustainable strategy is to identify the low hanging fruits (e.g. easy to implement activities) and work on these practices first. Professionals within a company can then look to identify other opportunities.

4.1.3 The Importance of SSCM

Implementing SSCM can benefits organizations by having a greater responsibility toward their community, reducing environmental risks, and eliminating pollution and gas emissions. Organizations can earn customers respect and improve their reputation, which will result in gaining a bigger segment

of the market. SSCM could result in cost reduction by implementing more efficient practices using lean, six sigma, or agile manufacturing. Adopting sustainable design means providing effective design for organizations to be able to reuse or recycling material. Having an efficient design for products and packaging means safer warehouses and transportation that result in total cost reduction by decreasing turnover rate, paying less insurance premiums, and lowering disposal costs. One last point, adopting SSCM practices can develop a better relationship with customers by offering grants for local communities to encourage environmental friendly activities. Having organizations that are committed to the environment would benefit not only themselves of cutting unnecessary expenses but also will help solve some social issues and provide local job opportunities.

4.1.4 Barriers for implementing SSCM

Implementing SSCM can be a challenge for some organizations due to several factors. These factors can be summarized as follows:

1- High cost of implementing environmental programs: in order to be able to develop sustainable practices in SCM, organizations need to develop their production around efficiency and reducing waste. Also, organizations should meet some government regulations and obtain some certifications.
2- Uneconomical recycling and re-using of material: recycling or reusing material in some cases are not worth to be recycled or reused and using new material could be less expensive. This depends on the material used in the production phase and based on the availability of raw material.
3- Lack of management commitment: management commitment is the reason for any organizational change. If there is no commitment from management then SSCM practices can not be a success.
4- Lack of awareness: awareness is an important factor to implement SSCM. Buyers and suppliers may be lacking the awareness of the environmental crises e.g. global warming. Organizations can improve their customers and supplier awareness by offering training, workshops, advertising, and other educational practices.
5- Deficient of auditing and regulations programs: some countries or states have not developed enough programs or initiatives that encourage organizations to adopt SSCM.
6- High market competition: aggressive competition and fluctuating the demand distract organizations from implementing SSCM efficiently. In order for organizations to compete in the

market, they should offer a product or service with a better value than their competitors. This usually means cheaper prices with high quality. This may force organizations to look into less expensive practices without considering the environment impact of these practices.

7- Short term strategies: Establishing SSCM requiring a commitment from organizations and management. This commitment should be translated into ~~a~~ long-term goals and plans.
8- Low profit margins: sustaining environment friendly practices might be expensive and therefore it results in less profit. This could be solved by establishing long term partnership with suppliers to reduce prices.

4.1.5 Impacts of Technology on Sustainable Supply Chain Management

Several technologies have been used to support environmental practices. Environmental Management Systems (EMS) is an information system that can be used for improving environmental and business performance (Florida & Davison, 2001). For example, to have a more sustainable transportation, managers can run simulations using EMS to find the best routes, which their truck should take to deliver products. EMS also can show options of suppliers that support their environmental goals. EMS is important in calculating the ordering quantities in order to be less harmful to the environment. Other features may include generating reports, sharing information with partners, and sending or receiving alerts if environmental practices are not followed. Radio Frequency Identification (RFID) is another advance technology impacting the SSCM. RFID helped in "improving the environmental health of the world and the financial health of the retail giant and its suppliers… reducing unnecessary truck deliveries …and reducing customers' trips to stores for items that were out of stock during their initial visit" (Swedberg, 2007) (Al-Odeh & Smallwood, 2012). Blockchain and other newer technologies also impact SSCM (Saberi, Kouhizadeh, Sarkis, & Shen, 2019). In light of the recent advancement in technology and experience with logistics and supply chain, e-commerce and same day delivery have become important for business growth (Alsibaei, Haridy, & Badar, 2019).

4.2 Proposed SSCM Framework

With an increasing interest in implementing SSCM, there is a need to provide guidelines to help organizations implement these practices successfully into their SCM. As a result of reviewing activities and practices in SSCM, a framework is conceptualized to help organizations develop SSCM (Seuring & Müller, 2008) (Ahi & Searcy, 2013) (Seuring, 2013) (Narimissa et al., 2020). This is further enhanced based on the current status, best practices, and needs of large, medium and small manufacturing

companies located in the Terre Haute region in regard to SSCM as explained in section 4.1.2. A final framework as shown in Fig. 8 containing eight steps has been developed.

The first step for organizations to develop SSCM is identifying the financial benefits that can be gained from this change. Financial factors can motivate. The financial gain can be calculated using factors such as: waste reduction, process utilization and efficiency, customers loyalty, brand reputations, and market share. Linking sustainability with financial goals will encourage organizations to work toward their sustainability goals to improved financial performance. This makes organizations stakeholder more comfortable toward adopting SSCM. Second, managers may find a government regulation or guideline to follow. In this step, organizations can get some help from the government agencies as they have the best practices through their experience with implementing sustainable practices. The next step is establishing environmental organizational culture by involving all stakeholders and sharing the goals of the new SSCM initiative and the benefits that can be gained from this new initiative. This is important because stakeholders play an important role in making the success of the transition process. Step four is to establish detailed plans and guidelines for all parties to explain the process to achieve the final goal. In this phase, organizations should provide the how, what, who, and when: how to implement the plan? What resources are needed to achieve the goal? Who is involved? And when is the start and end date for these plans? The next step is establishing long-term partnerships to build trust, improve collaboration, elevate any challenges or roadblocks, establish fair pricing policy, and offer a consistent and long-term support. Conducting a monthly meeting with partners is the next step of implementing these SSCM practices. This step is important to review partners practices, share ideas, discuss ways to collaborate, guide partners in developing environmental programs, and provide on-site recommendations. The next step is involving the local community by offering environment awareness workshops, offering grants and funding for environmental practices, and volunteering in community events. The last step is developing assessment and monitoring programs, which help organizations in correcting and updating their practices and achieving a successful SSCM.

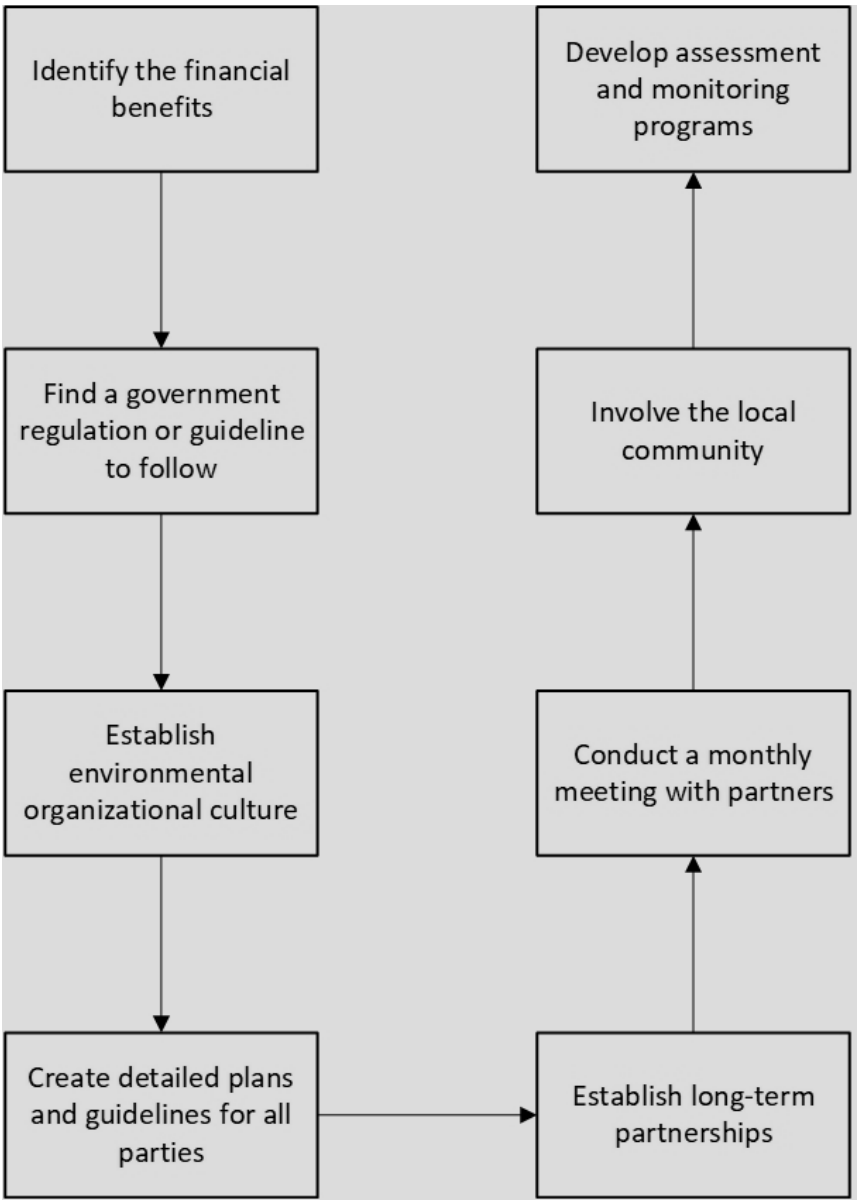

Figure 8 Framework for developing SSCM.

Discussion

The framework puts focus on environmental factors and sustainability issues in supply chain management as it asks for establishing environmental culture in the organization. This is in agreement with Kaswan & Rathi (2020b) that green lean six sigma (GLS) enablers are: awareness of green products and processes, top-level management commitment, and making sustainability as a company goal. Environmental waste reduction in terms of resource consumption or emission makes companies lean and aids financially. This is in agreement with the results reported in Cherrafi et al. (2016) and Kaswan &

Rathi (2020a). With rapid advancement in technology, the environmental consideration can be achieved at a minimal cost (Alsibaei, et al., 2019). This is in line with the entrepreneurship mind-set suggested in Johnson & Schaltegger (2019). All these will help companies grow globally and have financial benefits.

5. Conclusion

This article provides a summary of the SSCM definition and activities. An overview of regional manufacturing companies' status and initiatives in regard to SSCM has been presented. Importance and barriers of SSCM have also been discussed. Organizations that implement SSCM can gain benefits such as cutting unnecessary expenses, increase revenue and carrying a more responsible role in their communities. Organizations should be aware of the difficulties that can be associated with implementing SSCM such as expensive programs and un-clarity in government guidelines toward their SSCM.

Visiting regional manufacturing companies of small, medium and large employee sizes to observe their SSCM needs and initiatives, and interviewing their SCM professionals, it was found that the large and medium size companies are part of a larger corporation that have facilities around the world and more resources from which to draw. They still have needs but are better positioned for SSCM. These companies have access to more research and development. They can afford the expensive computer software packages such as SAP to help monitor, organize and report their data. They also have the expertise to implement their own Operational Excellence Programs.

It is more difficult for the smaller companies with limited resources nonetheless the professionals in these companies are creative in their effort to achieve a more sustainable supply chain. These companies can do many of the things mentioned earlier by partnering with other companies. For example, they can reduce their energy usage (power and lighting) by working with their energy provider (Duke Energy) to reduce energy consumption. They can also work with the company (Jadcore) that handles their waste to reduce the amount of material they send to the landfill. There are plenty of opportunities and part of the sustainable strategy is to identify the low hanging fruits (e.g. easy to implement activities) and work on these practices first. Professionals within a company can then look to identify other opportunities.

A framework has been proposed to help managers implement SSCM to their organizations and partners. Implication of this research to practitioners is that this framework can be applicable in any manufacturing company irrespective of the size with some modification considering the regional factors.

Implication for researchers is to use this framework as a base and enhance it. For example, as the technologies are improving very fast, the authors recommend investigating the impact of RFID, block chain, and other newer technologies on SSCM. Also, the authors recommend looking into a more specific framework for each of the SCM activities (e.g. framework for sustainable marketing, framework for sustainable packaging,…) and measure the effectiveness of each framework in real life.

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What universities in the Middle East can learn from the American online education system

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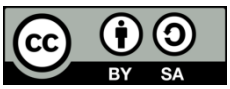
ABSTRACT

In this paper, the author provides insights and lessons that can be learned from colleagues at American universities about their online education experiences. The literature review and previous studies of online educations gains are explored and summarized in this research. Emerging trends in online education are discussed in detail, and strategies to implement these trends are explained. The author provides several tools and strategies that enable universities to ensure the quality of online education. At the end of this research paper, the researcher provides examples from Arab universities who have successfully implemented online education and expanded their impact on the society. This research provides a strategy and a model that can be used by universities in the Middle East as a roadmap to implement online education in their regions.



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1. INTRODUCTION

With the advance of emerging instructional technologies, online education has become a popular option in the United States (U.S). Online education is a learning technique that uses the World Wide Web (WWW) and its applications to deliver the content of a learning session or training. The flexibility and other advantages provided by online education has encouraged American students to take classes via the Internet. In the same way, American universities have used online education as one way to survive budget cuts and economic recessions by reducing their needed physical resources, such as labs and buildings [1, 2].

Successful experiences of online education in American universities and those around the world continue to support its growth and, therefore, have also increased the budget allocation for online education programs [3]. The success of online education has even encouraged traditional universities to replace their traditional campuses and programs with virtual campuses by creating environments of online or blended classes.

In 2015, Babson Survey Research Group conducted a study about online education in the U.S and found that university leaders consider online learning a crucial strategy to their institutional growth, and this perspective has increased from 48.8% in 2002 to 70.8% in 2015 [4]. This percentage dropped in 2016 to 63.3% [5]. In a study conducted by the U.S. Department of Education (2010), it was found that students in online courses performed better than students who were enrolled in face-to-face courses [6]. The study also found that learning outcomes for online learning exceeded those of face-to-face classes. The study recommended using technologies in on-campus classes to achieve the highest benefits from learning outcomes [6]. These types of classes are called blended or hybrid. It was estimated, in a study conducted by the National Center for Education Statistics (NCES), that 28.5 % of American students take online learning

courses at the postsecondary level [7]. Docebo [8] predicted that the market for online learning would grow by 5% between 2016 and 2023.

The impact of online education has affected most universities in the world, including in the Middle East area. The impact of the online education movement is relatively low in the Middle East compared to the universities in the US. This low impact is due to the late adopting of the Internet and its technological infrastructure in these countries [8]. However, some universities have been trying very hard to keep up with this new trend in education. In 2013, the Minister of Higher Education at the United Arab Emirates (UAE) considered interactive online education equivalent to traditional education programs [9]. On the other hand, other countries in the Middle East are still not accepting the idea of online degrees, and they are considering that this type of education is low quality compared to traditional education [10, 11]. Therefore, these countries would not approve online degrees as equivalence to traditional ones. The reality is that online courses are considered more challenging than traditional ones [12]. For example, to ensure students engagement, online faculty require more reading activities than the ones required in traditional courses.

This research provides a strategy and a model that can be used by universities in the Middle East as a roadmap to implement online education in their regions. The model is built based on reviewing best practices in American universities. The researcher is hoping to solve the problem of slow adoption of online education in Middle East universities. The reasons for the slow adoption are explained in the discussion section. To solve this problem, a strategy and model is proposed in this research to provide systematic method to guide education leaders in the Middle East to implement online education.

2. ONLINE EDUCATIONS GAINS AND BENEFITS

There are many benefits and advantages that can be gained from online education. These gains are for students, faculty, and institutions. Online education helps students to have more control over their learning process, as they would start the lecture and course material at their convenience, and it is not restricted by time or physical location [13]. Students would be able to build a study schedule that suits them and based on their availability and, therefore, they would benefit more this way. Students in the rural areas would enjoy taking classes from home, as it would be challenging for them to attend an on-campus lecture. These gains are not available in traditional education.

The other benefit of online education from the students' perspective is the cost. Students enrolled in onlinee degrees can reduce the cost burden of education [14]. For traditional education, tuitions are not the only costs for credits. Other costs associated with traditional education are housing, food, and transportation [15]. With online education, these costs are eliminated due to the fact that students can take classes while they are sitting at home. Another important point related to the cost is that most institutions offer online courses for lower tuition compared to traditional education due to no physical resources needed for online students. Giving free laptops and all software needed to online students is a common practice in American universities [16]. This also adds savings for students who decide to enroll in online programs.

Diversity is another benefit of online education. A student can be part of a diverse group of students from all around the world [13]. This would help students understand other cultures' perspectives and norms. Diversity in a classroom would enable students to be open to new ideas, think out of the box, and become more creative, not restraining with their own ideas. Diversity is also essential to career preparation. Having students from all around the world would encourage students to enter the global job market and have better opportunities securing a high paid job.

Faculty can also benefit from teaching online courses in several ways. Faculty would have more time to engage in developing instructional activities, and this would result in improving their teaching performance [17]. Teaching from anywhere is another enjoyable feature that faculty can have if they decided to teach online courses [18]. They could travel to conduct research and, at the same time, teach classes online. The Internet has eliminated the restriction of having faculty physically exist in the building to teach classes. Online education provides faculty with flexibility and, therefore, faculty can efficiently manage their time and achieve more of their career and life goals. Technological tools can also save faculty time and become more efficient [19]. For example, online quizzes can be graded instantly, and no time is needed from faculty other than developing quizzes online. Effective feedback can also be easily provided online and within a reasonable period.

Students in online classes also have the opportunity to express their opinions freely without being shy, as they might be in a face-to-face class [20]. The rich discussion environment of an online course is replete with deeper and more reflective opinions [21]. Such an environment helps faculty to know students at a deeper level and build strong connections with them. This further helps faculty to evaluate students' performance in the virtual environment accurately. Having students from around the word participating in

online classes also improves faculty communication skills by encouraging them to develop global communication techniques of thinking to address a global audience.

Public education institutions use online education to accommodate the demands of those who are interested in earning higher education credits [22]. This strategy eliminates the need for building new facilities to meet demand. Online education, in other words, helps institutions to expand and accept more students without the need to invest in physical facilities. In a 2025 strategic plan study conducted for the Florida State University System, it was estimated that the system would need $184.3 million dollars to build classrooms for their face-to-face students in the next five years. This cost can be avoided by offering courses fully online [23].

There are countless benefits that can be gained from the online education. These benefits include increasing student access to learning material, improving student quality of learning, better preparing students for life skills, providing increased learning opportunities, and many more.

3. THE LIMITATIONS OF ONLINE EDUCATION

This section includes a discussion of the difficulties that may be faced when adopting online education from the viewpoints of students, faculty, and institutions. Students may have difficulty taking online courses due to a lack of readiness to address this learning environment [24]. Readiness is important to student success in online education. Readiness can be demonstrated by having the necessary technology (e.g., Internet access and a laptop) available to students and supporting their ability to use these technologies. Another aspect of readiness is self-discipline, or self-directed motivation. This means that students need to have excellent time management and organization skills to be able to finish coursework on time [13]. Having no direct connection with instructors and other students in the course makes online education difficult and requires relatively more patience when engaging in the course and its activities [25]. Students may also feel lonely and unsupported during the online learning process [26]. Their engagement and participation in class activities is completely self-directed, and no one can encourage them to participate but themselves. Finally, yet importantly, technical difficulties might cause frustration and discouragement for online students if there is no technical support available to them [27]. In synchronous classes and during real-time class activities, videoconference, software upgrades, plug-ins, and network issues may occur and prevent students from participating. Faculty, therefore, should be prepared to deal with these issues in order to enable students to participate in synchronous sessions.

Online environments are also challenging for faculty. Just as student readiness is key, faculty should also be ready to use the required technologies [28]. Workshops and training sessions are required to ensure faculty readiness to teach online classes. Faculty should be given the needed training and time to become proficient in using instructional technology and in becoming online developers and instructors [29]. Having faculty who are not fully trained to teach online courses may lead to ineffective learning experience due to poor course management and inadequate communication with students. Another important point is that faculty need adequate time to design online courses and prepare written or video instructions for their students [30]. This time can be part of the faculty teaching load, with no additional compensation offered. Institutions, however, may offer grants and incentives to have their faculty design and develop new online courses during the summer sessions. Responding to individual emails and communication is also time consuming and requires extra commitment from faculty to address students concerns [31]. Responses to students might not be instant, as instructors may take a few days to reply to them. Students, however, are usually looking for quick responses from their instructors, and late responses may discourage them from participation in the class or asking another question. If an online instructor has difficulty finding the time to respond to students' questions, this may affect students' engagement, as they could feel ignored.

The main challenge of offering online courses, from institutions' perspectives, is the high initial investment cost [23]. The first cost of implementing the online infrastructure and strategies is very high due to the time spent developing the course and the need for online tools. A cost-benefit study conducted by the University of British Columbia found that the first offering of one of their classes was 75% over budget [32]. This cost significantly decreased in subsequent offerings because most of the online infrastructure is in place, resulting in no need to invest in major tools until the next system upgrade, usually in 3-5 years. The cost also decreases when student enrollments increase for a specific course [30]. Additional costs are needed to offer training for faculty to gain new strategies for teaching online courses. Offering training for faculty is necessary because it increases the level of faculty readiness and ensures the effectiveness of the learning experience. Through such training, faculty are equipped to face challenges and provide a positive experience to their students. Online instructional technologies require institutions to hire a technical support team to help faculty and students with the challenges that they might face during their online journeys [33]. This additional cost is additional to the cost of online education, but it is necessary ensure a positive and

engaging environment free of technical issues, especially in synchronous learning sessions. With rapid technological changes, institutions should be investing in the best online instructional technologies available. Therefore, it is necessary for institutions to have a clear plan for purchasing and upgrading their systems and technologies every three years, at the most, to gain the best advantages from technologies.

4. EMERGING TRENDS IN ONLINE EDUCATION

Online education emerged in the year of 1993 with the emergence of web services and the World Wide Web (WWW). Since then, the face of education, in general, and online education, in particular, have dramatically changed due to rapid developments in instructional technologies. Four of the newest trends in online education are discussed in this section.

Open Educational Resources (OER): One of the trends in education in general, and in online education, in particular, is toward making the educational material (e.g. technologies, media, and textbooks) available free of charge for all individuals who are interested in the subject [34]. One form of Open Educational Resources (OER) is the Massive Open Online Courses (MOOCs), an initiative that offered unlimited courses online. MOOCs started in 2011 when American universities began to offer courses on platforms such as Udacity [35]. There are thousands of courses available to students to be taken for free. These courses are designed by providing short video lectures, followed by automated multiple-choice quizzes, to ensure students' understanding of the module content.

Fee-based completion and assessment: These type of online courses are designed for students who want to earn certificates of completion for a course or training [36]. They are offered with inexpensive fees. This type of learning allows potential students who are thinking about advancing their careers to sample courses by enrolling in certificate or degree programs. Examples of organizations that offer this type of education are coursera.org and udemy.com. Course fees range from $10.99 to $100 [36].

Social media and mobile applications integrations: Social networks have affected people's lives. Connecting electronically with friends and family has become one of life's necessities. Online education has invested in customizing mobile applications and social media to be used in the classroom. Desire to Learn, Blackboard, and Canvas are all Learning Management Systems that have iOS and Android apps available to students [37-39]. These LMS platforms are also available in instructional versions to grade students' work and provide feedback. With easy to access these applications, students can complete courses using their phones. The need for more friendly interfaces is one of the current challenges with these applications.

ADA Compliance & accessibility: More than 15 university in the U.S. had to resolve complaint regarding the incapability of their students to access technologies and information used in their online courses [40]. The Americans with Disabilities Act 1990 and its 2008 amendments require instructional technologies and course material used by colleges and universities be accessible to all students including those with disabilities [40]. New trend in online courses these days is providing accommodation to all students who are enrolled in online classes including individuals with disability. Accommodation is enforced by implementing strategies such as providing alternative text, including links description, captioning videos, and transcribing audio [41].

Time to Graduation: time to finish a degree is a concern in higher education [42, 43]. It is considered as critical factor for educational institutions success. Therefore, policy makers and educators in the U.S. and other countries have created learning options to reduce time to graduation rate. These options include online courses, 2+2 or 3+1 programs, competency-based learning, prior learning experience credits, and personalized learning. Online classes also helped in reducing the time to graduate. Offering online summer classes enabled traditional students to register for classes during the summer while they are enjoying their time with their family.

5. THE QUALITY OF ONLINE EDUCATION

Flexibility in learning provides a great advantage to students, but the high quality and effectiveness of courses are also important to them and to industry. With the growth of online education, policies, standards, and guidelines have been created to ensure the rigorous application of the education process. The following are some of the practices that are used to ensure high quality online education:

Accreditation: Accreditation is one tool of evaluation that ensures the high quality of online programs. Accrediting agencies develop standards to evaluate the level of quality of online programs [44]. The accreditation team uses sets of standards related to such areas as academic and student support, technical support, faculty credentials, technological infrastructure, faculty and student resources, and administrative resources. Accreditation improves the reputation of institutions, and this helps to improve the enrollment rates, as students prefer to enroll in programs that are accredited over programs that are not [45].

Quality assessment measures: Quality Matters (QM) is a non-profit organization that has created assessment rubrics and measures to evaluate the quality of online courses [44]. QM rubrics consist of 43 specific review standards addressing areas such as learning objectives, assessment and measurement, instructional materials, learner engagement and interaction, and course technology. Three trained reviewers conduct the QM review process. The reviewers evaluate courses from students' perspectives and then provide suggestions on how to improve them. Figure 1 explains the QM review process for online and blended courses:

Figure 1. Quality Matters Review Process

Other institutions have created tools to evaluate the quality of online courses. The Online Learning Consortium, for example, is another non-profit organization that has had a significant effect on improving online education. Additional tools that have been developed to monitor course quality are Universal Design Online Content Inspection Tool (UDOIT) and Illinois Online Network Quality Online Course Initiative Rubric.

6. RESULTS AND DISCUSSION

The status of online education adoption process in Middle East is discussed in this section by providing examples from two countries. In addition, the proposed solution for the problem is explained using a strategy and a graphical mode.

6.1. Examples from the Middle East

The adoption of online education in the Middle East is slow compared to in the US and western countries. This slow process has been due to several reasons:

- Late adoption of the Internet and other technology infrastructures,
- The belief that traditional education is of better quality than online education,
- Lack of understanding of online education's advantages,
- The belief that on-campus resources and infrastructures are enough for the demand and that there is no need for supplemental solutions such as offering online education,
- Corruption and bureaucracy hinder establishing online programs.

Despite the slow adoption of online learning in the Middle East, these days there is a better understanding of online education and its need to make an impact on the education sector. Many Middle Eastern countries are considering this learning option, and many universities have hosted conferences related to online learning. The next section provides a discussion of two examples of Arab countries that have implemented online education successfully.

6.1.1. United Arab Emirate (UAE)

Hamdan Bin Mohammed Smart University Dubai (HBMSU) is the first virtual institution in the Arab world, established in 2002 [46]. The Ministry of Higher Education in the UAE accredited HBMSU as a research university [47] that offers learning experiences using advanced technologies such as mobile learning, online classrooms, discussion blogs, simulation games, and social networking. The university

underwent numerous challenges before implementing online education successfully. The first phase was pursuing their accreditation. When the university started in 2002, the Ministry of Higher Education and Scientific Research (MOHESR) did not have accreditation standards for online programs. Therefore, HBMSU had to partner with the University of Bradford, UK, to offer joint programs until new accreditation standards were released in 2005 [48]. The university convinced MOHESR that online learning had a positive impact on education in the UAE and in the Arab world. The university received accreditation and approval of their programs in 2006 [49].

The second phase was to train traditional faculty in using instructional technologies and online tools. Faculty redesigned their courses using advanced technologies to meet the needs of their programs. The third phase was supporting and motivating traditional students during the online learning process [48]. Getting students adapted to the new environment requires changing their learning behavior from the traditional learning environment to an environment that encourages students to discover, construct, transform, and retain knowledge. In order to provide technical support for learners and faculty, the university created an in-house information technology department. The forth phase was Arabization of knowledge, which involved translating textbooks into Arabic. In this phase, the university established a publishing venue to help them create course content, material, and textbooks to learners in their mother language [48, 50]. The last phase was monitoring, controlling, and improving the process. The last phase was important to implementing continuous improvement practices in their learning process. Recently, their name was changed from "e-university" to "smart university" to achieve its aspiration of becoming "a university of first choice in the Arab World [51]." The name change included changing the strategic plan to keep up with the latest advances in technological innovation.

6.1.2. Kingdome of Saudi Arabia (KSA):

The Saudi government offered online courses for the first time in 2002 [52]. These courses are designed for people who are interested in technical and vocational training. In order to ensure the success of this program, Center of e-learning training resources is established and created an electronic library with more than 50,000 books and 3,000 training programs [53]. In 2003, universities such as Um AlQura University and King Fahad University of Petroleum and Minerals established e-learning centers to support traditional programs to benefit from instructional technology by offering blended courses [54]. In 2007, the National Center for E-learning (NCEL) was established to support e-learning systems, but there was no online programs offered or accredited [55]. In 2009, the Ministry of Higher Education and NCEL organized the first international conference about e-learning and announced their acceptance of online programs [56]. Later, in 2010, the Ministry of Higher Education officially approved the online programs offered in the Saudi universities [52]. In 2011, the Saudi Electronic University was established as the first electronic university in the country to offer fully online and blended programs with collaboration from institutions such as eCampus Ohio University, University of Phoenix, Franklin University, Capella University, and Walden University [57]. Now, the university is in the process of achieving accreditation by national and international organizations to improve their quality of education and keep up to date with advancements in technologies.

6.2. Strategy to implement online education

In this section, a 5-step strategy for establishing online programs is provided. This strategy might help institutions in the Middle East to start their online programs. The first step is establishing a committee that consists of members of universities that value online education and have the passion to achieve this goal. This committee will act as a consummate resource to promote online education. The second step is to meet with administrators to convince them of the impact of online education on the society and explain the quality processes that can ensure the rigor of the education process. Step three is to develop collaboration with international and national organizations.

This collaboration will help to secure the funds needed to purchase technological infrastructures and train faculty and students. Many international organizations are offering funds to support education in the Middle East. One example of a collaboration has have been done in the Middle East area is that between the United Nations Educational, Scientific and Cultural Organization (UNESCO) and HBMSU in Dubai [58]. This also can be achieved by offering joint programs with American universities that have experience with offering online programs. The period for offering joint programs can be considered training experience for those universities which are interested in offering online programs for the first time. This period will help them to avoid any challenge that they might face once they are on their own. Step four is to work with administrators to establish standards, guidelines, and regulations that ensure the quality of online programs offerings. The last step is to establish quality assurance programs to ensure the continuous improvement of the learning process for the online programs. Figure 2 provides a model that summarizes this strategy.

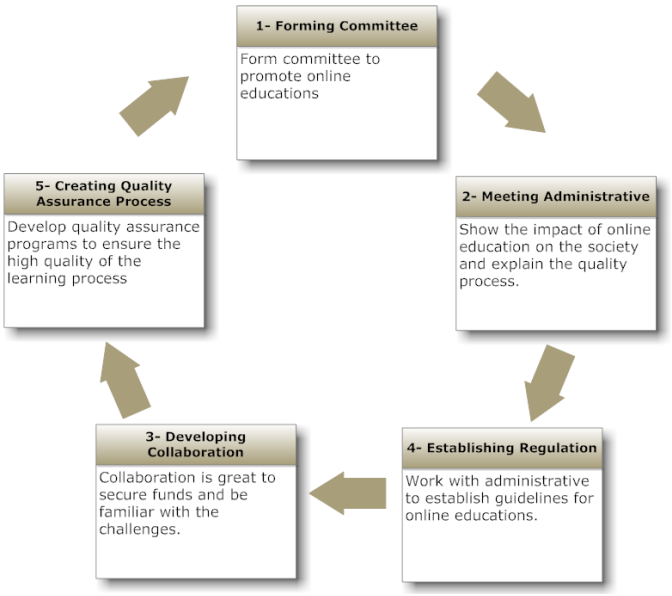

Figure 2. Model for implementing online education

7. CONCLUSION

Developing new online programs in the Middle East universities could be a challenge, but having a well-established technology infrastructure would make the process less challenging. Most Arab universities are offering blended courses as a strategy to enhance the quality of their traditional courses. Also, there are many academic programs offered with collaboration from experienced universities in the US and Europe. The researcher believes that universities in the Middle East are ready to implement online programs. The next step will be establishing government guidelines and standards to regulate the establishment of online programs and to ensure their high quality. Once these policies are in place, interested institutions should offer training to their faculty and students. Pursuing accreditation and collaboration with assessment organizations should be included in their strategic plans and should be achieved within 3-5 years. Monitoring and improving practices is important to ensure the continues improvement of the learning process and to keep up with emerging technologies.

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Challenges and Opportunities of Implementing Online Education in the Middle East

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Journal of the AArU, Vol. 39, No.1. 2019, 39-51 (doi-10.12816/0053042) **Mahmoud Al-Odeh**

Challenges and Opportunities of Implementing Online Education in the Middle East

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Abstract

This paper provides insights and lessons that can be learned from the American universities about their online education experiences. The literature review and previous studies of online educations gains are explored and summarized in this research. Emerging trends in online education are discussed in detail, and strategies to implement these trends are explained. This research paper provides several tools and strategies that enable universities to ensure the quality of online education. At the end of this research paper, the researcher provides examples from Arab universities who have successfully implemented online education and expanded their impact on the society.

ما الذي يمكن تعلمه من تجربه الجامعات الأمريكية في مجال التعليم الإلكتروني وتطبيقه في الجامعات في الشرق الأوسط

محمود العودة[2]

ملخص

باتت ظاهرة التعليم الإلكتروني ظاهرة عالمية غيرت طبيعة المؤسسات التعليمية التقليدية في العالم ومواكبة هذه الظاهرة أصبحت من الأمور الضرورية التي يجب الأخذ بها بعين الاعتبار في العالم العربي لتقليص النفقات التعليمية التقليدية.

سيشارك الباحث تجربته في التعليم الإلكتروني في الجامعات الأمريكية حيث سيشرح كيفية استخدام بعض الأدوات التكنولوجية والابتكارات المهمة في النظم التعليمية وسيتم مناقشة مزايا استخدام التكنولوجيا والإنترنت في التعليم وسيلخص العوامل التي تسهم في رفع كفاءة المؤسسات التعليمية العربية لتواكب الثورة العلمية الحديث في مجال الدراسة الجامعية.

كما سيتحدث عن الاتجاهات الحديثة للتعليم عبر الإنترنت في أمريكا وكيفية تطبيقها في الدول العربية وسيشارك الحضور في استراتيجيات يتم استخدامها لضمان جودة التعليم الإلكتروني.

واخيرا، سوف يسلط الباحث الضوء على أمثلة من الجامعات الناجحة في الشرق الأوسط في مجال التعليم الإلكتروني وعن الأسس التي اتبعتها ونجحت في تطبيق هذه الطريقة المتميزة في التعليم.

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The Impact of Corporate Reputation on Organizational Performance

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Abstract

The empirical study is carried out in Enterprises. The data was collected using a questionnaire distributed among 100 of the employees. The questionnaire is intended to measure the bank's perceived credibility on building and developing the business correlations with the clientele. Regarding the hypothesis's validation, Multiple Regression Linear statistics were performed using the SPSS software. The research findings revealed a direct interrelation between the independent variables (reputation, image, and culture) and the dependent variable. The higher the organization's importance is, the better its performance.

Keywords: Reputation; Intellectual Capital; Corporate Image; Culture; and Performance.

Introduction

The idea that rivals cannot readily compete with certain firms that have won is one of the most debatable issues [1]. A good reputation can be developed if decisions are well determined, and by that, it is considered to be a piece of particularly competitive advice and a very important asset. Although unsuccessful firms cannot gain anything from those who have received it, they are nevertheless entitled to be engaged in strict ads and other efforts to affect a client's reputation over time. So, the company should work on protecting its image and reputation to maintain

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sustainability in the long run [2]. The integrity of corporations and the standard of earnings, "was founded by Basdeo [18] in his report. The scientific proof that a corporate image is positively linked to higher income performance was reported. The findings also demonstrate that the company image promotes superior earnings efficiency and tends to produce greater total profits [3]. The findings were evaluated using the SPSS statistical method. The results suggested that a direct connection existed between the business's credibility and valuation: the greater its reputation, the higher its value will be [4].

Companies with a stronger image have higher pricing labels than firms with a lower image. The image should be used as a measure of consistency. A reward for maintaining the company's good image results from a monetary reward from higher prices [5]. However, administering financial resources to an image is empirically challenging. By taking over 55,000 "Gmail Invitations" listings on eBay, Barbaro [15] aimed to explore the potential prediction of a higher likelihood of a sale and an increased price for good images. Barney [16] major empirical impediment is that it is difficult to evaluate; it is also difficult to distinguish between a company's image and the other indicators that also form transactions. Therefore, Leis was able to disintegrate the deal's price into items that have been linked to the consequences of the photo and those that are irrelevant to the illustration in the following work, "Financial Cost of Reputation: Proof from eBay Aucts of Gmail Invitations [6]."

The study found that companies that increase their reputation have a 5.5% higher probability of sales and a 6.0% increase in the buyer evaluation involved after adjustment to truncation distortions from failing auctions [7]. The study shows that the image cannot be passed globally through various items. Lei concludes that compliance with evidence confirms the theory that the image positively affects both the sales and price of goods. Conversely, highly reputable companies are more likely to sell their goods more quickly than those with less reputation. They can also sell them at a higher price than their less reputable competitors [17].

In this relation with human beings, it is suggested that people with credibility be more desirable than those with a poorer reputation. Benson [19] explores the different dimensions of how a brand's credibility affects its price performance on online markets and concludes that a poor reputation harms a company's image rather than a favorable one [8]. It is recorded that a bad reputation is increasingly growing the market value of companies and, through cooking unearned income and account records, transform good practice from nice to unfavorable in commercial governance in Nigeria; these findings illustrate a big truth. The authors demonstrate a good reputation as a company in their study "Dimensions of reputation in electronic markets" to significantly improve its performance [9].

Problem Statement

Recently, many Small Medium Enterprises faced many problems in their financial performance [10]. Thus, this research aims to study the impact of corporate reputation on organizational

performance as a whole [11]. However, the research questions will be addressed: What is the impact of Corporate Reputation on the Organizational Performance of Small Medium Enterprises?

Reputation, Governance and company' value

One of the major values of a good reputation is that it is not easy for competitors to imitate those enterprises that have acquired it [12]. A good reputation is considered a specific competitive advantage and a very important asset but is also destructible if decisions are not well taken to strengthen it. While competitors cannot obtain it from the ones that have acquired it, they can nevertheless be hired in strict de-marketing activities and other unfavorable attempts to drown the reputation of a company that has acquired for itself over time. So, companies that have this valuable intangible asset should enviously preserve it [13]. Corporate Reputation and Financial Performance" was studied by Bernston [20], which stated that a corporate image is linked in a positive way to higher earnings quality. His results also indicate that corporate reputation helps to organize superior earnings quality and generate higher total sales in Chinese public firms. However, his research was based on the quantitative methodology throughout addressing a sample of 150 respondents in different firms [14]. The results were analyzed using the SPSS statistical tool. The outcomes proposed a direct relationship between reputation and the company; the higher the reputation is, the higher the value of the company will be.

The price label that companies put on their products has been stated to be related to their image. Therefore, companies with a stronger image put higher price labels on their items than those with a lower image. The image is suggested to work as a quality indicator. A reward for keeping a company's good reputation results from a monetary reward derived from higher prices. It is nevertheless empirically challenging to administer financial worth to image. By taking more than 55,000 auctions of "Gmail Invitations" on eBay, Firer [22]'s objective was to examine the hypothetical forecast that sellers with a good image have a higher probability of selling as well as getting a higher transaction price. The major empirical obstacle to which Lei was confronted in his duty is that a company's image is difficult to evaluate and hard to put apart from other indicators that also form transaction results. Therefore, in the following research, "Financial Value of Reputation: Evidence from eBay Auctions of Gmail Invitations," an authentic benchmark price series was armed by Lei, who was capable of disintegrating the settlement price into elements that are attributed to the impacts of image and those that are not associated to the image. A shred of evidence was found by the study that sellers who enhance their image from the lowest to the next quintile have a 5.5% higher probability of sales and a 6.0% hike in the involved buyer valuation after adjusting for truncation bias from failed auctions [23].

Lei conclude that the image is stated by the study to not be internationally transferable across different items. Lei finds that enforcing evidence affirming the theory that image positively influences both the sale and the price of items. Speaking differently, there is a higher probability that highly reputable enterprises will not only sell their items more quickly than the ones who

enjoy less reputation but can also do so at a higher price than their less reputable competitors. If this is related to human beings, famous persons are more favorable in doing a lot of tasks than those who have less reputation. According to Gotsi [24], another research studies the way various dimensions of the way a company's reputation impacts its pricing power in electronic markets. It is found that a negative reputation damages the image of a company more than a positive one helps it. It is stated that the wat a bad reputation quickly decreases the market value of companies that change the best practice from a friend to an unfriendly one in commercial governance in Nigeria, especially by the mean of cooking of unearned income and accounting books; these outcomes underscore a major truth. In their study "The Dimensions of Reputation in Electronic Markets," the authors demonstrated a good corporate reputation to considerably enhance a company's performance.

Corporate Reputation and Investment Performance of companies

A lot of experimental evidence to which a positive link relates a company public perception and its financial to equity market performance do exist. Paradoxically, the relationship between a company's reputation and the price of its products and the value of the enterprise, Guthrie (2004) in their study concentrate on the way a firm's reputation impacts its value stock in the market. In their study entitled Corporate Reputation and Investment Performance: The UK and US Experience", it is found by the authors that companies that possess a high rank in reputation have a better performance "on a total equity return basis" than the ones that have a low rank on reputation. The study was implemented based on a mixed approach based on a sample of 200 respondents in the UK. The results proposed that the relationship between the company's reputation and its price tends to be positive. The higher the reputation is, the higher the product's price will be, reflecting a higher value of the firm.

Moreover, Kandie [26] find in their study of the link between a company's reputation and the returns on its shares that exceptional returns are made by investors who buy stocks of companies whose reputation has considerably increased. This results from a message for companies to invest in their reputation to generate a good image of themselves. This study shows that reputation plays a vital role in enhancing the performance of a company. A generated goodwill is a major asset of the company, resulting from prior reputation improved activities. Evidence that internally-generated intangibles such as reputation are added to the research by the findings is part of its stock market value. This evidence is provided on the relative worth of an augmentation in its reputation, which should not continue to be part of companies' financial statements as an intangible asset. This can lead to the following hypotheses:

H1: There is a direct relationship between corporate reputation and performance

Methodology

Collecting data throughout using different instruments can be defined as a research methodology.

Research design

Layer One – Philosophies

A theory of research relates to beliefs regarding the nature of the truth under review [29]. It is the meaning behind the essence of knowledge. Study ideologies may vary about the research aims and the appropriate way of achieving such objectives [30]. The choice of research philosophy is defined by the type of information being researched in the research project [31]. This is not necessarily different. In the research process, there are three main philosophies. Ontology–ontology is about truth analysis. This explains the essence of the truth. It discusses what it takes to perform the work and how it impacts culture and the climate. Ontology reveals the distinction between reality and the perception of reality. Throughout fact, it shows you how it impacts people's behavior. The ontological worldview primarily comprises three metaphysical perspectives [21]. These are objectivism, building, and pragmatism. The ontology includes; objectivism and constructivism.

- Objectivism makes you know about a social event and how different people relate to it. This differentiates the effects of different people's social experiences.
- Constructivism assumes that people create social processes; that it is the reverse of objectivism.
- Pragmatism: The ideas used for the treatment of a particular issue.

Compared with others, the latter is quite a new one, and it offers an alternative to epistemology. The most commonly used epistemology is in scientific research, and this is because it helps you find information that you can without doubt prove. Here, after rigorous testing, you must define acceptable knowledge about your research and give information about results. Philosophic perspectives within epistemology include positivism, logical realism, and interpretivism. Axiology–Axiology helps you understand how your work's compilation and interpretation reflect your values and opinions. The effect of people's opinions on data selection and insights was recognized by [32]. It helps you understand that the opinion of people matches a lot during a study.

The research will implement the ontology approach throughout practicing the quantitative methodology and through using the survey

Layer Two – Approaches

The two words used in the second layer of the analysis onion are deductive and inductive. It is important to understand the research aim and its limitations in the previous onion layer. The deductive approach builds on a theoretical assumption and then formulates a research approach for testing it [32].

The deductive approach

The deductive method can be seen as especially appropriate to optimistic methods, which provide an acceptable level of likelihood to be developed hypothesis and statistically checked for expected results.

Inductive Approach

The inductive approach allows you to create rather than take a theory as an inductive approach. In both approaches, this clearly describes the difference. The inductive method is characterized as a step from one to the other. No structure first guides the collection of data, so the study's aim can be defined after the data is collected [33]. The deductive approach will be used in the research since it will rely on previous theories to validate the research hypotheses

Layer Three: Research Strategy

The research strategy outlines how the scientist plans to do the job [25]. The technique may cover various strategies, including trial, intervention, case studies, interviews, surveys, or systematic literature reviews.

Experimental

Experimental research relates to the study technique to analyze the effects of an experiment against the expected findings. It can be used in all research fields and usually considers a relatively small number of factors [34].

Survey

Research onion survey strategy is frequently linked to a deductive approach. The study technique is one of the best and most competitive. This method allows you to collect rich and reliable data. The polls also include interviewing many of the population in quantitative research programs [34].

Case Study

The survey technique for onions analysis is often related to a deductive method. One of the best and efficient is the research technology. You can collect rich and reliable data with this tool. The surveys also include interviews in quantitative research programs with a large part of the population

Action research

This type of research is popular in education or nursing, where practices may examine ways to improve their commitment to their specialty's discipline and knowledge. The main aim of this approach is to find a solution to a certain problem. However, the research will implement the survey since I will distribute the questionnaire over a defined number of respondents for data collection, and then the data will be analyzed using the SPSS statistical tool

Layer Four: Choices

This is the fourth layer of the research study and is also known as the choice of research. This layer will help you know whether quantitative and qualitative methodologies should be combined or if it is only possible to use one method. There are three described choices in the investigative onion, including the choice or approach of the research method mono, mixed and multi-method.

Mono method

You have to gather one type of information when using this method based on either quantitative or qualitative methods. You can't bring the two together.

Mixed method

This method allows one to combine quantitative and qualitative methodologies to create a precise dataset in research. The mixed-methods combine methods to create a single dataset, while multiple methods are used to divide the research into segments, each with its particular dataset. However, since the research will implement the survey, the research will rely on the mono method since only one methodology will be implemented.

Layer five: Time horizons

The time frame specifies the time needed for the project research to be done. Where time horizons in study onion are specified: cross-sectional horizons and longitudinal horizons.

Cross-Sectional

The timeline shows the period required to conduct the project study. Where horizons are specified in study onion: transverse horizons and longitudinal horizons.

Longitudinal

A longitudinal time frame is used for data collection, where a significant factor for analysis is the examination of changes over time. Data collection is regularly important over a long period. The longitudinal horizon will be practiced in the research since it will follow up with the respondents for data collection.

Layer Six: Techniques and procedures

This is the sixth and last stage of the study cycle. The process contributes substantially to the study's overall reliability and validity in this research [27]. Data are compiled and analyzed using an analytical methodology [28]. The framework explains how data used for analysis are obtained and analyzed. It also provides information on the data source, study structure, sample size, sample fairness, sample shortcomings, reliability, and validity. The data collected may be primary or secondary. The key information is pure data, which is obtained directly from the source. Secondary data is indirect information, as opposed to primary data. Primary data is classified as a source or hand-held data. You can do so through multiple questionnaires of instruments, oral or written interviews. Secondary evidence is extracted from the research or perspectives of the scientific literature of the others. Both types of data will be practiced through research [35]. The first is to distribute a questionnaire, and the second by addressing previous studies in the Literature Review [36].

Variables and Hypotheses Development

The following section will address the variables used in the research and the development of the hypotheses.

- Dependent Variables: Performance
- Independent Variables: Culture, Corporate Reputation, Image

$H1_0$: There is no relationship between culture and performance
$H1_1$: There is a relationship between culture and performance
$H2_0$: There is no relationship between corporate reputation and performance
$H2_1$: There is a relationship between corporate reputation and performance
$H3_0$: There is no relationship between image and performance
$H3_1$: There is a relationship between image and performance

Ethical Considerations

The implementation of research ethics was commonly carried out to ensure the findings are valid and accurate since primary research engages in the research. The ethical research values used include informed consent, anonymity, and confidentiality. Knowledge demands that primary

research subjects be given consent that supports the research goals and encourages prospective participants to determine whether or not to engage in primary research. Regarding confidentiality, the primary research respondents' specifics are not included and are not related to primary research outcomes. Nevertheless, those who believe in the study do not share the analysis results with regards to secrecy.

Sampling and Population

To study the effect of culture and company reputation on the firm's performance, the quantitative approach was used, and 150 respondents from different accounting and auditing companies were sent a questionnaire, as shown in table 1.

Inferential Statistics

Table 1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.715
Bartlett's Test of Sphericity	Approx. Chi-Square	6698.949
	Df	151
	Sig.	.000

As indicated, the KMO coefficient is greater than 0.6. We can conclude that the sample size condition is validated. On the other hand, Bartlett's test with a P value < 0.05 indicates that the different variables' correlation matrix is an identity matrix. From this perspective, we can conclude that the instrument is statistically dependable for further statistical analysis, as shown in table 2.

Table 2. Factor Analysis

Factors	No. of Items	Cronbach's Alpha	Analysis
Factor1: Corporate Image	7	0.715	For all the Factors, Cronbach's alpha value is greater than 0.6. We can conclude that: The Internal Consistency of the instrument is Confirmed for all factors
Factor2 : Corporate Culture	10	0.695	
Factor3: Corporate Reputation	8	0.691	
Factor 4: Company Financial Performance	3	0.741	

The results are shown in the above table. For all the factors, the Cronbach's alpha coefficients are greater than 0.6; accordingly, we can conclude that the scale reliability is validated.

Hypotheses Validation

After proving the validity and reliability of the questionnaire multi-attributes scale, we assessed each of the suggested hypotheses by relying on correlation and regressions analysis to draw correlations among the independent and dependent variables under consideration, as shown in

table 3 and table 4.

Table 3. Model Summary

Model	R	R Square	Adjusted R Square	Std. The error of the Estimate
1	.650[a]	.602	.601	.30565

Predictors: (Constant), Performance

Table 4. Coefficients

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	87..83	6.385		13.792	0.0075
	reputation	1.3208	0.063	0.94	9.824	0.000
	image	0.958	0.043	0.677	8.877	0.000
	culture	0.485	0.032	0.252	3.667	0.000

a. Dependent Variable: Financial Performance

Discussion of the Findings

This section of the research will address the validation of the hypotheses and discuss the findings based on the respondents' data and based on the statistical analysis practiced. Concerning statistical testing and the analytical literature and hypotheses, the findings demonstrate that there is a strong correlation between reputation and corporate performance, that means the acceptance of the "reputation is positive for corporate performance" alternative hypothesis and the failure to accept the null hypothesis, "There are null hypotheses" The statistical analysis showed a P-value of less than 5%, with recent studies showing that companies with a good reputation tend to perform better than companies with a bad reputation.

On the other hand, the results showed the positive correlation between image and corporate performance, which means accepting the alternative hypothesis that "corporate image is positively interrelated with corporate performance" and that the null hypothesis is not acceptable. The higher the level of employee qualifications, the higher the productivity reflects better financial performance, the more important is intellectual capital to measure corporate performance. Finally, the research results show a positive correlation between the organization's culture and performance. Since the statistical results show a P-value lower than 5 percent, the research's above variables show a positive correlation. Thus, the better the culture, the greater the organization's financial performance. This section will address the conclusion by providing a general summary of the literature findings and the research findings.

Theoretical Contribution

The research addressed the phenomenon of reputation and its impact on the organization's performance, taking into consideration several variables. Previous research proved that corporate reputation impacts financial performance; the findings revealed a positive correlation among the mentioned variables. Companies that tend to have a good reputation tend to have higher performance than organizations that don't. The research had been conducted in the MENA region, and the results had been tested using the descriptive analysis to validate the hypotheses. Other researches proved that there is a positive correlation between CSR activities and corporate performance. CSR activities had been defined as practices done by the organization to benefit the organization's community. At last, studies proved that there is a direct correlation between intellectual capital and corporate performance. The better the intellectual capital is managed, and the higher the organization's performance will be.

Practical Implication

The research findings proved that the hypothesis states a direct correlation between reputation, intellectual capital, corporate social responsibility, and financial performance. The higher these practices are implemented in the organization, the higher the performance will be and maintain financial sustainability in the long term. Furthermore, the research addressed two case studies and worldwide, and both studies proved a direct correlation between corporate reputation and corporate performance. It is highly recommended to implement a further study based on new research variables to study corporate reputation's impact on corporate performance considering new variables. It is also highly recommended to address many respondents to get accurate results and validate the research hypotheses. Finally, it is recommended to implement a specific case study on a bank or organization with many branches to address in brief the impact of corporate social responsibility practices and its impact on corporate performance. This will add value to the research.

Study Limitations and Future Research

- Some respondents refused to answer the questionnaires to maintain confidentiality in the workplace, and some respondents did not have the time to answer.
- The research addressed only one case study
- There are many variables which are not addressed briefly
- The number of respondents is considered low because of lack of time
- The research is considered very wide.
- Only one methodology was practiced in the research

Research Contribution

- The research focused on the importance of reputation and its impact on the organization's financial performance.
- The research showed that many variables impact reputation, including the corporate image and organizational culture, adding on them the corporate social responsibility practices implemented in society.
- The research findings complied with the empirical literature findings reflecting a healthy correlation among variables of the research.
- Address Several Variables
- Take into consideration more case studies
- Practice both methodologies to study the point of view of managers and experts.

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Supply Chain Management Information Systems Survey for Jordanian Companies

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Supply Chain Management Information Systems Survey for Jordanian Companies

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Abstract
Effective information system (IS) has been one of the key factors that shaped the supply chain management (SCM) developments in the last few decades. The literature on surveying IS in SCM is somehow scarce, particularly in developing countries. The purpose of this study is to investigate the current use and future adoption direction of Supply Chain Management Information Systems (SCMIS) in Jordan. Data from 64 manufacturing and service firms were collected. The results show that i) the overall implementation of SCMIS is very poor, ii) the currently implemented SCMIS, and the expected to implement, are mostly focusing/will focus on separated functions within firms, iii) integration with suppliers' and customers' system, resistance to change from employees, and insufficient vendor support; are the main problems facing the adaptation of SCMIS, and iv) for improving SCM activities; enhanced information provision and closer cooperation between firms and associated governmental agencies are needed. The study is concluded with recommendations for SCM policymakers, firms' managers, and SCMIS vendors.

Keywords- Information systems, Supply chain management, Jordan, Survey.

1. Introduction

During the past 20 years, supply chain management (SCM) has emerged as one of the major areas for firms to gain a competitive edge. In addition to globalization, outsourcing, and sustainability issues; information technology evolvement has been shaped the supply chain management (SCM) developments. The evolution of the information systems (IS) facilitated by technological advancements has dramatically affected the supply chain (SC) integration, enhance SCM performance, and providing more value to customers. Particularly, many benefits have been achieved by using IS in SCs, including sharing information, generating real-time reports, supporting the process of making accurate prompt decisions, adapting quickly to the market changes, reducing waste and cost, and improving customers' satisfaction (Al-Odeh, 2016).

Whether it is intra-organizational or inter-organizational, an IS is a collection of information technology (IT) resources, including communications networks, hardware IT applications, standards for data transmission, and human skills and experiences (Williamson et al., 2004). There has been a lot of literature indicating the use of intra-organizational IS such as Material Requirements Planning (MRP), Manufacturing Resource Planning (MRPII), Enterprise Resource Planning (ERP), Supplier Relationships Management (SRM), and Customer Relationships Management (CRM) (Ketikidis et al., 2008). Fewer developments in inter-organizational have been

advanced. Shore (2001) categorized inter-organizational IS developments in four phases: paper-based information flows (e.g. copies of purchase orders), the development of electronic data exchange (EDI), Enterprise-wide systems mainly characterized by Enterprise Resource Planning (ERP), and the systems enabled by the use of web development technologies such as Extensible Markup Language (XML) and Java. Other technologies, such as wireless and mobile technology and Radio Frequency Identification (RFID) have been also implemented in the SCs of different business sectors.

Although it is impossible to achieve an effective supply chain without integrated IS, few literature studies on surveying the IS in SCM can be found (Gunasekaran and Ngai, 2004). Literature scarcity becomes worse for developing countries. This research aims to explore the current use and future adoption direction of IS for SCM in Jordan, accordingly, provides guidelines to policymakers and firms' managers for better-fitted policies and resources allocation. As a predecessor step for surveying Supply Chain Management Information Systems (SCMIS), the adoptions of common SCM strategies within the surveyed companies are investigated.

The paper is organized as follows. First, previous SCM-related studies conducted in Jordan are reviewed. Then, the research methodology and the characteristics of the responding firms are discussed. Section four presents the research findings while section five discusses these findings. Finally, section six provides some concluding remarks and recommendations.

2. SCM Previous Studies in Jordan

Limited literature can be found with respect to SCM activities in Jordan. Although it is possible to summarize this research work in chronological order, it was selected to present it according to the studied subject, detailing the approach adopted and the major findings.

Al-Ma'aitah (2014) studied the cultural perspective in supply chain relationships within the Jordanian manufacturing sector. The study examined eastern Arab cultural values and their impacts on the long-term relationships between buyer and supplier. A quantitative survey methodology of two samples including 350 buyers and 302 suppliers, were conducted in this study. Six main values were investigated (to know someone, networking, promise, fatalism, face-saving, and consultative). The results show that the medium to strong relationship exists between the studied values and long-term buyer-supplier relationship.

Abdallah et al. (2014) conducted a study to investigate the impact of SCM practices on supply chain performance by surveying 104 Jordanian manufacturing companies. The researchers found that three management practices impacted the efficiency of a SC, namely: internal integration, information sharing, and postponement. Surprisingly, the supplier integration and customer integration were found insignificant with regard to the performance of SC in Jordan. With respect to SCM-financial performance for companies, Salhieh (2011) studied the relationship between SCM practices and organizational financial performance. There are 28 manufacturing companies registered in the first market of the Amman Stock Exchange participated in the study. Regression analysis results indicated a strong relationship between SCM practices companies and bottom-line profits. In another SC-performance related research, Al-Saa'da et al. (2013) conducted a study to measure the effect of SCM dimensions on the quality of healthcare services dimensions in private hospitals in Jordan. The study analyzed 315 questionnaire responses collected from employees working in the departments of supply and procurement in 36 Jordanian private hospitals. The study

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results showed a significant relationship between the SCM dimensions and relationship with suppliers, specifications and standards, after-sales service; and the quality of health services.

Recently, Green SCM (GSCM) has attracted some of the Jordanian researchers' attention. In their work, Hijaz et al. (2015) evaluated the current state of the Jordanian marketplace in the context of GSCM aspects including product delivery time, currency exchange, the use of IS for data sharing, tax increments, and indecent competition. Based on interviews with a sample of small-to-medium enterprises (SMEs) the study found a high deficiency in all GSCM aspects and concluded that SMEs in Jordan have minimal attention towards the environment. Al Khattab et al. (2015) examined the GSCM impact on the performance of environmental-based marketing. Through questioning top and middle managerial levels in five Jordanian companies, the statistical analysis of the results showed that the significant GSCM practices which affect the environmental-based marketing performance are: internal environmental management, green purchasing, green IS, cooperation with customers, eco-design and packaging, and investment recovery. Focusing on Jordanian food production companies, Zu'bi et al. (2015) implemented descriptive and inferential statistical tools to investigate the effects of supply chain integration on environmental performance. The results of the study indicated that supply chain integration can positively affect environmental performance, control, and pollution management.

Jraisat (2010) developed and examined a conceptual framework that explains factors of the export supply chain relationship, for fresh fruit and vegetables between Jordan and the European Union, with focusing on information sharing. Based on expert interviews and ten case studies analyses, the study found that companies can gain strategic advantages from SCM based on the information; thus, improve their financial and non-financial export performance. Al-Odeh (2010) investigated the state of SCM and the use of information systems to support it at Al-Hassan Industrial Estate in Jordan. Through interviewing 49 companies, the study mainly found Jordanian companies are focusing on developing relationships with suppliers more than customers.

As can be seen from the above literature survey, no previous research was conducted to examine the implemented strategies and information systems for SCM in Jordan. This research aims to cover this gap.

3. Research Methodology

Combinations of different methodologies were used in this study: literature review, questionnaire survey, and interviews (by phone and over the Internet). Studying previous literature helped the researchers understand the different information systems (IS) that are used for SCM and to design an online questionnaire to gather data from firms on issues related to the current situation, challenges, benefits, and development of SCMIS in Jordan. The study surveyed 64 out of 170 companies from the manufacturing and service sectors. The researchers sent the survey to operations, supply chain, and/or technology managers of those companies to partake in the study. An email with a link for the survey is sent to 170 managers and then followed up with a phone call to confirm receipt within two days. This practice encouraged managers to participate in the study and take it while they are on the phone. The sample is identified by performing a google search with "List of Companies in Jordan" as the key phrase. The participants voluntarily participated in the study. The data collected and the conclusions from these interviews are explained in the following section.

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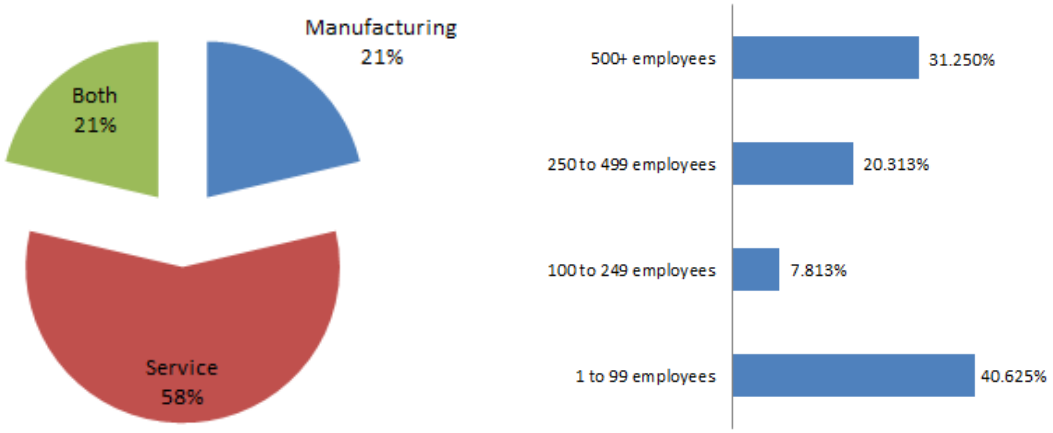
Figure 1(a) shows the sectors of the participated companies while Figure 1(b) shows their size. As can be seen, the focus (58%) was on companies from the service sector. This emphasis is justified since about 59% of the Jordanian gross domestic product (GDP) is generated by the service sector, agriculture contributed around 4 %, and 25.43% came from the manufacturing and industry sector (The World Bank, 2013) (Jordan Chamber of Industry , 2014) (statista.com, 2017). Similarly, since the majority of Jordanian firms are in the small-to-medium size range (Al-Mahrouq, 2010), the majority (68.75%) of participated companies fits under this category (had less than 500 employees).



(a) The participated companies profile (b) The size of the participated companies

Figure 1. Surveyed companies' background

The questionnaire consists of 17 closed questions built based on best practices from literature and industry. A pilot survey was conducted as a validation strategy to ensure that the research objectives can be achieved through the questions used in the questionnaire. Three companies were randomly chosen for this refinement process. The questionnaire was updated regarding recommendations from the participants of the pilot survey. About 15 minutes were needed to finish the questionnaire that consists of four parts: The first part aimed to identify the profile of the companies who participated in the study. The second part investigated the surveyed companies' background regarding SCM. The third part of focused on the current SCMIS used by surveyed companies. Finally, the last part of the survey was designed to investigate the 2-year future of SCMIS adoption in Jordan.

After collecting the data, the SPSS software was used to analyze it. Mainly, descriptive analysis was conducted and figures were used to give a better understanding of the results.

4. Research Findings

The survey's data analysis showed interesting findings in significant issues related to the objective of this study. These findings are classified into three succeeding subsections and summarized in a later subsection.

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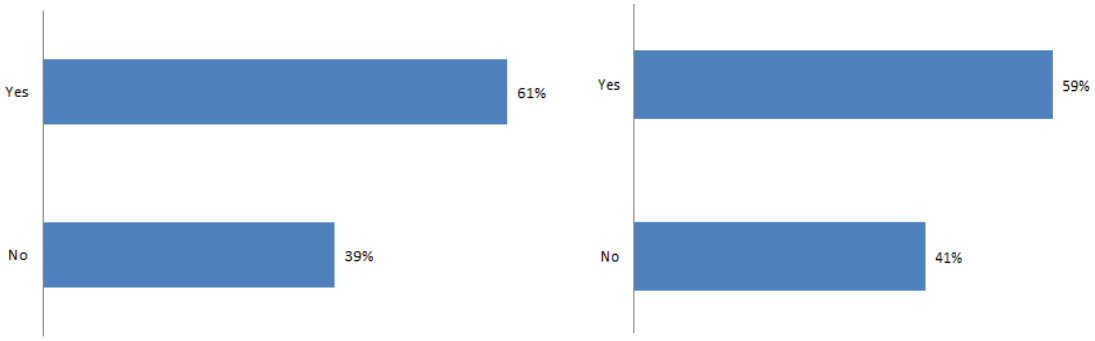
4.1 SCM Background in the Companies

This part of the survey described the SCM background of the surveyed firms including SCM within the firms' structure, adopted SCM strategies, evaluating logistical customer service, and the success rate of implementing SCM activities.

As indicated by Figure 2, the results indicated that 61% of the surveyed firms have separate SCM/logistics departments. Interestingly, very close percent (59%) of survey participants (operations and technology managers) believed that their companies SCM/logistics strategic plan is clear.



(a) Separate SCM department (b) The clarity of SCM strategic plan

Figure 2. SCM in companies' structure and strategies

Figure 3 summarizes the questions' answers about evaluating logistical customer service. Total cycle time, customer feedback, and percent of correctly delivered products/services were the most popular utilized methods for measuring logistical customer service in Jordan. Products availability and tracking came next but with roughly comparable scores. This result is, in fact, encouraging as it implies that logistical customer service, as acknowledged from the customers' perspective, can be significantly improved by adopting better appropriate SCMIS.

As a part of companies' background, the survey tried to uncover which SCM strategies Jordanian companies find keen to manage their supply chain. Although neither single nor group of strategies gained an overwhelming score, Figure 4 indicates that the main three strategies adopted were a close partnerships with suppliers, close partnership with customers, and holding safety stock.

Finally, this part of the survey asked about the success in managing Jordanian SCs and the companies' satisfaction regarding current public policies. As given by Figure 5(a), only about half of the surveyed companies were found successful or highly successful in managing their SC. The success in managing SC is measured based on these factors: inventory turnover & accuracy, delivery/shipment times, and warranty costs as a percentage of sales. Interestingly, more than 78% of the companies were neutral or worse with respect to their satisfaction with the current public SCM-related policies (Figure 5(b)). The public SCM-related policies are policies and guidelines established by the government authorities to regulate the activates in the SCM sector. These results imply a motivating opportunity for improved SCM activities and policies, and whom better than SCMIS to support achieving this target.

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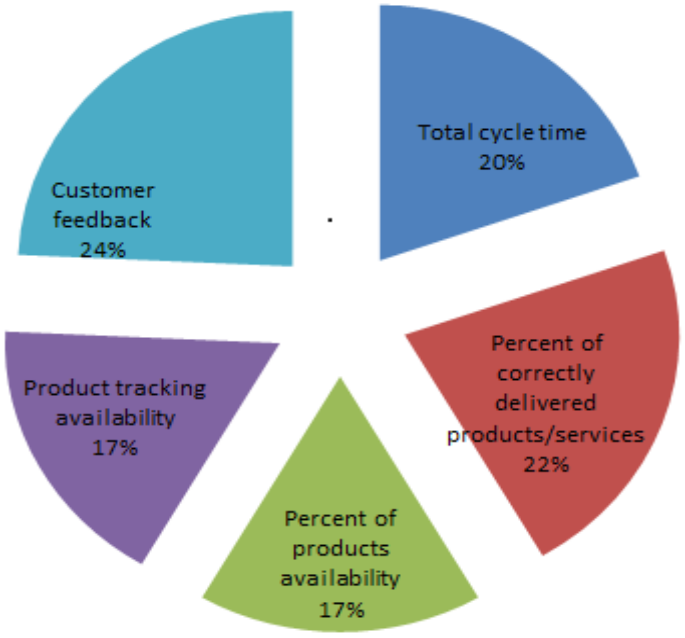

Figure 3. Strategies used for evaluating logistic customer service

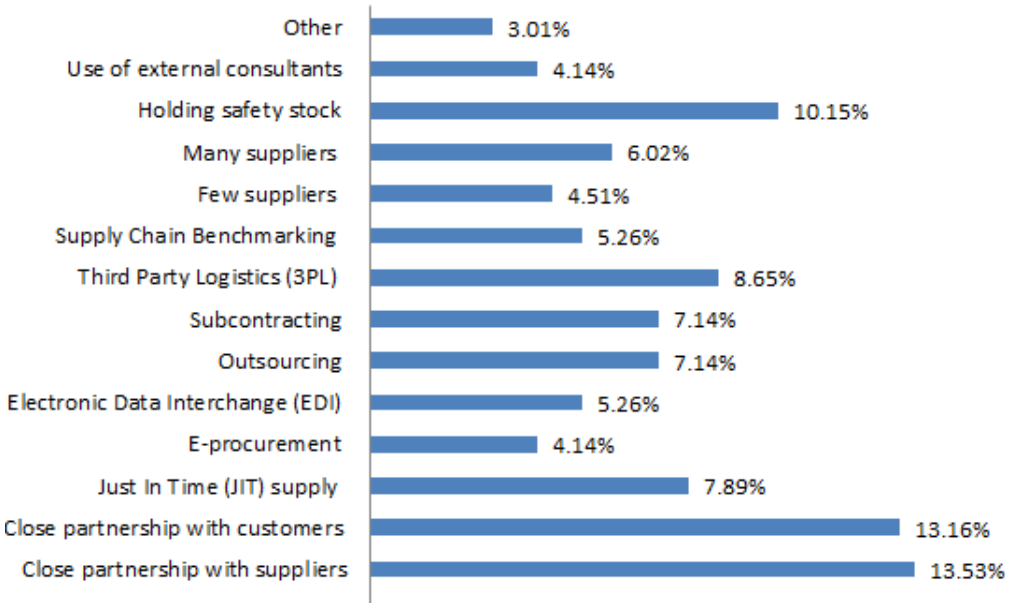

Figure 4. Current implemented SCM Strategies

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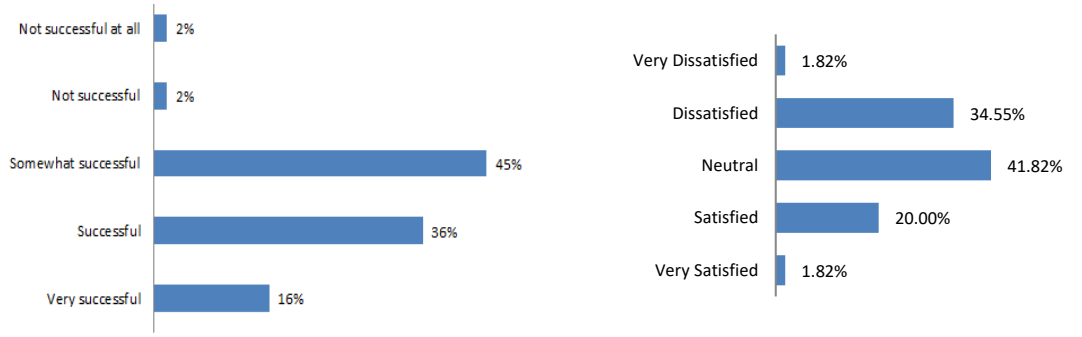

(a) The success of managing SC

(b) Satisfaction with current SCM public policies

Figure 5. SCM activities and public policies performance

4.2 Current Use of SCMIS

This part of the analysis focuses on the current situation of the SCMIS in Jordan. The issues which looked after here were the current use of SCMIS, its' benefits, and problems faced. Figure 6 depicts the most popular IS that are currently in use by Jordanian companies to manage their SCs. MRP systems, WMS, CRM systems, and ERP systems; were found the most usable systems. Surveyed managers indicated that the following criteria were dramatically enhanced by implementing SCMIS: inventory level, accurate costing, operational efficiency, and quantity of information. Other performance criteria were improved but with less achievement as summarized in Figure 7. Finally, as illustrated by Figure 8, the most significant problems that rose when implementing new SCMIS were: change resistance by employees, integration with existing systems, and insufficient vendor support.

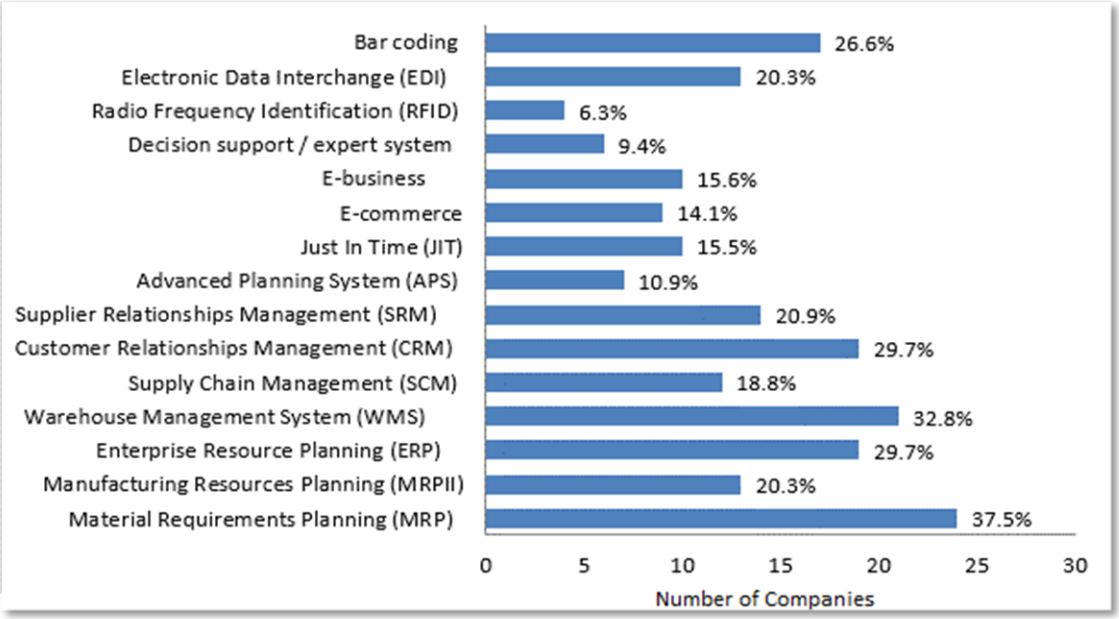

Figure 6. Current use of SCMIS

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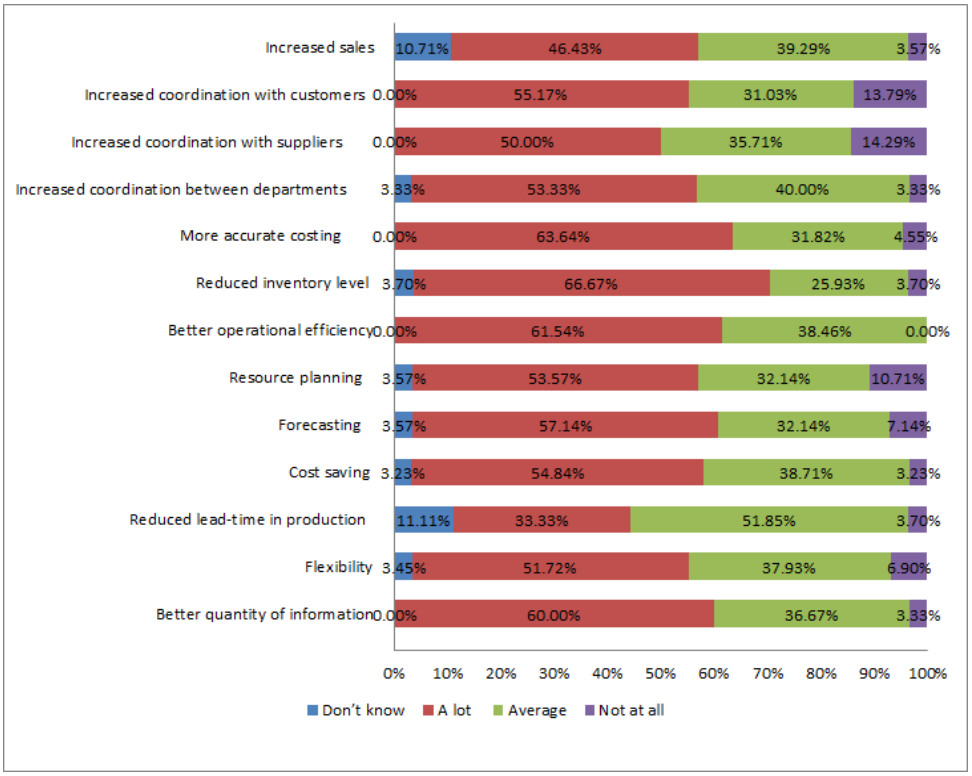

Figure 7. The benefits of using the SCMIS

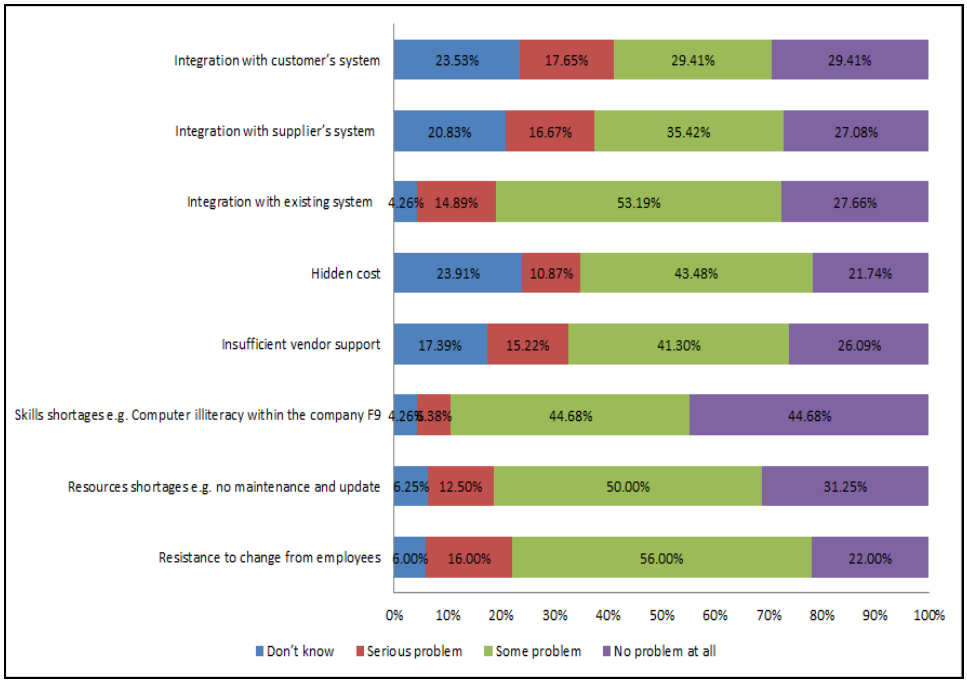

Figure 8. The problems of using SCMIS

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4.3 Future Direction of SCMIS

Two issues were surveyed regarding the future of SCMIS in Jordan: what SCMIS Jordanian companies are planning to implement within the next two years, and required strategies which are necessary for SCM improvement and the relationship of these strategies with IS. Regarding the first issue, as depicted by Figure 9, it was found that the main SCMIS are: MRP, SCM benchmarking, ERP, and WMS. RFID and E-commerce systems attracted the least implementation intention. For the future SCM-strategies requirement issue, the surveyed companies believed that improved information provision, and closer cooperation between companies and government are the most important strategies which need to be advanced for pushing SCM activities. Interestingly, both of these strategies are IS related. Other strategies such as improved cooperation with the chamber of commerce and better education and training came next. Figure 10 summarizes the results of this issue.

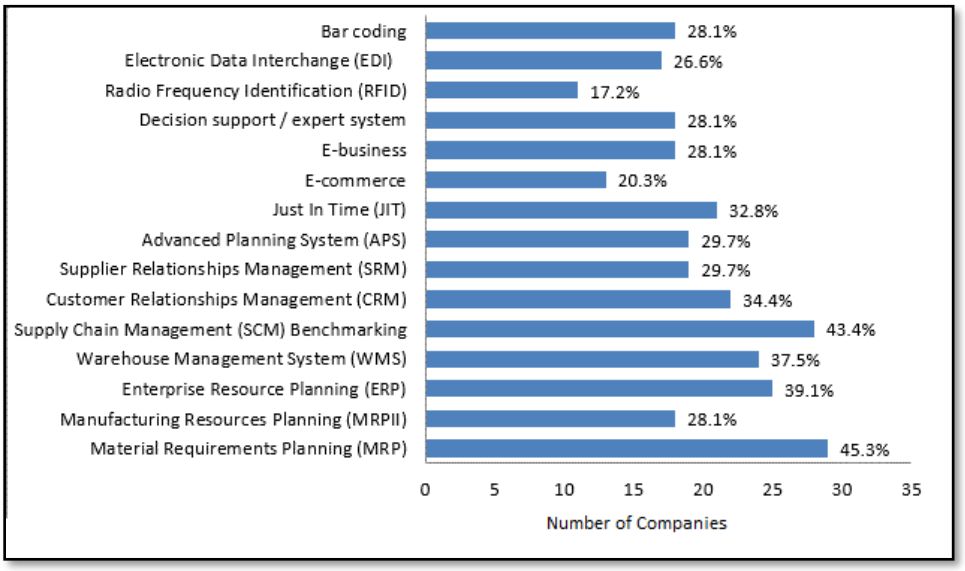

Figure 9. What SCMIS companies will implement within the next two years

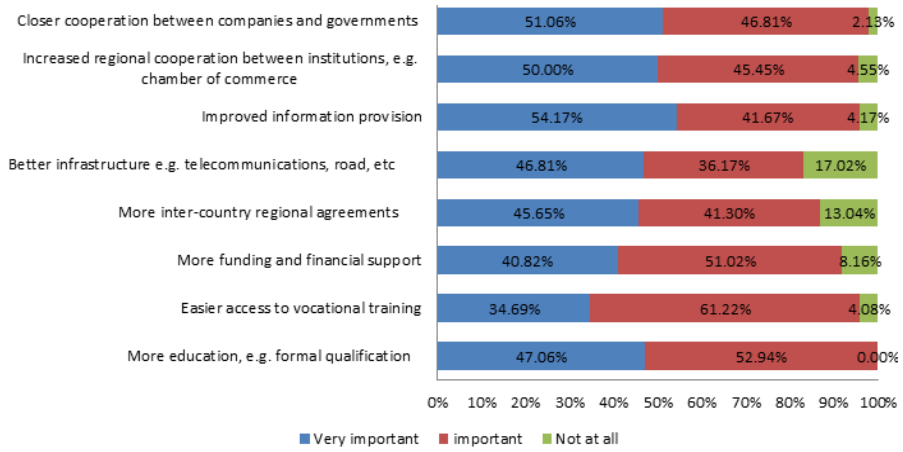

Figure 10. Strategies to improve the future of SCM

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4.4 Summary of the Findings

This section summarizes the findings of the current study in the following points:

- The majority the firms have separate logistics department, consequently, SCM strategic plan was clear for the majority of companies.
- The most popular methods for measuring logistical customer service are total cycle time, customer feedback, and percent of correctly delivered products/services.
- Developing a better relationship with suppliers, with customers, and holding safety stock; are the key SCM strategies which Jordanian firms are currently implemented.
- Motivating opportunities exist for improved SCM activities and policies since the majority of the survey answers showed dissatisfaction with current SCM activities in companies and SCM governmental policies.
- The implementation of SCMIS (mainly MRP, WMS, CRM, and ERP) significantly enhanced inventory level estimation, accurate costing, operational efficiency, and quantity of information.
- The following are serious problems facing the implementation of SCMIS: integration with suppliers' and customers' system, resistance to change from employees, and insufficient vendor support.
- The SCMIS which are expected to be implemented in the new future are: MRP, SCM benchmarking, ERP, and WMS.
- Improved information provision and closer cooperation between companies and government are the most important strategies which need to be advanced for improving SCM activities in Jordan.

5. Findings' Discussion

It was encouraging to discover that about 60% of the surveyed managers had a clear picture of the SCM strategic plan in their companies. Unfortunately, this was not totally reflected in the SCM success rate which was just about 50%. This result can be explained by, although respectively it was among the most implemented SCM strategies, the poor relationships with the suppliers and customers (only about 13% have a close partnership with suppliers or customers). Additionally, the deficiency of public SCM-related policies and the shortage of professional related training are certainly major reasons for the low success in implementing SCM activities and in achieving its objectives. In fact, better SCM employee training can help in reducing the problems which may be faced in implementing SCMIS as resistance by employees and integration with existing systems.

The findings analysis indicated that most of the currently implemented SCMIS, and the expected to implement, are focusing/will focus on discrete processes or functions within the company walls (such as MRP, WMS, and ERP); few are targeting/will target customers' relationship (such as CRM and E-commerce), or suppliers' relationships (such as SRM), or both (such as EDI and RFID). Generally, focusing on SCM activities within a company more than on relationships with customer, suppliers, or both; is a normal practice [Ballou book] for immature SCs. In the Jordanian case, this helped the companies, and not the supply chains, mainly in improving their inventory managing, products' costing, and operations' efficiency. However, as numbers indicated the implementation percentages of SCMIS in the Jordanian companies are clearly insufficient in all levels: the company level and the collaboration with customers and suppliers level.

Few disturbing findings were discovered from the results analysis. For instance, the very low number of companies who are currently implementing strategies of 3PL, outsourcing, and

subcontracting indicates the unconsciousness regarding the importance of such strategies (according to Ketikidis et al. (2008), 3PL strategy is one of the most important strategies that are used in both local and international supply networks around the world). Similarly, RFID technology was found to be the least popular SCMIS; only 7 companies are currently implanting it while 11 are planning to implement it within the next 2-year period.

Many findings from the current study pointed on the need for implementing new and/or improving current SCMIS. For example, better SCMIS can help in refining most of the criteria, which are currently adopted to evaluate logistical customer services such as total cycle time products' availability and tracking. Additionally, SCMIS can significantly support achieving future-required SCM strategies: improved information provision, closer cooperation between companies, and government.

6. Conclusions and Recommendations

The current study explores for Jordanian firms 1) the current SCM strategies implemented with its implementation satisfaction level, 2) the currently utilized SCMIS with attained benefits and encountered challenges, and 3) the future need for effective SCMIS and SCM policies. Although with low percentages, establishing good relationships with suppliers and customers, and holding safety stock; were found the most adoptable SCM strategies. On the other hand, MRP, WMS, CRM, and ERP; were the most utilized SCMIS. The near future is not expected to see much change in the adaptation of new SCMIS. Regarding the problems facing the implementation of SCMIS, integration with suppliers' and customers' system, resistance to change from employees, and insufficient vendor support; were found most severe.

The following recommendations can be attained as a result of the current study:

- For SCM policymakers: increase awareness in benefits of strategic relationships with supplier and customer, 3PL, and outsourcing, and subcontracting;
- For firms' managers: implement SCMIS that facilitates information sharing and coordination between various echelons in the SC, provide employee training on SCMIS issues, and improve SCM activities.
- For SCMIS vendors: improve your after-sale support, and educate middle and lower management levels regarding the benefits of SCMIS.

Conflict of Interest

The authors confirm that there no conflict of interest to declare for this publication.

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EMPHASIS RELATED CAPSTONE CLASS: THE USE OF REAL-LIFE EXPERIENCE TO ENHANCE WORKFORCE READINESS

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ABSTRACT*: Preparing students for the workforce is one of the most important priorities in the education sector. The needs of industry are constantly changing and educators strive to find the best way to meet these needs. Providing a culminating experience in classroom settings is one strategy that allows students to apply the knowledge that they gained throughout their undergraduate coursework. This paper explains these efforts to develop a high-impact senior capstone course for Engineering Technology related majors. This research aims to explain a proven strategy for teaching this course after its two-year pilot phase. The course was created to address concerns of industry. The creation of an industrial environment in the classroom helps prepare students for the real world of work. This research is based on a course titled "Emphasis Related Capstone" (ERC), which is offered at Bemidji State University. The ERC course centers on product design and development and is used to prepare students for future careers. Steps for designing the capstone course are shared in this paper. Multidisciplinary teams (e.g. electrical manufacturing, design, project management) were formed to achieve deliverable outcomes. Examples of manufacturing projects conducted in the capstone course are also provided and instructors' responsibilities for teaching capstone courses summarized. In addition, a grading strategy for such capstone courses is provided.*

KEYWORDS: Capstone Course, Case Study, Applied Project Management, Technology Management, Workforce Readiness, Product Development

INTRODUCTION

The Emphasis Related Capstone (ERC) is a completely lab-based 4000-level capstone course designed to help students increase their practical hands-on activities and apply what they have learned throughout their undergraduate degree coursework. The class is required of all technology students and it is offered once a year in the Department of Technology, Art, & Design. The course is similar to an external industrial experience in that each student brings to the enterprise/class various skills, abilities, talents, and knowledge sets. Further, all students must work together, pooling their expertise, to achieve the final goal of producing a product that is a) of high quality, b) made to specifications, c) on schedule, and d) produced within a defined budget. Many products are developed in ERC, such as diploma frames, clocks, decorative items, and others. There are four to five groups involved in ERC, and each group consists of seven functional departments:

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manufacturing and production, design, quality control, sales and marketing, purchasing, safety, and packaging. Each department should contribute to the process of developing at least one product. Machines that are available in the labs include planers, a laser epilog, a Kongsberg packaging cutting table, belt sanders, table saws, miter saws, routers, CNC, and speed sanders.

CAPSTONE IMPORTANCE

The US manufacturing sector faces many challenges, including global competitors who provide better features of products or services (Center for American Progress, 2011). These challenges have created a lot of pressure on organizations to implement best practices in their operations. They, in turn, have reached to workforce educators to help them develop the future workforce. Industry representatives, for example, provide feedback through discussion sessions on what skills Engineering Technology (ET) students should have (The Quality Assurance Agency for Higher Education 2014, 2014). Educators, meanwhile, have found that the best to meet these needs is by creating capstone courses, which provide opportunities for students to integrate formerly disconnected knowledge and/or skills into a coherent format (Mosher & Ramaswamy, 2014). Through capstone experiences, students have the opportunity to make meaning of their education and experiences, to recognize their strengths and weaknesses, and to understand what gaps remain in their knowledge and skills (Miller & Olds, 1994). They can then apply this knowledge to address challenges that face them in the real world. This experience also helps student to develop critical thinking, creative problem solving, and effective communication (Paretti, Layton, Laguette, & Speegle, 2011). Implementing capstone classes in the ET curricula has many advantages, such as the following:

- Apply the knowledge gained throughout their undergraduate degree (Dutson, Todd, Magleby, & Sorensen, 1997);
- Equip students with employability skills (e.g. critical thinking, creative problem solving, and effective communication);
- Provide students with culmination of theoretical approaches and applied experiences (Todd & Magleby, 2005);
- Prepare students for graduate studies;
- Help students in the transition to the world of work;
- Link students to employers and alumni;
- Connect senior students to alumni and prepare them to become active alumni; and
- Help graduates earn higher salaries.

CLASS STRUCTURE AND ENVIRONMENT

In order to meet our local industry needs, a senior Emphasis Related Capstone course was created for the technology students in the Technology, Art, & Design department. The class provides a real industrial experience for ET students through lab-oriented activities allowing them to design and develop products. This class experience is similar to an industrial experience in terms of working in a team environment, developing high quality products, meeting a schedule, and working within a defined budget.

The class was offered two times over a two-year pilot phase before it was required class. Four students enrolled the first year the class was offered and thirteen the second year. Since it has

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become required for all technology students, a full class of 25 students is expected in the Spring of 2017. Four projects were developed during these offerings.

The environment of the ERC class is different from that of the traditional classroom since students are treated as employees in a manufacturing company. The class is held three times a week for two hours each day for 15 weeks. Orientation and training sessions are given in the first two weeks. In the orientation week, students are trained using team-building activities such as "Multiple Intelligences," which is recommended by industry representatives who indicated that their employees lose their jobs much more frequently for not being good team players than for any other reason (Kennedy & Nilson, 2008). This training helps students to understand their strengths and weaknesses through focusing on linguistic, musical, logical-mathematical, spatial, body-kinesthetic, interpersonal, and intrapersonal intelligences (Christison, 1999).
Figure 1 summarizes these intelligences.

Figure 1: Multiple Intelligences

Soft skills topics that are covered in the orientation week include the following: obstacles to effective team work, building communication skills, basic listening skills, and principles of negotiation.

Professional topics covered in the class include project management skills, time management, quality assurance, design process, process analyses, charts developments, time studies, jigs and fixtures design, documentation preparation, oral and written report presentation, safety and risk management, technical sales and marketing, budgeting, and scheduling.

The following – table 1 and table 2 – summarizes these topics:

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Table 1: Career success skills topics

Verbal communications
Reliability
Positive Attitude
Responsibility and Accountability
Problem Solving
Continuous Learning
Critical Thinking

Table 2: Product development topics

Project management skills
Production planning and control
Time management
Quality assurance
Design process
Documentation and report preparation
Oral and written report presentation
Safety and risk management
Technical sales and marketing
Budgeting
Scheduling

The class is offered once a year with an expected average number of 25 students ("employees"). The students are divided into groups of 5. Matrix structures are developed in the class to diversify the projects, with five functional areas used in the matrix organizational structure. **Figure 2** shows these five areas.

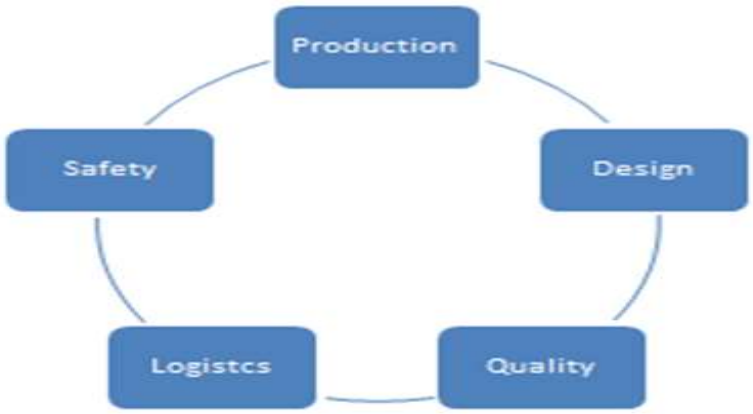

Figure 2: Organization Structure

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INSTRUCTOR RESPONSIBILITIES

The non-traditional environment for this course requires clarification of the instructor's responsibilities. There are six best practices that the instructor has to implement to achieve the best outcomes. First, there is identifying the learning outcomes. Instructors should identify 7-9 learning outcomes that can be achieved through the course. Developing these outcomes will help students to understand what they need to accomplish after finishing this course. Second, there is developing multidisciplinary teams to ensure the diversity of skills in each team. More details are provided in the team forming section. Third, there is developing the guidelines for the student projects, which include a resume presentation, a prototype report and presentation, a final report and presentation, and a daily blog assignment. The fourth responsibility is determining assessment strategies and criteria. An example of an assessment strategy is provided in the grading section in table 3. The fifth task is to provide effective feedback on student work. This is important because critical reflection provides students with the opportunity to understand their weaknesses so that they can strengthen them in the future. The last responsibility is to provide the opportunity for students to showcase their achievements through presenting their projects to a campus audience.

COURSE OBJECTIVES

The following are the goals that students are expected to meet by the time they finish this course:
1. Synthesize the knowledge learned throughout the college experience and bring that collective knowledge to bear in a simulated industrial situation.
2. Operate within the structure of a simulated manufacturing organization while performing all of the functions necessary to design, produce, package, and deliver a product.
3. Research and prepare (individually and with team members) a presentation based on course specific content following the requirements stated.
4. Examine and apply the principles of human relations and apply the principles of project management in teams.
5. Work with other students to create, design, purchase materials, manufacture, package, and deliver a high quality product within a budget, to specifications, and on time.
6. Experience the attendance and participation standards imposed by industry.
7. Experience and adhere to the safety standards required in an industrial setting.

CLASS ATTENDANCE POLICY

This course experience is similar to an industry environment and, therefore, the attendance policy is similar to that of industry. Students cannot accomplish the goals if they are not present or leave early. Each unexcused absence or tardy detracts from a student's final points in the following way. Three "tardy" or "early leaves" will equal one absence. If, at the end of the semester, a student has no unexcused absences, that student will receive 10 points for attendance. Following the progressive discipline principle, 1 ab = 9.5; 2 ab = 8.5; 3 ab = 5.5 4; and ab = 0. Excused absences require acceptable written documentation to be presented at the class period following the absence. Students are encouraged to call in or email before an absence.

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GRADING

The course objectives and outcomes will be assessed based on the student's level of creativity, teamwork and collaboration, presentations, peer evaluations, blogs, and attendance. The following, Table 3, explains the grading strategy used in the class:

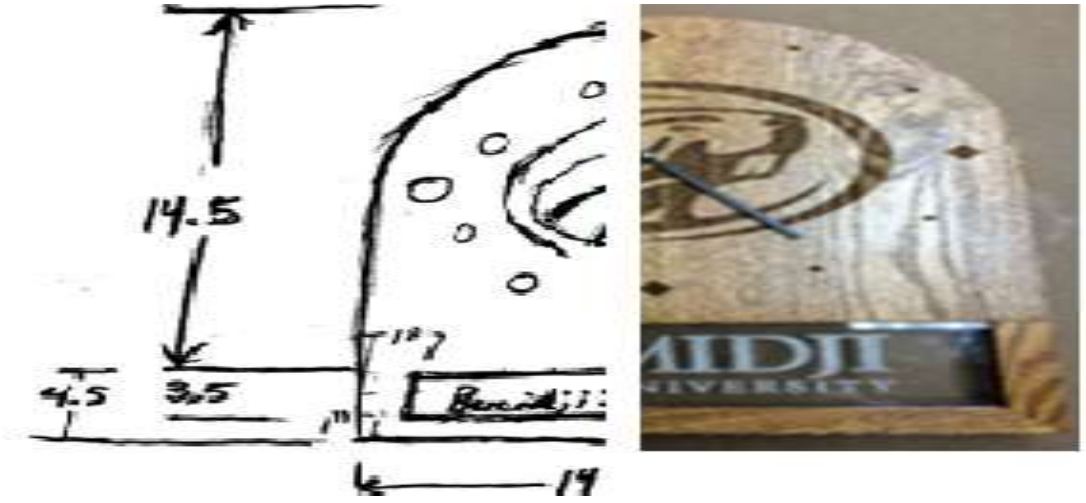
Table 3: grading strategy

Evaluation Category	Points/ Percent
Project Proposal & Timeline	20 pts / 20%
Weekly Meetings & Plans	15 pts/ 15%
Collaboration & Manager Evaluation	15 pts/ 15%
Individual Blogs	5 pts/ 5%
Final Presentation& Report	25pts/ 25%
Peer Evaluations	10pts/ 10%
Attendance	10pts/ 10%
Total	**100 Pts/ 100%**

PROJECTS AND BUDGET

The projects in the ERC class are classified into product design and development categories. Students are asked to find a product that they can design, produce, package, and sell. An example is the design and production of a clock with an LED light window, shown in **Figure 3**.

Figure 3: LED clock



CRITERIA FOR SELECTING PROJECTS

Each group is given a budget of $250 to purchase raw material and, especially, tools for their projects. The process for selecting the projects is based on the following criteria:

1- Students should start with market analysis to identify their target market.
2- The Bemidji State University logo should be displayed on the product.

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3- The project should not exceed a budget of $250.
4- Students will work on the project over a 4-month period. It should not be too complicated or too simple.
5- Design and prototype processes should take place within the first two months.
6- The actual production phase will take place after the prototype phase.
7- Products should be made from more than one material.
8- Project should include electrical components (e.g., battery, LED lights, etc.).

TEAM FORMING AND DEVELOPMENT

Developing a multidisciplinary instructor-assigned team is one of the challenges of designing capstone classes. Faculty who are teaching this class have to take enough time to form teams of diverse technical experience based on the courses students have finished or the work experience that they had (e.g., interns). Instructor-selected teams are formed through the best distribution of skills and abilities

Therefore, the resume presentation assignment is important in this class. It gives the instructor an idea on what skills the students have. Some factors and skills that should be considered when forming the teams include GPA, leadership, volunteering background, favorite classes finished, fabricating and manufacturing, electrical, packaging, 2D and 3D design, sales and marketing, and safety.

The most qualified persons are selected as team leaders, and they facilitate a weekly meeting, insure the flow of the process, and adjust plans as needed. The qualifications for the leadership position are calculated using a systematic approach. Scale 1-5 is used, with 5 being the highest. The students with the highest overall average are selected as leaders.

Table 4: factors could be used to select leaders

Factor
GPA factor (1-5)
Leadership factor (1-5)
Volunteer factor (1-5)
Experience factor (1-5)
Other factors (1-5)
Overall

The responsibilities of team leaders are to motivate the team, set weekly meetings with goals, review the goals and time schedules, and report any issue during the work.

Practicing written and oral communication is essential in this class because industry in need of this skill (Todd, Sorensen, & Magleby, 1993). Therefore, several tasks are designed to focus on these skills. One example of a written communication assignment is the daily blog assignment, in which each student is required to write his or her goals for the day. An example of oral communication is prototype phase presentation, in which each team present shows their sample product to the

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other teams. Flow charts, time studies, tools to be used, fixtures and jigs, bills of material, and other details should be included in the presentations.

PRODUCT DESIGN AND DEVELOPMENT APPROACH

There are five phases for designing and developing products in the ERC class.

The first phase is brainstorming. In this phase, students are asked to generate a list of ideas for products, and their functional specifications. Students should consider the market segment on which they want to focus (e.g., students, faculty, gender, children, adult, seniors, etc.). Industry representatives believe that one of the most important aspects of working in a team environment is to value the contributions of teammates who might have different abilities and perspectives from our own. Therefore, a training session on conducting brainstorming is provided so that students become aware of the basic brainstorming rules:

1. No criticism. Any idea is a good idea and it should be listed.
2. Strive for quantity. The more ideas, the better.
3. Combine ideas together and improve them to produce stronger and higher standard projects.

The following points summarize the activities that take place in the first phase:

1. Students research new product ideas or improvements to existing ones.
2. Students identify similar products in the market and the success of such products.
3. Students identify potential customers (required).
4. Students clarify the cost of similarly situated products in the marketplace.
5. Students should work with the resources (e.g., money, machines, time) that are available for them.

The second phase is screening ideas using affinity diagrams and multivoting techniques. Students will be trained to use affinity diagram techniques to organize the ideas generated from the brainstorming session into themes. A multivoing technique is used to prioritize and narrow down the number of ideas that the students have. This technique refers to simply allowing students to vote for the best idea to select their project. Rules should be established on how many votes each student has.

The third phase is developing a product design. In this phase, students are asked to create a hand sketching of their product. Once the sketch is finalized, it will be converted to a digital 2D & 3D technical drawing that shows several views, dimensions, parts specifications, and tolerances. A packaging design is developed in this phase as well.

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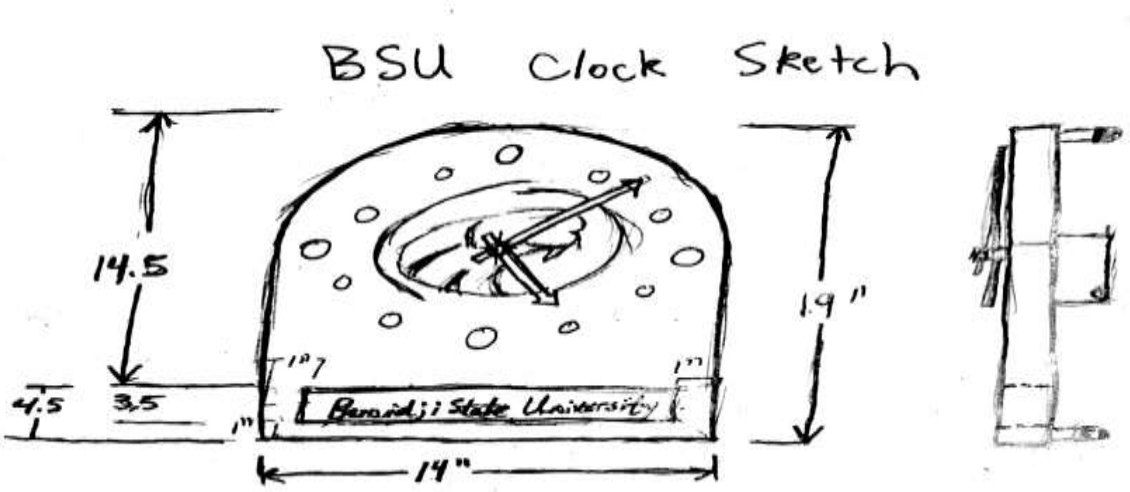

Figure 4: Hand sketch of LED clock

Prototyping, the fourth phase, happens after students get the approval of the instructor and before starting the actual production phase. This phase is important because it will be the first attempt to create a sample of the product. In this phase, teams will deal with hidden problems not considered in the planning phases. As a result, several product modifications will occur in this phase, at the end of which teams will have proven that their products meet the specifications identified in earlier phases. This phase requires students to work in a multidisciplinary team comprising all the types of skills described in the matrix structure in **Figure 2**. Teams will be able to establish an accurate Gantt chart for all the project activities. Process sheets, quality procedures, techniques, tools (e.g., jigs and fixtures) are established in this phase as well. **Figure 6** shows a sample process detail sheet.

Figure 5: LED clock with customized options

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PROCESS DETAIL SHEET

PROCESS ID: 14		PROCESS TITLE: Mount LED Circuit		
TASK SCOPE		SET UP TIME	RUN TIME	TOOLS & EQUIPMENT
TASKS	TASK DESCRIPTION	(PER UNIT)	(PER UNIT)	DESCRIPTION
1	Mount battery sled to back with glue	1	2	Epoxy glue
2	Glue LED strip to bottom of opening	0.5	2	Epoxy Glue
3	Glue acrylic into opening	0.5	2	Epoxy Glue
	Total Setup + (Run Time X 7 Units) =	44		*Time in minutes

Best machine/tool to ensure quality:
Glue is used to hold the LED strip in place along with the provided adhesive strip to ensure a quality bond.

Fixtures needed: none

All resources needed are purchased to save time.

Notes:
*Do all gluing at once as epoxy needs to be mixed

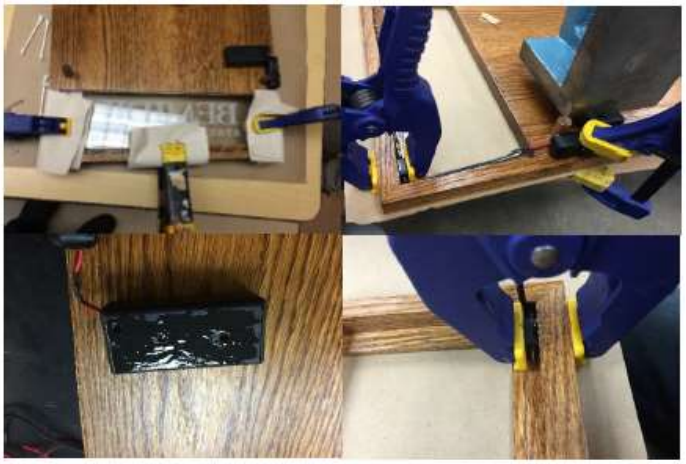

Figure 6: Sample of Process detail sheet

The following activities occur in this phase:

1. Fabricate a quick prototype of the product and the package that meets the proposed functions.
2. Develop jigs and fixtures to ensure the quality of the product and to stay within the allowed tolerances.
3. Produce a sample of the product and the package.
4. Have all team members (i.e., the cross-functional team) review the sample product.
5. Test the sample (e.g., by a drop test).
6. Collect feedback from each member on how to improve the product.
7. Create a sample if major changes have occurred.
8. Establish more accurate tolerances.
9. Based on the testing procedures, adjust and update plans for resources, requirements, procedures, and timelines of finishing the product.
10. Finalize the design drawings and documentations (e.g., parts descriptions, process plans) with reference to all team members.
11. Establish time studies and process details to calculate the team's capacity.
12. Identify the quantity that can be produced based on the capacity and time studies.
13. Develop a production schedule.

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14. Finalize the list of potential suppliers.
15. Develop an initial marketing strategy that will be adjusted throughout the process.

The fifth phase is to start production at full capacity. After accepting the product samples, teams can start producing products based on the adjusted plans, tolerances, and instructor feedback. Packages are also prepared in this phase so that products can be made available for customers as orders are received. All products should go through a final quality check before they are sent to the customer.

CONCLUSION

After two years of taking this pilot course, students have found it an excellent experience that helped them to adapt to a real industrial environment. Through this course, students become familiar with solving real world problems, preparing them for professional work and graduate study. After two years of success, the department faculty voted to include this course in the department core and make it required from all technology students. This type of experience provides students with a more realistic picture of the real work environment.

AUTHOR BIOGRAPHIES

Mahmoud Al-Odeh, PhD is an Associate Professor of operations and technology management. He joined Bemidji State University (BSU) College of Business in August 2012. He teaches courses for the B.S. in Engineering Technology, B.S. Project Management, B.A.S Applied Management, and B.A.S Applied Engineering programs. Before joining BSU, he had taught at Indiana State University as PhD candidate in the Applied Engineering and Technology Management department for two years. He also worked in industry as Quality Control Broadcasting Engineer and CAD design engineer. He is a member of IIE, SME, and ATMAE. Dr. Al-Odeh is certified by the Association of Technology, Management, and Applied Engineering (ATMAE) as Certified Senior Technology Manager (CSTM) and Certified Senior Technical Professional (CSTP). He specializes in in the areas of Statistical Quality Control, Value Stream Mapping and Lean Manufacturing, Supply Chain Management Technologies, Radio Frequency Identification (RFID), and Products Development. Dr. Al-Odeh is a reviewer for different journals and conferences. He has been invited to judge several professional events including VEX Robotics competitions, Northern Minnesota Regional Science Fair, and Edison Awards competition. Dr. Al-Odeh has served as a president (2012-2015) of the Distance Learning (DL) division in the Association of Technology, Management, and Applied Engineering (ATMAE).

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Supply Chain Information Systems Technologies and Management Strategies in Northern Minnesota

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Abstract

Improving supply chain (SC) operations is one of the goals that all organisations strive to achieve. Enhancing Supply Chain Management (SCM) will help organisations improve efficiency, generate more profit, and reduce business expenses. High value customers and suppliers can be added or retained by maintaining a reliable SCMinformation system. Using SCMinformation systems is considered as best practices in the management field. The more reliable and efficient SC,the more profits a company can generate and the easier to compete globally. This research aims to explore Northern Minnesota enterprises' strategies, practices, and information systems technologies that are used for managing their supply chains. An online survey is used to collect information on three questions: What are the major challenges with the use of information systems for SCM in Northern Minnesota? What is the level of satisfaction of current strategies and practices that are used in SCM? What are the actual needs for the effective use of SCM information systems? The reliability of the survey has been insured by conducting a polite study of the survey by three companies. SPSS program is used to analyse the collected data. Descriptive analysis is used to present and explain the results. This research may help managers to determine the needs to improve their supply chains. This research can be used as a benchmark and can be implemented in other areas.

Keywords: Supply Chain Management, Strategies, Information Systems Integrations, Bemidji, Northern Minnesota

Introduction

Tremendous research studies have been conducted in the last decade to investigate the best practices inSupply Chain Management (SCM). Researchers and organisations focus their efforts to identify strategies and techniques to improve SC efficiency and customers' satisfaction, and reduce cost (Singh & Pandey, 2015). Involving different partners (e.g. customers, suppliers etc.) and activities (e.g. reverse logistics) inSCM makes it a complex environment to be managed and this complexity increase managers' uncertainty in making decisions.

Implementing an efficient SCMrequires considering different factors. First, companies need to implement integrated information systems to better collectSC data and monitorthe internal and external activities such as raw material, inventory, purchasing, distribution, delivery, production process, and vendor (Arnold, Chapman, & Clive, 2011).

Globalisation is another factor that should be considered. Organisations are not competing locally anymore; their customers and suppliers are from all over the world and therefore establishing efficient information systems to compete globally is required.

Third, sharing informing through electronic systems will enable companies to achieve real-time information flow along their supply chains partners. Digital technologies (e.g. IoT, cloud-base applications) are used to assist firms build stronger relationships with local and global customers and suppliers. By using these information technologies, companies are increasing the level of sharing important information with other partiesinside and outside an organisation.

Other traditional factors are included in the following section to cover all important aspects of the SCM.

Literature Review

Supply Chain Management Pillars

Forrester (1958) identifies the pillars of SCM field as "Management is on the verge of a major breakthrough in understanding how industrial company's success depends on the interactions between the flows of information, materials, money, manpower, and capital equipment".

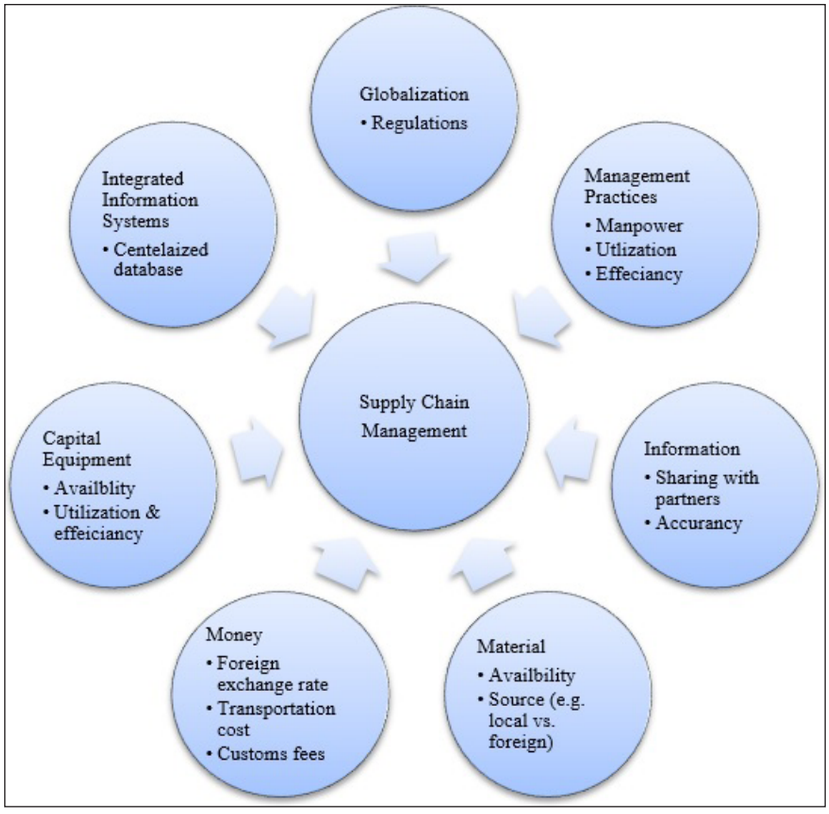

Fig. 1. Factors Impact Supply Chain Management

Forrester provided some of the factors that affect the performance and efficiency of managing SC (e.g. exchange rate as explained in Magara, Oloko, & Nyangau, 2013). The globalisation and integrated information systems are added to these factors to make it more comprehensive model as summarised in Fig. 1.

Supply Chain Management Definition

The Council of Supply Chain Management Professionals (2015) considers SCM as "The planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners which can be suppliers, intermediaries, third party service providers, and customers."

There are a lot of opinions about SCM, but it can be summarised by three opinions. The first opinion is from Monczka, Trent, and Handfield (1984) who believe SCM should be defined based on the integration between different parties. They defined SCM as a concept "whose primary objective is to integrate and manage the sourcing, flow, and control of materials using a total systems perspective across multiple functions and multiple tiers of suppliers". Other researchers, La Londe and Masters (1994) classify SCM according to building relationships between two or more parties "the development of trust and commitment to the relationship" between two or more firms. Finally, Stevens (1989) considers that SCM system should be managed to address customers' needs. He believes that "the objective of managing the supply chain is to synchronize the requirements of the customer with the flow of materials from suppliers in order to affect a balance between what are often seen as conflicting goals of high customer service, low inventory management, and low unit cost." Stevens emphasizes on the importance of customers' relationships with a firm, and how it is important for a firm to improve this relationship to be stronger.

From these definitions, in order for a company to implement an efficient SCM, four characteristics should be addressed:

1. Managing, monitoring, and controlling the flow of material efficiently

Fig. 2. Supply Chain based on the flow of material and information

2. Strengthen external relationships with customers and suppliers
3. Empowering internal parties.
4. Forming cross-functional teams to makea balance between material processing, customers' satisfaction.

Supply Chain Types

SC can be classified based on the flow of material and information. For example, Christopher (1992) classifies SC partners into three categories: upstream, downstream, and the activities that connect the first and second categories. He defines SC as "network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer". Fig. 2 explains these categories. The two-side arrow refers to the flow of material and information that could be going into both sides: from upstream to downstream or vice-versa(Abdulkader, Bhatt, & El-Mekkawy, 2015).

Other research studies divided SC into two types. The first type is the external SC which involves companies' relationships with customers and with suppliers. Also, it may include external firms as a third party. The internal SC is the second type, which involves the relationship between different units within an organisation. Fig. 3 shows the internal and external types (Hicks, 1999; Dobler & Burt, 1996).

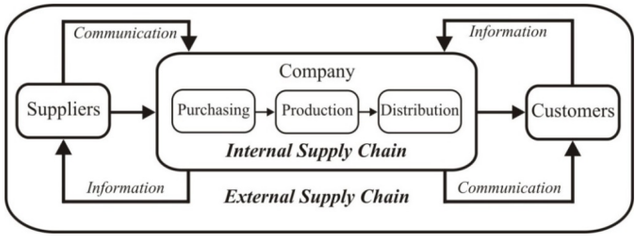

Fig.3. The Internal and External Supply Chains (Hicks, 1999)

Another researcher was concerned with defining SC in more depth by dividing SC into three degrees of complexity (Mentzer, 2001). These three degrees are a direct supply chain, an extended supply chain, and an ultimate supply chain. A direct SC is when the flow processes of products, services, and information is divided between three parties, the firm itself, a supplier, and a customer. Fig. 4 shows the first level of SC.

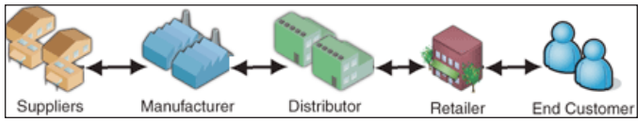

Fig.4. Direct Supply Chain

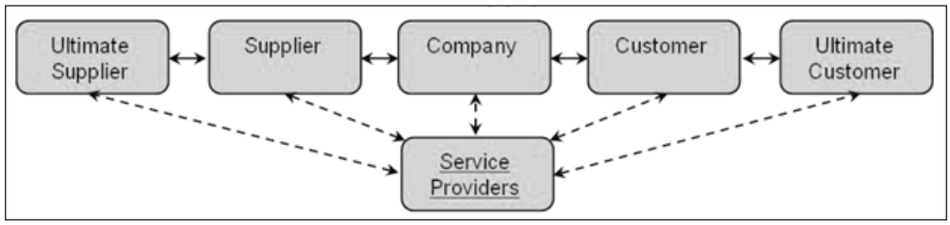

Fig. 5. Extended Supply Chain (SCM Globe Corp, 2014)

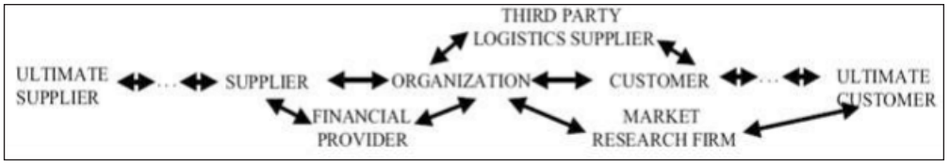

Fig. 6. Ultimate Supply Chain (Mentzer, 2001)

The extended SC is when the flow process of products, services and information is divided between "suppliers of the immediate supplier and customers of the immediate customer (Mentzer, 2001)." Fig. 5 Shows the Extended Level

The ultimate SC level is when all organisations shared in managing the flow processes of products, services, and information "from the ultimate supplier to the ultimate customer (Mentzer, 2001)." Fig. 6 summarises this type of SC.

Integrated Information Systems in Supply Chain Management

Implementing efficient and reliable SCMinformation systemscan lead to goals that help organisations success and compete in the global marketplace (Varma & Khan, 2014). The efficiency of a SC depends on the ability of managing the flow of materials, information, and money. Managing this flow is supported by information system (Turban, Rainer, & E. Potter, 2004). The most encouraging factors for implementing information system in SCM are: reduce costs and increase customers' satisfaction(Kumar, Saxena, & Agrawal, 2012).

The A.T. Kearney Management Consulting Company conducted a study about challenges in SCM. The main SC challenge that has been found in the study is the cost. It has mentioned that "supply chain costs can represent more than eighty percent of the cost structure in a typical manufacturing company" (Kearny, 2008). Most of the costs came because there were losses in sales regarding insufficient customer service or sold out products. Also, the study concludes that "for every dollar of inventory in a system, there are one to two dollars of hidden supply chain costs: working capital costs, asset costs, delivery costs, write downs and so on" (Kearny, 2008). The study emphasizes on the importance of implementing SCM information systems to improve SC efficiency. If a company invested in implementing information systems,it can improve the efficiency of their SC and it can "achieve savings equal to three to seven percent of revenues compared with their median performing peers" (Kearny, 2008). A similar study conducted by IBM (2010) found the cost containment is number one issue in SCM along with other factors such as visibility, risk, customer intimacy, and globalisation.

Another study estimated that "42 days could be removed from the typical grocery supply chain, freeing up $30 billion in current costs, and reducing inventories by 41 percent" (Mentzer, Fundamentals, 2004).

Implementing integrated electronic information systems between SC partners is necessary to meet the future SC challenges and will help companies achieve the high performance efficiency. The SC information systems help organisations compete in the global market byreducing cost, improving services, maintaining sufficient inventory level, and reducing backlog (Bhatt, 2000). All these factors will lead tobuild stronger relationships with customers and suppliers.

Another factor encourages companies to implement integrated information systems is improving communication with partners (e.g. customers, suppliers etc.). Efficient communication will help managers improvecustomers' satisfactions (Stevenson, 2014). For example, customers can use companies' website to order customised products. The information entered by the customer on the website can be shared with different suppliers and departments in the company. The information can be shared with the suppliers who will better plan for the future demands. Allowing customers to manage their orders help companies to move from the customers' satisfaction level to customers' loyalty level because of better understanding for the customers' needs. Fig. 7 demonstrates the different levels of customers' satisfaction. This chart assists the reader understand that building partnership with customers is the ultimate goal to build an efficient SC (Singh H, 2015). This partnership can be achieved by implementing SCM information systems that integrate customers' information with the different departments in a company.

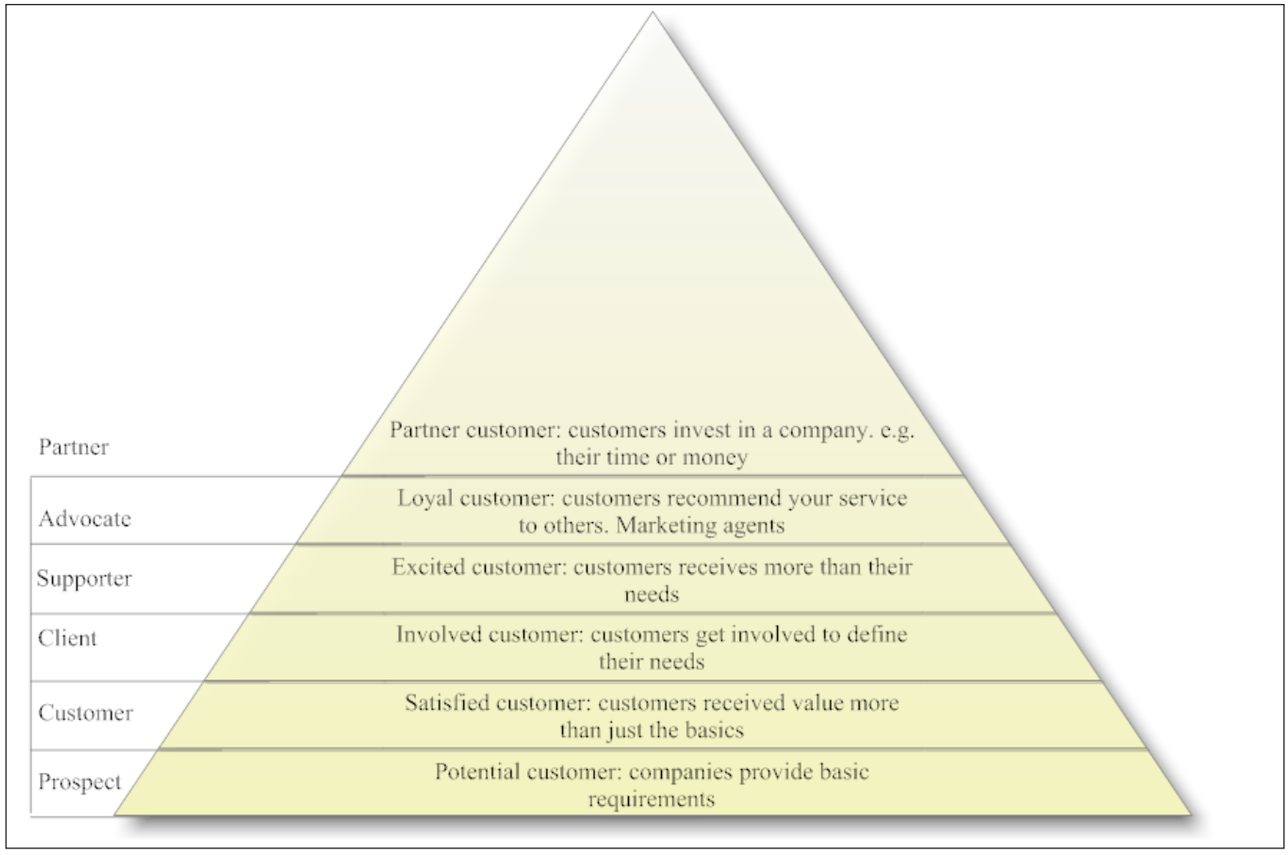

Fig. 7. Customers Satisfaction Levels

Improving customers' satisfaction can be achieved by reducing backlog and maintaining sufficient inventory levels. One way to achieve this goal by using inventory buffers alert feature that exists in every SC information system. The integrated SC information system means connecting companies' SC information system with suppliers'systems. The alert feature is activated when inventory levels fall under pre-defined certain level, warning messages will be sent to SC manager and suppliers who both will have more time to prepare for future orders and avoid backlog or any risk associated. Using such feature requires integration in information systemsbetween the SC partners and this will result better planning, shorten the delivery time, and improve customers' satisfactions.

Last but not the least, waste can be reduced using efficient SCM information system. Most SCM information systems these days have monitoring functions that will help managers determine areas of improvements in the operations. Using these functions will enable companies reduce waste by maintaining sufficient levels of inventory (Singh, Sohani, & Marmat, 2013). Managers will order products when needed and they will not have any extra or unneeded material.

There are a lot of information systems that are used to manage, monitor and improve the SCM operations. Examples of the systems can be Material Requirements Planning (MRP), Manufacturing Resource Planning (MRPII), Enterprise Resource Planning (ERP), Supplier Relationships Management (SRM), and Customer Relationships Management (CRM). These days, the most powerful technique in management is technology (Mentzer & Kahn, 1996; Mavengere, 2014).

Companies are using information systems technologies to coordinate activities and share information with their SC partners including upstream, internal processes, and downstream. For example, one of the most recent SCM information technologies is adopted by Walmart is the wireless technology Radio Frequency Identification (RFID). The RFID technology is supposed to be able to eliminate many of the problems with SC efficiency. It helps in tracking assets by using electromagnetic waves. RFID helps companies to improve tracking processes,

processing information and customer relationships (Parvatiyar & Sheth, 2001). Example on real-time information sharing and systems integration between the supply chains partners is implementing Cisco's e-hub solutions that allow multiple organisations interact and exchange information in a SC (Kaplan & Sawhney, 2000). Using these solutions, suppliers can have benefits such as sharing safety inventories (Lee & Whang, 2001).

Statement of the Purpose

The study aims to investigate the SCM practices and information technology systems in rural area in Northern Minnesota. Strategies and practices for managing SCareexplored.The use of information systems for SCM in Northern Minnesota is investigated. This study analyses the majorchallenges and developments, level of satisfaction of current practices, and determines the needs of enterprises for the effective use of SCM information systems. The result of this study may help managers and policy makers in the State of Minnesota to determine the needs to improve SCM performance in the area. It has been assumed that the target populations of this study are representative of the industry located Northern Minnesota.

Method of Investigation

There are different techniques areused in this study, a literature review, a questionnaire survey, and phone interviews. Previous studies are used to generate list of different information systems that are utilised for SCM. Reviewing the literature review helped in creating an online questionnaire to gatherdata from enterprises on issues related to challenges, benefits, and development on the use of SCM information systems.The survey has been sent to 120 companies that are located at Bemidji, MN. There are 27 of them who responded to the survey. Bemidji is a city in Northern Minnesota in the US with population of about 14500 (U.S. Department of Commerce, 2015). The survey is sent to the operationsand technology managers of those companies to partake in the research. Also, the subject names have been collected fromthe local yellow book. An Institutional Review Board (IRB) considered thestudy as an exempt study. The participants voluntarily participated in the study.

After collecting data, the analysis process started using descriptive techniques. Figures are used to give a better understanding of the results.

The Structure of The Online Questionnaire

An online survey consists of 17 closed questionsis designed based on best practices from the previous studies and feedback from industry. A trial study for the questionnaire was conducted to collect the participants' feedback regarding the questionnaire. Three companies were randomly chosen for this refinement process. The questions were modified based on the feedback that is received during the pilot study. About 10-15minutes areneeded to finish the survey that consists of five parts that aim to identify:

1. The demographics of the companies that are participated in the study.
2. The plans for managing supply chains.
3. Current information systems benefits and challenges.
4. The future SCM strategies and information systems.
5. The factors and measures that will help improve SCM.

Table 1 summarises the questions in the survey.

Findings

Companies Profiles

The majority of the participated companies (54%) are manufacturing companies. Fig. 8 shows the sectors of participated companies in the study. This result gives an indication that more manufacturing business in the area than service companies.

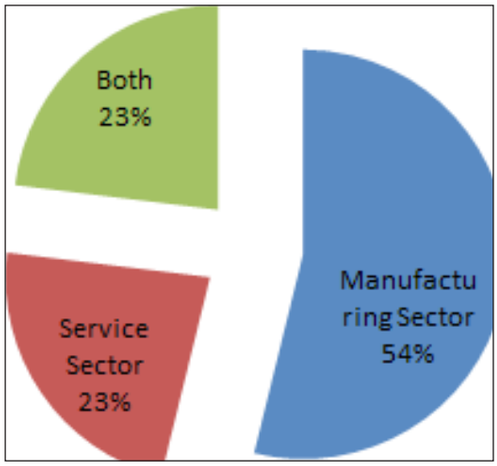

Fig. 8. The Participated Companies' Profile

Table 1. Questions Used in the Survey

Demographic Information	
• Business Type	• Is your company part of a group?
• Company Size	• Arethere other branches for your company outside the state or the country?
Strategic Planning for Managing Supply Chains	
• How do you evaluate logistical customer service?	• How do you manage your supply chain?
• How successful do you think is your company in managing its SCin general?	• Which of the following do you think that your company needs to do in order to manage its SC better?
• Does your company have a separate logistics department?	• Does your company have a clear logistics strategic plan?
• Does your company provide SCM courses or training programs to the employees?	
Current information Systems, Benefits, or Problems	
• What types of information systems are currently in use in your company to support SCM?	• How much did you actually benefit from using these systems?
• In what level is your company facing the problems below when using information technology systems?	
Future Plans	
• What types of information systems do you plan to implement in the near future (within the next 2 years)?	
SCM Polices and Measures	
• How satisfied are you with the current public policy regarding SCM and IT?	• How important are the following future measures for supporting your company effort in SCM and IT?

Companies' Size

The size of participated companies is shown in Fig. 9. The majority of the participated companies' size is 1-99 employees. Most of the businesses in the Bemidji area are small-to-medium size.

Fig. 10 summarises the strategy for evaluating customer service. The most effective strategies used by the

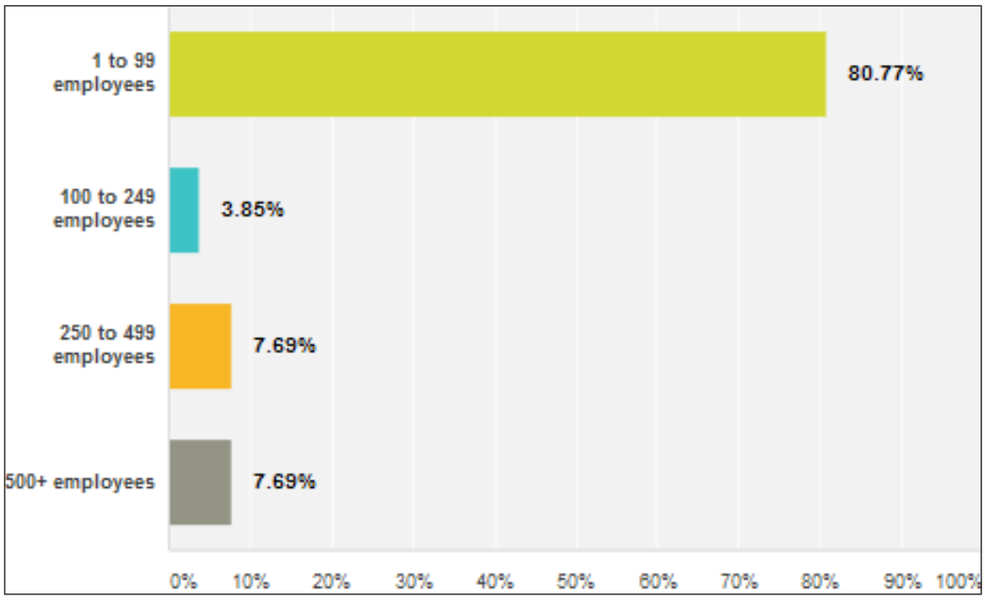

Fig. 9. The Size of the Participated Companies

companiesare total cycle time, customer feedback, and percent of correctly delivered products/services.

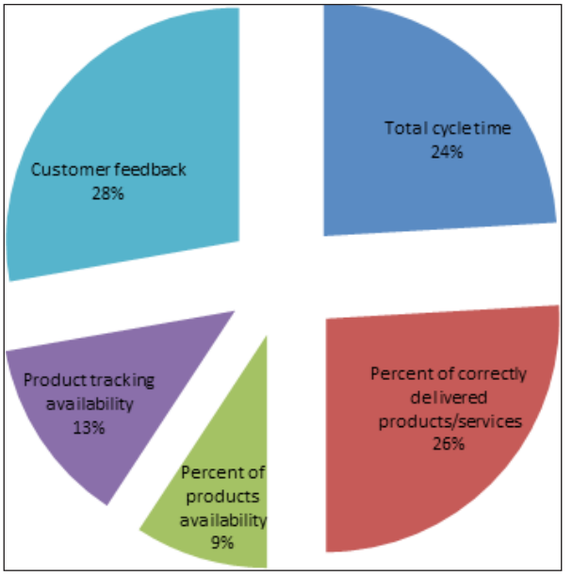

Fig. 10. Strategies Used for Evaluating Logistic Customer Service

Supply Chain Management Strategies

The top three techniques used for managing the SC are: close partnership with suppliers, close partnership with customers, and outsourcing. Benchmarking is not an appropriate strategy to be used by most of the companies. The result of this question is summarised in Fig.11.

The majority of the companies (56%) believe that they are successful in managing its supply chain.

In order to manage the SC better, the companies claim that their companies needpartnership with few suppliers and close partnership with customers. Fig.13 summarises the result for this question. The result confirms that the companies value the relationships with suppliers and customers. The companies consider the third party logistics strategy as not appropriate for them. This result should be investigated in future research to understand why the companies in the area do not consider 3PL as an appropriate strategy for them.

The three charts shown in Fig. 14, 15, and16 are related to the issue that the majority of the companies have problems with developing strategic plans for their SCM. It has been found that the majority of the companies (68%) do not have a separate logistics department. Not having a specialised people or department may affect their SC performance in the future. Fig. 15 demonstrates that the majority of the companies do have a clear logistics strategic plan. From Fig.16, the majority of the companies believe that they do not provide SCM courses or training programs to their employees. This confirms the results that the companies in the area do not use benchmark or 3PL strategies that require having specialised employees to develop plans to improve the SCM performance in the long term.

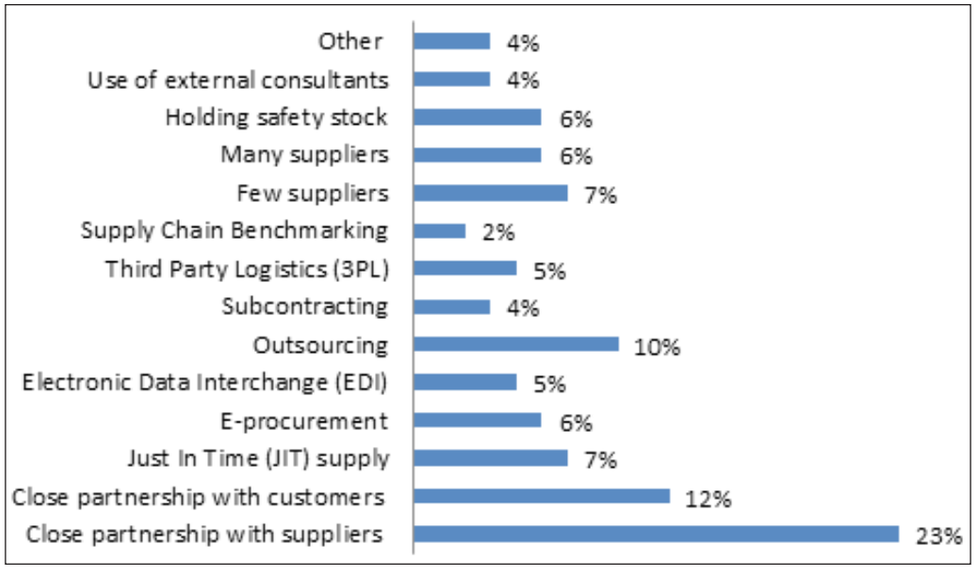

Fig. 11. The Current Supply Chain Management Strategies

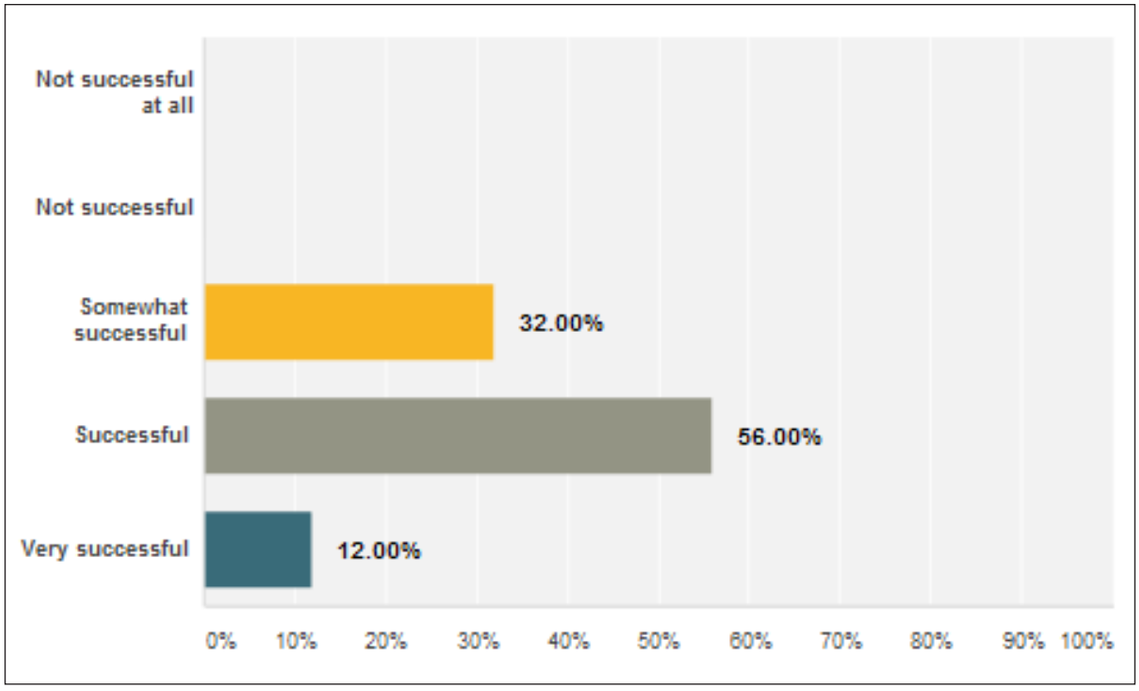

Fig. 12. The Success of Managing SCM

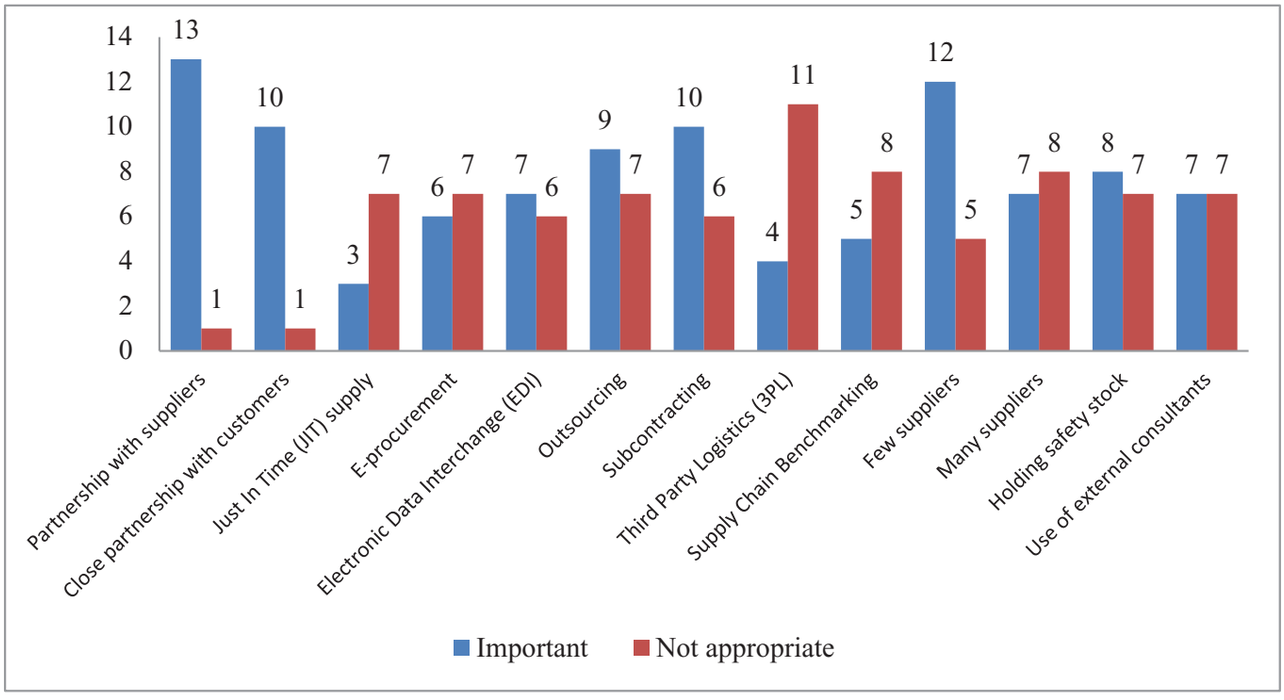

Fig. 13. Strategies that are Important to Better Manage the SCM

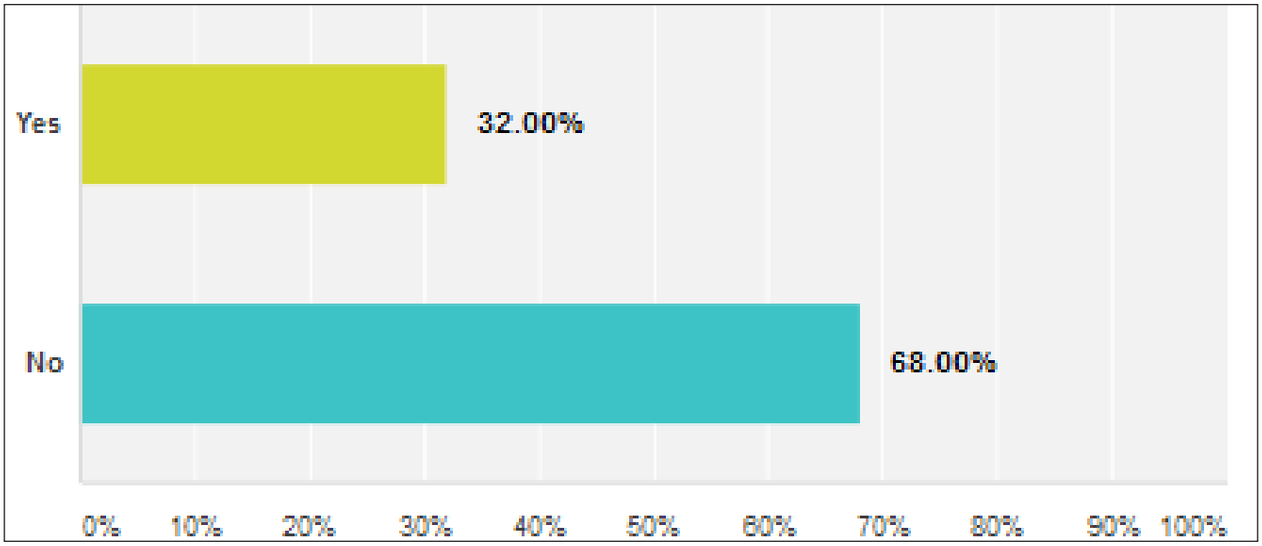

Fig. 14. Separate Logistics Department

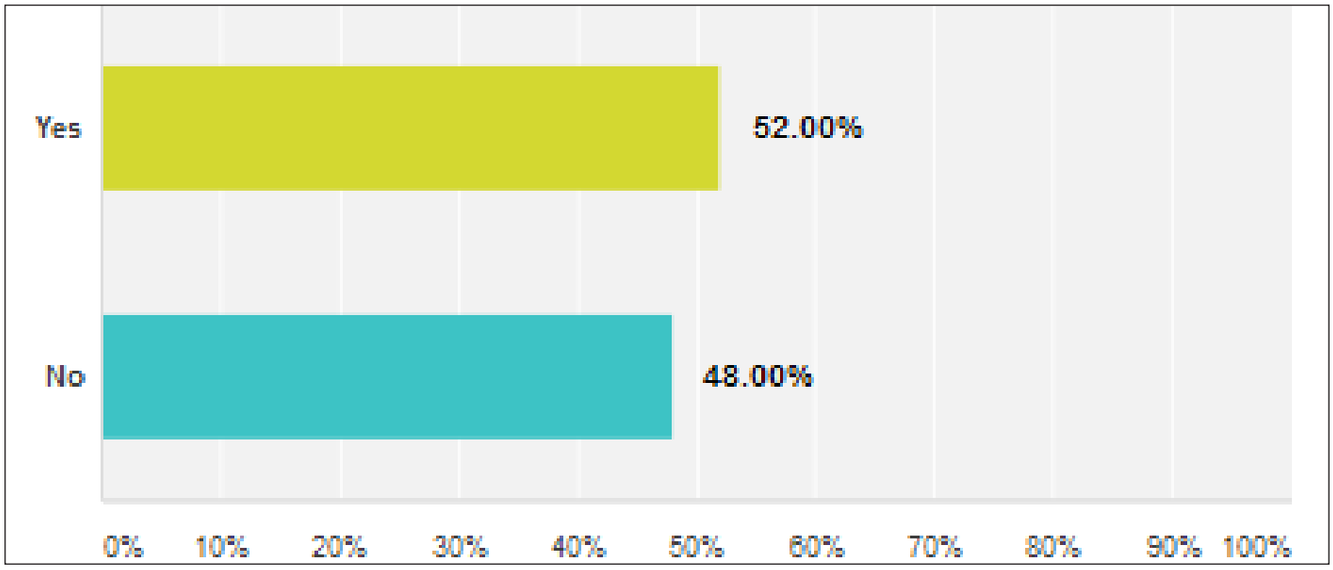

Fig. 15. The Clarity of Logistics Strategic Plan

Current Use of SC Minformation Systems

As displayed in Fig. 17, the most popular four technologies that are currently in use to manage the SC are: bar coding, just in time, warehouse management system (WMS), and material requirements planning (MRP). None of the companies is using the Radio Frequency Identification (RFID).

Benefits of Using the LCSM information Systems

It has been asked the participated companies that are using SCM information systems about the benefitsof using the systems. The companies consider that using the SCM information systems benefited them a lot by

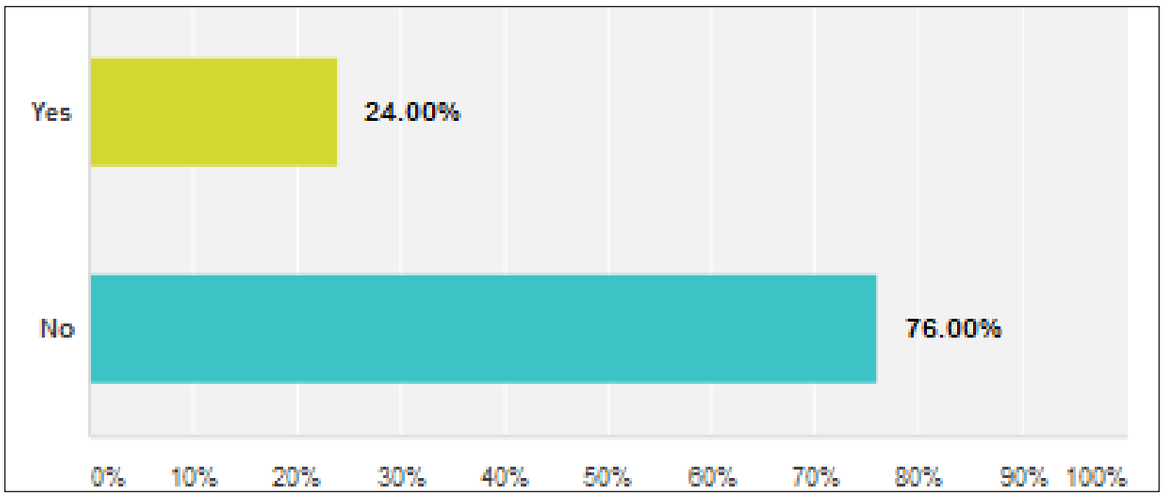

Fig. 16. Providing SCM Training to Employees

achieving: better operational efficiency, reduce lead-time in production, cost saving, more accurate costing, and flexibility. The results are summarised in Fig. 18.

Problems of Using the SCM Information Systems

Fig. 19 shows that the companies are facing the following serious problems when using SCM information technology systems: resources shortages i.e. no maintenance and update, skills shortages, hidden cost, and integration with existing system.

Future Use of SCM Systems

The most three popular systems that are used by the companies are planning to implement within the next 2 years are: customer relationships management (CRM), supplier relationships management (SRM), and warehouse

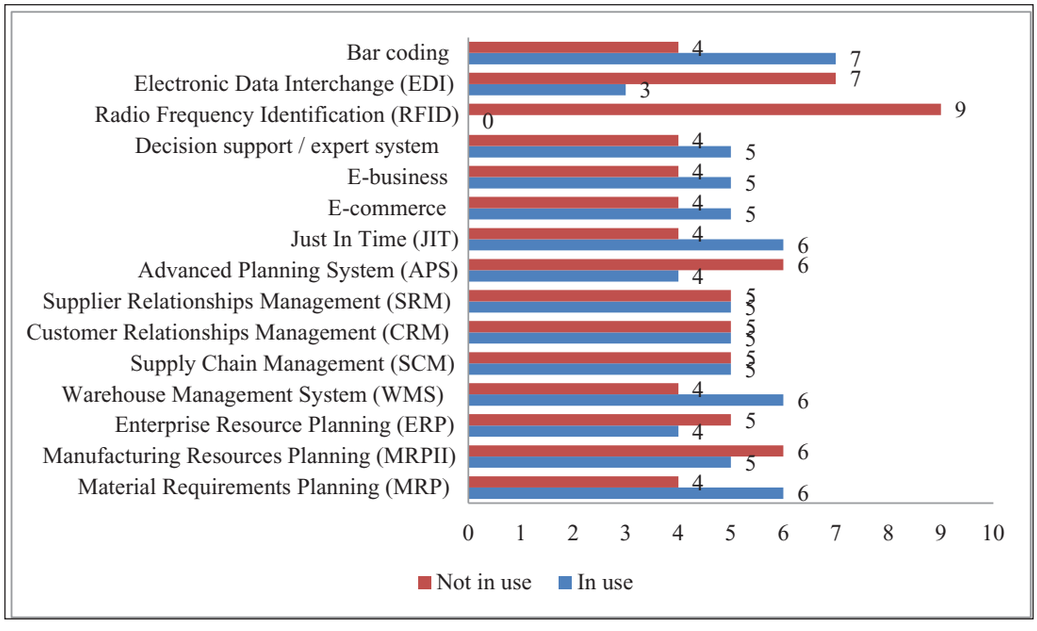

Fig. 17. Current Use of SCM Information Systems

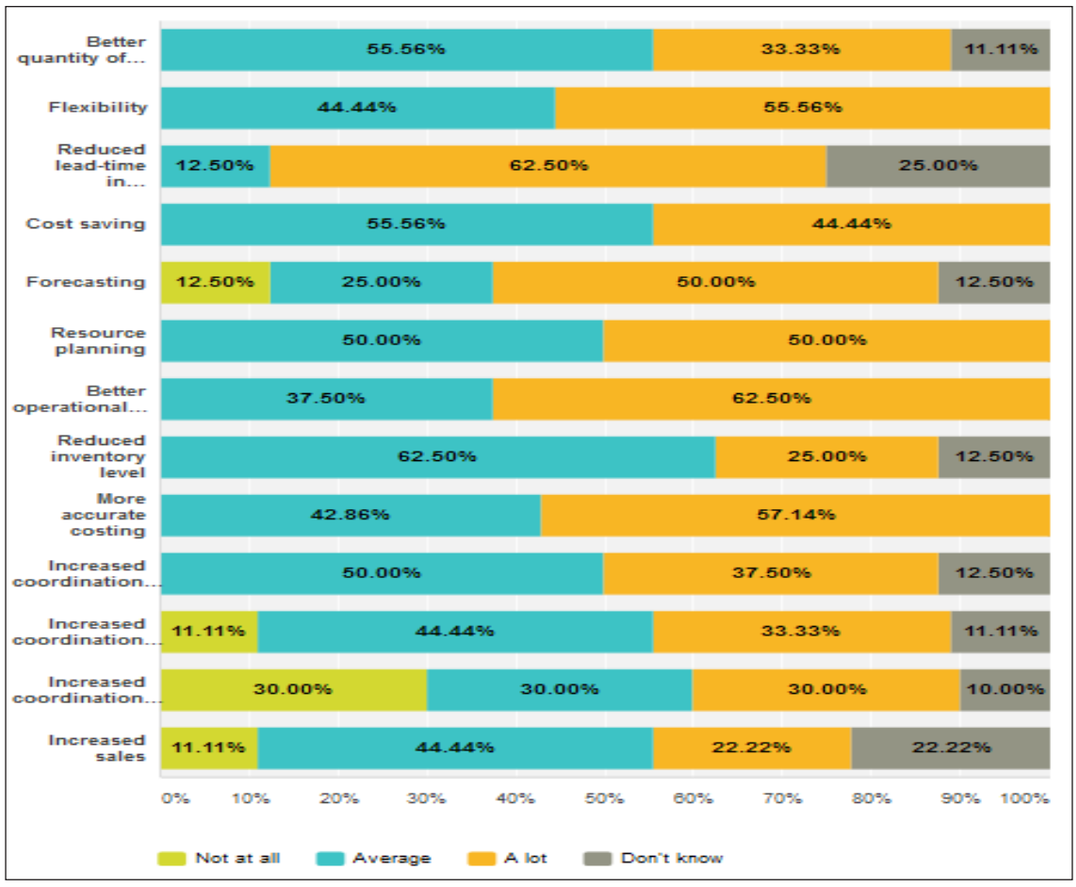

Fig. 18. The Benefits of Using the CSM Information Systems

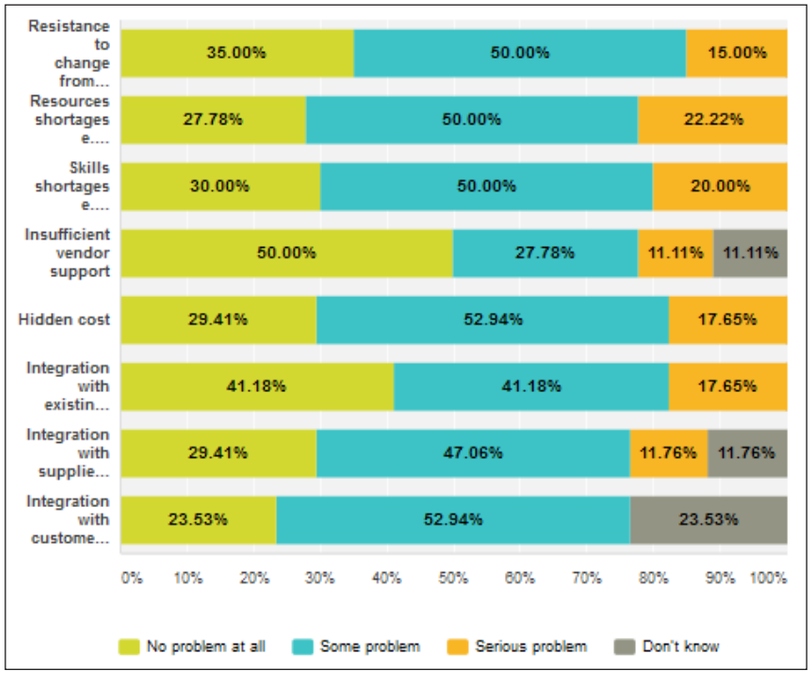

Fig. 19. Problems of Using SCM Systems

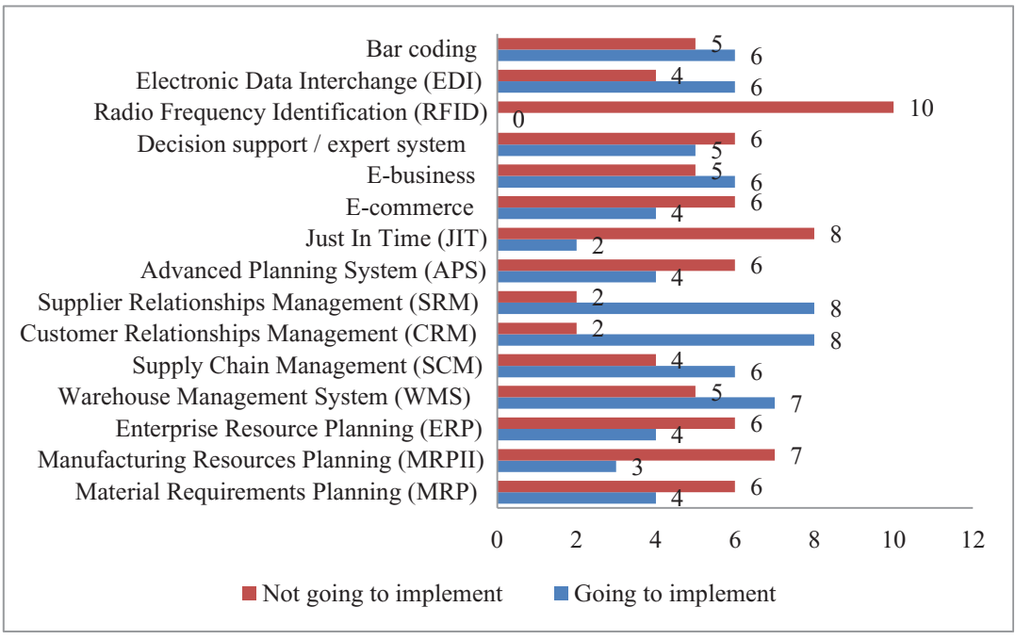

Fig. 20. Future Use of SCM Systems

management system (WMS). None of the companies are planning to implement Radio frequency identification (RFID) within 2 years.

Policies Regarding SCM

Fig. 21 summarises the companies' satisfaction with the current public policy regarding SCM. The majority of

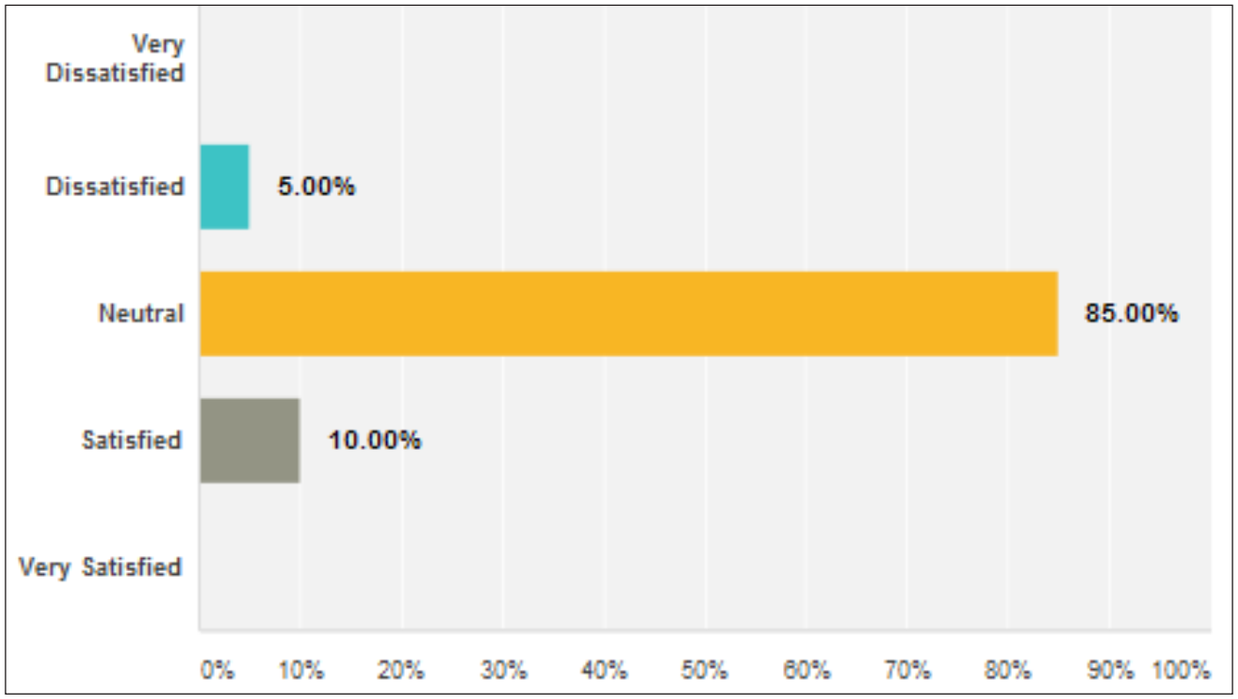

Fig. 21. Satisfactions with Current SCM Policies

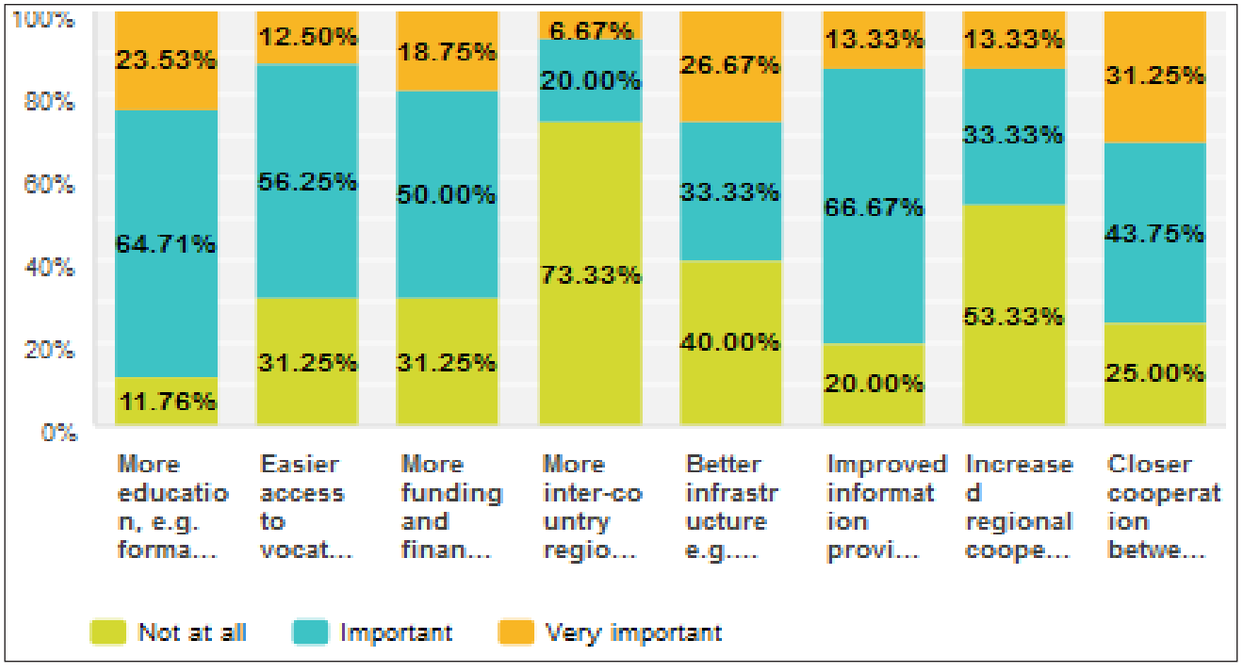

Fig. 22. Measures to Improve the Future of SCM

the companies are neutral or satisfied with current public policies.

Measures to Improve the Future of SCM

Fig. 22 shows that the most three important measures for supporting the companies'effort to improve their SCM: more education, improved information provision, and closer cooperation between companies and government.

Summary of the Findings

This section presents the finding of the current and future status of the SCM in Bemidji, MN. These findings can be summarised in the following points:

- The companies are focusing on developing a better relationship with suppliers and customers.
- The companies currently are focusing on building more relationships with few suppliers.
- The majority of the companies do not have a separate logistics department.
- The majority of the companies claim that they have a clear logistics strategic plan.
- The companies do not provide enough training to their employees.
- The companies agreed that bar coding, warehouse management system (WMS), and material requirements planning (MRP) systems are currently in use for their SCM.
- The surveyed companies agreed the systems are using the systems are helpful in achieving more accurate costing and better operational efficiency.
- The surveyed companies agreed that the systems are not efficient in improving coordination with suppliers or customers.
- The companies are facing the following serious problems when using SCM technology systems: resources shortages, skills shortages, hidden cost, and integration with existing systems.
- The companies agreed that implementing customer relationships management (CRM) is important to meet the future SCM challenging.
- None of the surveyed companies are going to implement RFID technology in the coming 2 years.
- The majority of the companies are neutral or satisfied with current public policies.

- More education, easier access to education, improving information provision, and closer cooperation between companies and government are important measures for improving the future of SCM for the companies.

Discussion

Based on the results of this study, it can be found that the companies are currently focusing their partnerships on dealing with suppliers more than customers. Thus, it can be said that building strong relationships with suppliers has been more important in their SC than building strong relationships with customers. Also, like this relationship means that the companies are focusing on the production more than the market orientation. In order to be more successful in the future, these companies should focus on understand the market needs and build stronger relationships with customers.

In the future, companies will be strengthening their relationship with their customers by implementing customer relationships management (CRM) system to meet the future SCM challenging. This indicates that in the future, the companies are shifting from production focus to customer ad market focus. This demonstrates their understanding to the importance of the customers' satisfaction.

The 3PL strategy is one of the most important strategies that are used in both local and international supply networks around the world (Wasatkar & Jadhav, 2012; Ketikidis, Koh, Dimitriadis, Gunasekaran, & Kehajova, 2008). The result of the survey indicates that only 5% of the Bemidji area companies are partnering with 3PL companies. This result gives a glance that the companies are not aware of the importance of the using 3PL strategy. Providing training sessions to their employees on 3PL may increase their awareness toward using this strategy, which will increase SC efficiency and improve customers' satisfaction.

Another interesting result is that RFID technology is not appropriate for the companies and none of them will be implementing this technology in the next 2 years. This result might be because of the high cost of the technology or efficiency of the technology.

Companies agreed the current information systems are not efficient in improving coordination with suppliers or customers.For future implementation, there is a need for systems that enable companies to share information with partners and this will help them better planning and coordination. This confirms the result about the integration problems. From Fig.19, integration is a problem that is faced by the companies. It could be happening of using the standard package systems more than the custom made system.

Conclusion

This research clarifies the current and future status of the SCM in Bemidji, MN. Currently thecompanies' strategies are focusing on building relationships with suppliers more than customers. In the future, they will build stronger relationships with customers through implementing Customer Relationships Management (CRM) and will maintain their relationships with suppliers. The information systems benefit the companies by achieving better operational efficiency, reduce lead-time in production, cost saving, more accurate costing, and flexibility. Also, the companies need to have access to more SCM education and training to improve their SCM efficiency. For future research, it is recommended to investigate the reasons behind why the companies are considering the 3PL, benchmarking, and RFID as not appropriate practices for them. Also, the integration problem affects level of sharing information with partners and therefore there is a need to be investigated in further research.

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THE VIABILITY OF RESIDENTIAL GRID-CONNECTED SOLAR PHOTOVOLTAIC SYSTEMS IN THE STATE OF INDIANA

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ABSTRACT

While the use of green energy has gained popular support and efforts have been made to market it, few studies have investigated the economic advantages and the savings that could be gained by implementing green solutions for energy challenges. This study aims to measure the financial viability of installing and using a residential grid-connected photovoltaic (PV) system in the State of Indiana while predicting its performance in eighteen geographical locations within the state over the system's expected lifetime. A systematic approach of six steps was used to collect and analyze the data. The analysis has been condcutded using engineering economic methods including payback period, net present value (NPV) and internal rate of return (IRR). It has been found that installing a PV system for a single family residence in the State of Indiana will not pay for itself within 25 years assuming the average cost of a system. The government incentive programs are not enough to offset the cost of installing the system against the cost of the electricity that would not be purchased from the utility company.

Keywords: Net present value, internal rate of return, payback period, residential solar PV system, renewable energy, State of Indiana.
JEL Classification: O22, Q28, Q42

1. INTRODUCTION

Different types of renewable energy are increasingly being used throughout the world to meet the growing demand for energy. Tremendous efforts have been invested in the United States to improve residents' awareness of the use of such resources as wind, solar, and biomass energy. In recognition of this fact, the U.S. government, in general, and the state of Indiana, in specific, has offered a number of incentive programs that help reduce the costs of installing renewable systems to make these systems more affordable for the residents (Nemet, 2009; Diamond, 2009).

Among the solar systems available, photovoltaic (PV) systems would allow households to produce their own electricity with little noise or air pollution (Tsoutsos, Frantzeskaki & Gekas, 2005; Turney & Fthenakis, 2011). In order for a PV system to become a practical solution for Indiana residents, it must be perceived as attractive financial investments for its owners. The lack of knowledge regarding the economic assessment of installing and using a residential grid-connected PV system has resulted in a low number of homeowners installing the systems in the state. In order to address this knowledge gap, this study aims to measure the financial viability of installing and using a residential grid-connected PV system in the State of Indiana while predicting its performance in different geographical locations within the state over the system's expected lifetime. The study has taken time value of money, system maintenance (e.g. convertor replacement every 10 years), and future electricity price increases into consideration.

2. DATA AND METHODOLOGY

This section describes the goals, questions, assumptions, tools, procedures and methodology of this research work.

2.1. Goals and Objectives

This research aims, first, to determine the suitable and standard size of a residential PV system for average Indiana households. Second, to estimate the energy generation of a standard PV system and determine areas with high solar potential. Third, to gain understanding of the economic benefits of using a standard PV system. Also, it aims to identify the factors that should be considered when determining the economic payoff of installing and using a PV system in terms of electricity rate, system performance, and incentives. The fifth goal of this research is to use US Department of Energy recommendations and methodologies to develop a model for building a standard PV system. Evaluating the current policies toward installing a standard residential PV system in the state of Indiana is the sixth goal of this reserach. Finally, this reaerch aims to determine the areas suitable for installing a commercial PV system in the State of Indiana.

By achieving the goals and objectives that are mentioned above, the following questions can be answered: What is the precise size of a PV system suitable for a typical single family home in Indiana?; How much does a standard PV system cost?; Does the government subsidy programs i.e. federal tax credit make the system financially attractive investment to Indiana homeowners?; and what is the payback period and the internal rate of return for a standard PV system?

2.2. Statement of Purpose

This study aims to measure the financial viability for a residential grid-connected PV system in the State of Indiana. In order to evaluate the financial feasibility of typical residential grid-connected PV systems in the State of Indiana, data regarding the counties of Indiana State should be collected, evaluated, and analyzed through mathematical models and formulas. In addition, information about prices and the size of a typical system should be collected from the professionals and representatives who work in the PV industry via online quotes.

2.3. Assumptions

This study is conducted based on the following eleven assumptions: 1) the PV system is assumed to be integrated within the utility grid, eliminating the need for investing in batteries or an electrical storage system; 2) the data obtained using the PV Watt application, a performance calculator for on-grid PV systems, is assumed to be an accurate predictor; 3) the analysis period for this study is 25 years because the warranty that is provided by the PV professionals in Indiana is 25 years (Energysage, 2016) , so it assumed that is a reasonable lifetime (Lagorse, Paire & Miraoui, 2009; Branker, Pathak & Pearce, 2011); 4) the market interest rate will remain steady at 3% (Indiana Department of Revenue, 2012); 5) it is assumed that the net metering program is available in all the areas and for all the residents of Indiana; 6) it is assumed that PV energy production degradation is equal to 3% per year based on the literature (Energy Efficiency & Renewable Energy, 2008; El–Bassiouny & Mohamed, 2012; Jha, 2010); 7) it is assumed that the end of life decommissioning cost is equal to end of life salvage price; 8) it is assumed that the average electricity cost will increase in a constant pattern over the lifetime of the system at an annual rate of 1.052 % based on the literature (U.S. Energy Information Administration, 2012; Edison Electric Institute, 2006; Indiana Utility Regulatory Commission, 2012; Americas Power, 2012); 9) it is assumed that the selected counties, which are the counties with the highest population in each geographical area, are typical of that area of the state of Indiana; 10) it is assumed that tilt is equal to latitude and azimuth is equal to true south to avoid shading; 11) and it is also assumed that a typical single family in the state of Indiana consumes 11000 kWh / year (Energy Efficiency and Renewable Energy Clearinghouse, 2012).

2.4. Statement of Limitations

One limitation of this study is that changes may occur over time that may make the results time sensitive.

2.5. Research Tools

The study utilized the following methods, tools, and applications:

1. PV Watts application: The PV Watt is a computer simulation application developed by the U.S Department of Energy to predict the energy production and cost savings of grid-connected photovoltaic (PV) energy systems throughout the world (Safaei, Freire, & Antunes, 2013; Dobos, 2014).
2. Google Earth: Google Earth is an application that provides geographical information regarding locations. Microsoft Excel: Microsoft Excel is a software package used to produce spreadsheets and graphs and perform mathematical functions and calculations.
3. Online quoting: Via their websites, PV system providers were requested to provide online quotes of the size, necessary components and their costs, maintenance expenses, and lifetime of a standard single family residential PV system.
4. Zip Code finder: The Zip Code Finder is a general web application offered by many websites to identify the zip code of a specific area for the counties in the State of Indiana.

2.6. Research Design Methodology and Procedures

This study has employed a systematic approach to collect data via reviewing the relevant literature, requesting information about the system's cost from PV professionals, collecting data about the Indiana cities location, using a computer simulation program called PV Watt Calculator to estimate a standard system's performance, and then evaluating and analyzing the collected data using engineering economic methods, including breakeven, cash flow analyses, net present value, and internal rate of return, to determine the economic features of the system. The following explanation for each step:

Step One: Reviewing relevant literature

Reviewing the literature was important to identify electricity usage of a typical house and the average electricity rates increase in the State of Indiana. This study only considers the real increase in electricity prices during the period of 2005-2011 without considering the impact of the new EPA regulations. Table 1 shows the average electric rates in the State of Indiana between 2005 and 2011. Also, from the table, it can be found that the average increase in electricity rates is 1.052%. This rate is used in this study to measure the impact of future increase in electricity prices on the economic performance for the standard PV system.

Table 1: The Average Electric Rates in the State of Indiana, 2005-2011

Year	Price (Cents/KWh)	The increase
2005	7.5	
2006	8.22	1.096%
2007	8.26	1.01%
2008	8.87	1.074%
2009	9.5	1.07%
2010	9.56	1.01%
2011	10.06	1.05%
The average increase		1.052 %

Source: U.S. Energy Information Administration, 2012.

The Energy Efficiency and Renewable Energy Clearinghouse (2012) estimates the average yearly energy consumption for a typical home according to the 23 appliances described in Table 2.

Table 2: The Average Energy Consumption for a Typical Home

Appliance	Time in use	kWh / year
Air Conditioner (one ton)	4 hrs / day, 180 days/ yr	2278
Clock radio	24 hours / day	44

Clothes washer (does not include hot water)	2 hours / Week	31
Coffee maker	30 minute / day	128
Dehumidifier	12 hours / day	700
Dishwasher (does not include hot water)	1 hour / day	532
Electric blanket	8 hrs / day,120days / yr	175
Fan (furnace)	12 hrs / day,120 days / yr	432
Fan (whole house)	4hrs / day, 120 days / yr	270
Fan (window)	4 hrs / day,180days / yr	144
Hair dryer	15 minutes / day	100
Heater (portable)	6 hours / day,120 days / yr	1240
Iron	1 hour/week	52
Microwave oven	2 hours/week	89
Radio (stereo)	2 hours / day	73
Range (with self-cleaning)	2 hours/ day	775
Refrigerator (frost free 16 cubic feet)	24 hours / day	642
Television	4 hours / day	292
Toaster	1 hour / day	73
Vacuum cleaner	1 hour / week	38
VCR	4 hours / day	30
Water bed (no cover)	12 hrs / day,180 days / yr	620
Water heater (40 gallon)	2 hrs / day	2190
	Total	10948

Source: Energy Efficiency and Renewable Energy Clearinghouse, 2012

Step Two: Identifying the standard system's size and specification

Data regarding the costs of installing a standard system was collected by requesting online quotes from PV professionals via their websites. The names and the websites of PV manufacturers, distributers, dealers, and repair specialists were identified using the key phrase "Solar System" and the location of "Indiana" to search the electronic version of the Yellow Book. The results were then filtered by selecting the following three categories:

1. Solar Energy Equipment and Systems–Dealers;
2. Solar Energy Equipment and Systems–Service and Repair; and
3. Solar Energy Equipment and Systems–Manufacturers and Distributors.

The online quotes provided data regarding required components and their costs, size, maintenance costs, and expected lifetime, necessary to address the following questions:

A. Components and costs:
   1. What are the major components of a grid-connected PV system?
   2. What is the cost of each component and its installation, and on what basis is the cost determined?
B. Performance:
   1. How the electrical performance of PV modules and arrays is typically rated?
   2. How should a PV array be oriented for maximum energy production?
C. Size
   1. What is the surface area that is required for installing a PV array?
D. Maintenance
   1. What is the estimated annual maintenance cost of a standard PV system?
E. Lifetime
   1. What is the expected lifetime of a standard PV system?

Step Three: Selecting the cities and locations

The third step in the research methodology was identifying the cities and counties of Indiana. According to the State of Indiana website (IN.gov, 12; IN.gov, 13), the counties are grouped into the six geographical regions of North, East, West, Central, South Central, and South. The counties within each group were sorted based on the population and then the county with the highest population within each group was selected to represent the geographical region, as it is most representative of the greatest number of Indiana residents in that region. By using this procedure, it may be easier to target the most populous locations where the findings can be made known to the greatest number of residents, which will facilitate the study goal of increasing awareness of PV systems among the greatest number of Indiana residents possible.

Step Four: Finding the potential solar power based on the location

The next step was identifying the zip codes and the cities within each of the selected counties (regions of the state) using the Zip Code Finder application. Identification of the zip codes for each city was used to collect precise geographical data, including solar power potential, that affect the amount of electricity that can be generated via a standard PV system located in a particular area. More than one location within each of the six selected counties with different latitudes and longitudes were used (see later, Table 6). The reason for selecting more than one location is to have a more accurate results that show the generated energy at multiple locations in the county. Google Earth application was used to determine the solar azimuth and solar altitude, two parameters necessary to identify the exact locations for each zip code to determine the solar power potential for each area. More details can be found in Al-Odeh (2013).

Step Five: Estimating the system's performance

The fifth step was entering the geographical parameters (solar azimuth and solar altitude) and the system specifications (which gathered from PV professionals) into the PV Watt application to calculate the amount of energy that can be produced using a standard PV system. The application will show the cost of electricity for a particular area in terms of rate per kilowatt hour. If the area is not covered by any utility provider, it will show the rate for the nearest utility service area.

Step Six: Conducting the economic assessment

Once the technical requirements of the standard PV system have been stated, the economic analysis, which was the final step in the research methodology, carried out. The economic assessment included both costs and benefits of the system. The economic assessment was conducted by using Excel spreadsheets for calculation of the financial parameters, including cash flows, project balance (PB), net present value (NPV), and internal rate of return (IRR).

The PB starts with negative values in this case as it is an investment project in a PV system. The project balance (PB) for the year 0 is equal to the cash flow (CF) for year 0, and it is equal to initial cost and the installation costs (Al-Odeh, Stergioulas, & Badar, 2012). For the remaining years, PB can be calculated by multiplying PB of the previous year (t-1) by (1 + interest rate i) and adding CF of that year (t) (Newnan, Eschenbach, & Lavelle, 2011; Rosen & Dincer, 2003; Dasgupta & Stiglitz, 1974).

$$PB_t = [PB_{t-1} * (1+i)] + CF_t \quad (1)$$

If PB reaches 'zero' at a particular time while changing from negative to positive values, this time is referred to as discounted payback period (DPP). If PB remains negative till the end of the analysis period (i.e., n = 25 years) meaning the project is not justified economically (Newnan, Eschenbach, & Lavelle, 2011).

Project balance (PB) helps to determine the discounted payback period (DPP). PB vs time (year) can be plotted to determine the discounted payback period (DPP). The DPP over 25 years has been calculated along with the internal rate of return (IRR) and the net present value (NPV) or present worth (PW). IRR is the interest rate (i*) at which the project benefits are equivalent to the project costs or the present worth (PW) of the project is zero. IRR (i.e., i*) can be obtained by solving Equation 2 for i*.

$$NPV(i^*)=PW(i^*)=0=PW(i^*)_{benefit}-PW(i^*)_{cost}=\sum_{t=0}^{n}CF_t(1+i^*)^{-t} \quad (2)$$

NPV or net PW or PW represents an equivalent amount of the project cash flows at t = 0 (i.e., present time) at interest rate (i) (Newnan, Eschenbach, & Lavelle, 2011; Khan, & Iqbal, 2005). NPV can also be computed from a range of cash flows (from period 1 to *n*) using the NPV function in the Microsoft Excel as given below (Newnan, Eschenbach, & Lavelle, 2011).

NPV:=NPV(rate, values) (3)

If any cash flow occurs at *n* = 0, it is added algebraically to the value obtained from Equation 3 in the excel NPV function. If NPV is less zero, the project is concluded to be not justified (Kim, Y. H., Philippatos, & Chung, 1986; De Reyck, Degraeve & Vandenborre, 2008).

IRR can also be computed from a range of cash flows (from period 0 to n) using the IRR function in the Microsoft Excel as given below (Newnan, Eschenbach, & Lavelle, 2011). If IRR is less than market interest rate or MARR, the project is concluded to be not justified.

IRR:=IRR(values, [guess]) (4)

Thus, DPP, values of PB at n = 25, and NPV and IRR for n = 25 were used to evaluate the economic feasibility of installing a grid-connected PV. The total system's cost (which was collected from PV professionals) and the projected cash flows (which were based on analysis of system costs, expected energy production, electricity rate, maintenance expenses, expected lifetime, and interest rate) were the two most important factors for conducting this analysis. Figure 1 shows the process that was used to make the economic assessment for the standard PV system.

Figure 1: The Process of Making the Economic Assessment for the Standard PV System

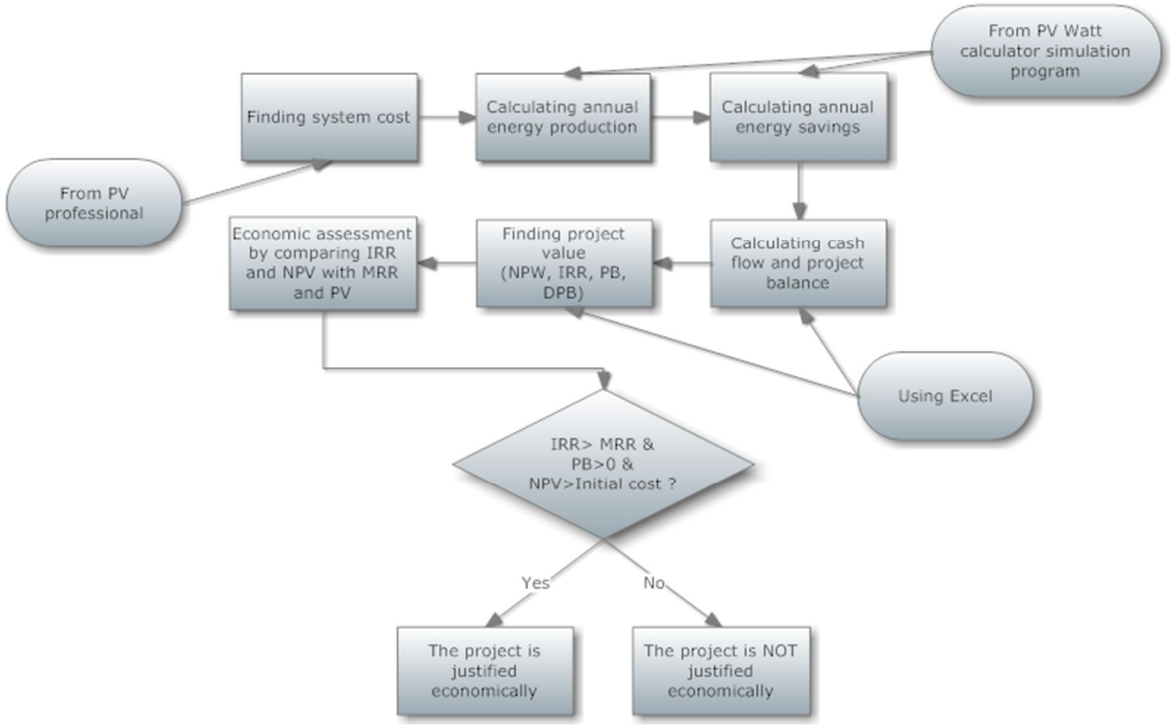
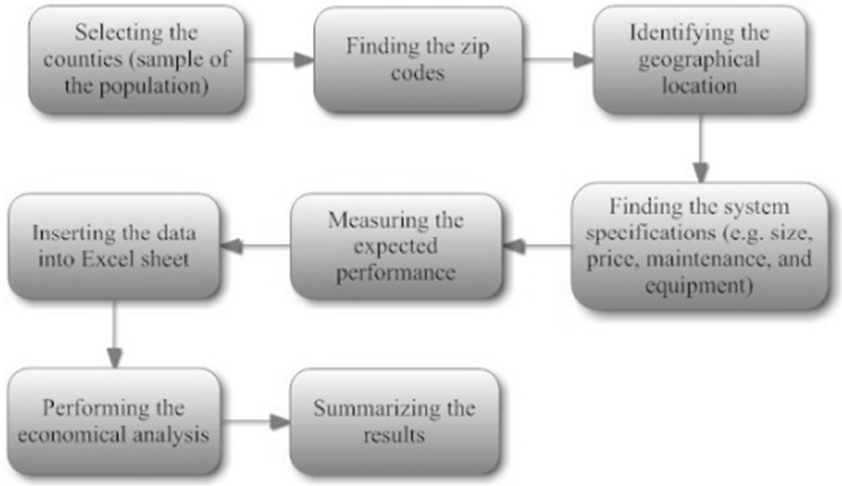


Figure 2: Research Methodology



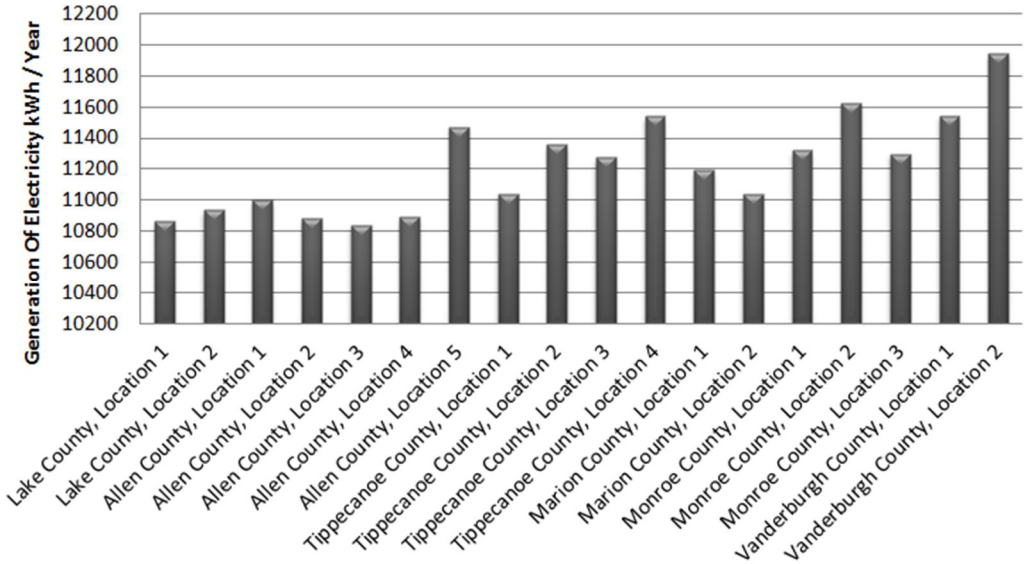
3. FINDINGS AND DISCUSSIONS

This section describes the research finding details including: system and cost specification, system efficiency, and the economic analysis in each Indiana location studied.

3.1. The Selected Locations and the Amount of Electricity Generation

After identifying the locations, potential solar power and the system performance were calculated. Figure 3 summarizes the electricity that could be generated by a standard PV system in all of the selected locations.

Figure 3: Electricity Generation by a Standard PV System in the Selected Locations



3.2. The System Specification

PV professionals in the State of Indiana estimated a standard size of a PV system suitable for an average single family home in Indiana, to be 9.36 KW. The system consists of 36 panels of 260 W each and enables a

household to generate 11,000 kWh per year. The system is enough to supply a typical house in Indiana with the needs of electricity. Installing this system could eliminate the need for buying electricity by up to 100% because it generates all the electricity needed, and excess electricity could be sold back to the electric utility to offset power needed at night.

Table 3: System Specifications

PV System Specifications	
DC Rating	9.36 kW
DC to AC Derate Factor	0.77
AC Rating	7.21 kW
Array Tilt	32.0°
Array Azimuth	180.0°
Array Type	Fixed Tilt
Weight per Panel	46.7 lbs
Panel Width	39.41
Panel Length	65.94
Total Panels	36

Source: Interviewing several industrial professionals in a focus group session

3.3. The Cost Specifications

The cost of a standard PV system varies from one manufacturer to another and depends on the system's configuration (e.g., roof or ground mounted, accessories…). The data regarding the system component and the rates have been collected via the process of requesting online quotes. Quotes were obtained from 13 of the 23 providers with online quotes capability. The rates for the system components are summarized in Table 4.

Table 4: The Rates for the Solar System Parts

Provider	Solar Panels Price ($ per W)	Inverter	Racking, Mounting, Wires, and Accessories
1	$1.59	$2,543.21	$140.72
2	$1.89	$2,646.15	$55.12
3	$2.13	$2,785.19	$57.23
4	$2.43	$2,841.03	$64.46
5	$2.28	$2,895.00	$75.55
6	$2.53	$2,842.53	$65.61
7	$2.63	$2,449.77	$76.73
8	$2.80	$2,510.45	$87.83
9	$2.75	$2,527.69	$90.91
10	$3.13	$2,357.90	$99.03
11	$3.43	$2,391.50	$100.09
12	$3.89	$1,789.50	$91.10
13	$4.45	$3,089.50	$124.14
Average	$2.76	$2589.96	$86.81
Total	$25869.60 (for 9.36 KW)	$2,589.96	$781.28 (for 9 racks)
Total Cost	$ 29,240.84		

Source: Interviewing several industrial professionals in a focus group session

The cost of the PV panels ranges from $1.59 to $4.45 per Watt. The average cost for installing a 9.36 kW system is $ 2.76 per Watt. From the online quotes, the researcher found that the PV manufacturers in the State of Indiana provide a warranty of 25 years for the panels and 10 years for the inverter. The price of the inverter ranges from $ 1,789.5 to $ 3,089.5. The average price for an inverter is $ 2,589.96. The maximum cost for a

standard PV system is $44,882.22 (4.45*9360+3089.5+140.72). The minimum cost is $16,727.02 (1.59*9360+1789.5+55.12). The average cost for a standard PV system is $ 29,240.84 ($25,869.60 +$2,589.96 +$781.28). The average price was used in this study to calculate expected cash flows of the system. The system price includes 36 panels to generate kWh per year, one inverter, nine rack systems, accessories (e.g., wires, connectors, breakers, and switches…), and installation. There is no maintenance required for the system but it is suggested that a household buy a new inverter every 10 years.

Homeowners in the State of Indiana are eligible to receive a 30 percent federal tax credit for the installation of solar technologies (Solangi, Islam, Saidur, Rahim & Fayaz, 2011; Wiser, Bolinger & Barbose, 2007). The federal tax credit is Residential Renewable Energy Tax Credit and if a taxpayer owes less than the tax credit, the excess credit generally may be carried forward to next tax year. This tax credit reduced the average net cost for a standard system to $20,468.588 ($ 29,240.84 – $8,772.252). Other parameters that should be considered in the analysis process are the market interest rate 3% (according to Indiana Department of Revenue), production degradation is equal to 3% per year starting from the second year (Energy Efficiency & Renewable Energy, 2008; El–Bassiouny & Mohamed, 2012; Jha, 2010) and the yearly increase in the cost of electricity 1.052 % (U.S. Energy Information Administration, 2012; Edison Electric Institute, 2006; Indiana Utility Regulatory Commission, 2012; Americas Power, 2012).

3.4. The System Efficiency

The efficiency of the system is called the DC to AC derate factor. According to U.S. Department of Energy (2012), the efficiency of the system (derate factor) is considered to be 77% (PV module nameplate DC rating= 0.95 * Inverter and transformer=0.92 * Mismatch =0.98* Diodes and connections =0.995* DC wiring =0.98* AC wiring =0.99 * Soiling = 0.95* System availability =0.98* Shading = 1.00 * Age =1.00). In order to consider degradation factor, the system performance (electricity production) is reduced by 3% per year starting from the second year.

3.5. Summary of the Analysis Parameters

The analysis depends on the following parameters:

1- The average net cost of a standard system = total cost - federal taxes credit (30% of the total cost).
The average net cost of a standard system = $ 29,240.84 – ($ 29,240.84* 30%) = $ 29,240.84 – $8,772.252 = $20,468.588
2- Geographical location of an area (depends on solar azimuth and solar altitude).
3- Electricity cost (varies from area to other).
4- Sales Tax= 7%.
5- The market interest according to Indiana Department of Revenue rate =3%.
6- The yearly increase in rates of electricity =1.052%.
7- Degradation factor = 3% starting from the second year (U.S. Department of Energy, 2012).
8- Yearly Maintenance = 0.
9- Salvage value = Decommissioning cost.
10-Array Tilt =32° (U.S. Department of Energy, 2012).
11-Array Azimuth =180° (U.S. Department of Energy, 2012).
12-Panels lifetime =25 years (According to the PV professionals in Indiana) (Energysage, 2016).
13-Inverter lifetime = 10 years (According to the PV professionals in Indiana) (Energysage, 2016).

3.6. Description of Conducting the Engineering Economy Assessment

The specifications mentioned above were used to economically evaluate the viability of the system. The calculation of the annual cost or savings from the PV system depends on how much electricity was generated per month or per year. Electricity generated from the system was computed based on the available solar potential of the counties of Indiana.

The interest rate is equal to 3%, which calculated according to Indiana Department of Revenue. The electricity rates were computed according to the rates that are provided by the utility company that serves the area. The

electricity cost is considered to increase 1.052% every year. Savings were computed by multiplying the electricity cost with the amount of electricity generated. It has been considered that the system efficiency is 77%, which is the derate factor. Starting from the second year, degradation factor was considered to be equal to 3% per year. Cash flows and project balances for a standard system over an analysis period of 25 years are presented for each of the selected counties (regions of the state).

The cash flow at the end of the first year is the saving due to electricity generation multiplied by the state sales tax of 7%. The cash flows for the remaining years have been computed by multiplying the cash flow for the previous year by 1.052 (to account for the 1.052% yearly increase in electricity cost) and by 0.97 (to account for a 3 % yearly decrease in system efficiency or to count degradation factor). A household is advised to replace the inverter every 10 years. Therefore, assuming the inverter average cost remains the same during the system lifetime; $2,589.96 was added to the project balance at the 10^{th} and 20^{st} year. An analysis period for this work has been calculated to be 25 years because the warranty for the system is 25 years. Project balance amounts were calculated using Equation (1), IRR was computed using the IRR spreadsheet function in Equation 4, and NPV was computed using the NPV function in the Microsoft Excel in Equation 3. If any cash flow occurs at n = 0, it is added algebraically to the value obtained from Equation 3 in the excel NPV function.

3.7. Conducting the Analysis

This section explains the process for calculating the engineering economy parameters only for the first location in the Lake County, Indiana. The system in this location can generate 10864 kWh in the first year. This value is multiplied by the cost of electricity 11.6 ¢/kWh ($1260/year), and then multiplied by the 7 % state tax. Therefore, a household in this location could save $1,348.21(=1260 *1.07) in the first year. The project at the end of year 25 has -$8,632.74 as a balance. According to these numbers, the NPV is equal to $15,869.46, which is less than the initial cost for the system ($20,468.59), the IRR is 0.491%, which is less than MARR (3%), and the project balance is negative. Therefore, it can be concluded that installing a standard PV system in that area is not justified economically. Table 5 is a sample to show the cash flow and project balance calculation for the first location in the Lake County, Indiana.

Table 5: Cash Flows and Project Balances for a Standard System at the First Location in the Lake County, Indiana

Year	Cash Flow	Project Balance	Year	Cash Flow	Project Balance
0	-$20,468.59	-$20,468.59	13	$1,060.61	-$13,524.68
1	$1,348.21	-$19,693.99	14	$1,039.62	-$12,859.62
2	$1,321.52	-$18,923.64	15	$1,019.04	-$12,195.79
3	$1,295.36	-$18,157.13	16	$998.87	-$11,532.84
4	$1,269.72	-$17,394.03	17	$979.09	-$10,870.36
5	$1,244.58	-$16,633.93	18	$959.71	-$10,207.96
6	$1,219.95	-$15,876.40	19	$940.71	-$9,545.27
7	$1,195.80	-$15,121.02	20	-$1,667.87	-$11,549.53
8	$1,172.13	-$14,367.36	21	$903.84	-$10,965.06
9	$1,148.92	-$13,614.99	22	$885.95	-$10,381.49
10	-$1,463.78	-$15,531.14	23	$868.41	-$9,798.47
11	$1,103.89	-$14,860.07	24	$851.22	-$9,215.67
12	$1,082.03	-$14,191.38	25	$834.37	-$8,632.74

The same technique was used in all 18 locations to calculate the cash flow, project balance, NPV, and IRR. Table 6 summarizes the result of the economic analysis for all the selected counties in the State of Indiana.

Table 6: Summary of the Study Results

County	Electricity rate	Generation of Elec./ Year	Project Balance by end of year 25	NPV	IRR
Lake County, location 1	11.60	10864 kWh	-$8,632.74	$15,869.46	0.491%
Lake County, location 2	11.50	10935 kWh	-$8,746.96	$15,816.50	0.460%
Allen County, Location 1	7.30	10999 kWh	-$23,677.31	$8,893.37	-4.427%
Allen County, Location 2	10.20	10880 kWh	-$13,642.66	$13,546.39	-0.944%
Allen County, Location 3	9.90	10842 kWh	-$14,869.06	$12,977.71	-1.319%
Allen County, Location 4	9.70	10890 kWh	-$15,429.92	$12,717.64	-1.494%
Allen County, Location 5	10.00	11472 kWh	-$12,481.77	$14,084.69	-0.598%
Tippecanoe County, Location 1	11.00	11043 kWh	-$10,290.32	$15,100.85	0.032%
Tippecanoe County, Location 2	10.70	11358 kWh	-$9,928.59	$15,268.58	0.133%
Tippecanoe County, Location 3	11.30	11277 kWh	-$8,140.01	$16,097.93	0.625%
Tippecanoe County, Location 4	10.90	11539 kWh	-$8,642.62	$15,864.88	0.488%
Marion County, Location 1	10.20	11194 kWh	-$12,372.82	$14,135.20	-0.566%
Marion County, Location 2	9.70	11035 kWh	-$14,884.85	$12,970.39	-1.324%
Monroe County, Location 1	10.40	11319 kWh	-$11,437.39	$14,568.96	-0.295%
Monroe County, Location 2	11.50	11626 kWh	-$6,026.24	$17,078.08	1.186%
Monroe County, Location 3	10.90	11297 kWh	-$9,501.03	$15,466.84	0.252%
Vanderburgh County, Location 1	10.90	11543 kWh	-$8,818.05	$15,783.53	0.440%
Vanderburgh County, Location 2	10.00	11942 kWh	-$10,649.42	$14,934.34	-0.070%

4. CONCLUSION

This study is intended to provide useful information to Indiana residents and homeowners considering the installation of a standard PV system as a means of reducing the cost of electricity. This study contributes to developing energy policies in the state of Indiana, by providing an independent analysis of the economic feasibility of using the grid-connected PV systems. The results of the study may help Indiana decision makers to evaluate the real needs and the applicable situations for using the residential PV system and may assist in the development of strategies and financial incentives that could make the PV system financially attractive.

This study found that the standard PV system does not produce a positive project balance and does not pay for itself within the life time of the system (25 years). The cost of solar PV is higher than the market valuation of the power it produces; thus, solar PV did not compete on the cost basis with the traditional competitive energy sources. Reducing the capital cost will make the standard PV system economically viable in Indiana. It is recommended that the policy makers in the State of Indiana may need to review the renewable energy incentive programs and make these programs more effective.

Even though the system does not seem to be economically viable in Indiana, environmental benefits could be gained from installing the system. For example, previous studies compared PV solar generation versus coal-fueled generation; they estimated that, on an average, producing 1000 kWh of electricity with solar power reduces emissions by nearly 8 pounds of sulfur dioxide, 5 pounds of nitrogen oxides, and more than 1400 pounds of carbon dioxide (Ibrahimov, 2013). Therefore, installing a standard PV system will enable its owner to reduce emissions by nearly 88 (11*8) pounds of sulfur dioxide, 55 (11*5) pounds of nitrogen oxides, and more than 15400 (11*1400) pounds of carbon dioxide. This study may help the resident of Indiana understand the inter-relationship between energy, economy, and environment. By installing a standard PV system, residents of Indiana might be able to make their state a healthier place that is more suitable to raise their kids in healthy environments. In addition, energy efficiency and healthy environment are important factors that attract other people to live in the State of Indiana. The government should create educational programs that help in improving the residents' awareness regarding the environmental benefits of installing the standard PV system. Improving the Indiana residents' awareness will support the U. S. Department of Energy's efforts in reducing energy shortages and reducing America's dependence on foreign oil. Indiana residents should know that energy efficiency is beneficial for themselves, beneficial for their cities, and beneficial for the nation and the world even without immediate financial benefit. The following are recommendations for future research:

1- The researcher recommends developing a future study to investigate the viability of one-axis and two axis PV grid-connected system and compare the result with the result of this study in order to develop a comprehensive picture for the viability of different types of PV systems.
2- Comparison study might be conducted to look at financial difference between the use of residential PV systems and residential wind turbines.

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VALUE STREAM MAPPING: RECREATING AN INDUSTRIAL ENVIRONMENT IN AN EDUCATIONAL SETTING

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Abstract

The creation of an industrial environment in the classroom helps students to prepare for the real world of work. Manufacturing students must be prepared to apply lean manufacturing (LM) concepts in an industrial environment. Value stream mapping (VSM) is one tool that can be used to implement the LM technique. The aim of this current study was to apply VSM in the Simulated Industrial Manufacturing Company (SIMCO) class at Indiana State University. At SIMCO, mass production techniques were used to manufacture products such as diploma frames. There was, then, a need to use LM techniques to minimize waste and maximize the flow. It is known that VSM is well able to identify opportunities for enhancing value, eliminating waste, and improving flow. In this study, the authors followed four steps to implement VSM: 1) identify the product; 2) create a current-state value stream map; 3) create a future-state value stream map; and, 4) create an action plan. Takt time, process cycle time, and process cycle efficiency (PCE) were computed for prior- and post-states for comparison. Although PCE did not improve, takt time, cycle time, budget, and the number of required employees were all significantly reduced.

Introduction

The Simulated Industrial Manufacturing Company (SIMCO) is a completely laboratory-oriented 400-level capstone course. This course was designed to help students increase their practice of hands-on activities. The class is offered once a semester at the Collage of Technology of Indiana State University. The course is similar to an external industrial experience in that each student brings to the enterprise/class (or SIMCO) various skills, abilities, talents, and knowledge; and, all students must work together, while pooling their expertise, to achieve the final goal of producing a product that is of high quality, made to specifications, on schedule, and produced within a defined budget. Many products are manufactured in SIMCO such as diploma frames, clocks, coffee tables, etc. SIMCO is comprised of eight departments: manufacturing and production, design, quality, sales and marketing, purchasing, human resources, safety, and packaging. Each department should contribute to the process of developing at least one product. Machines that are available in the SIMCO lab include planers, belt sanders, table saws, miter saws, routers, and speed sanders.

The researchers focused on using the diploma frame product to teach and implement the processes of production and the proper usage of machines. The prior process of producing the diploma frame product can be summarized as 1) the sanding process created a smooth surface on both sides of the wood stock and produced the required thickness of the board; 2) an edge-joining process was used to join the wood pieces at a 90-degree angle; 3) a miter saw process permitted the workers to cut the ends of the wooden piece at exact 45-degree angles; and, 4) router processes used the router machine to shape the edges of the frame. Two passes of the router were required: the inside edge was shaped with a 3/16-inch bit and the outside edge with 5/32-inch bit. Also, a Kreg machine was used to make a screw cut on all the wooden pieces. This process was important for assembling the wooden pieces with the use of screws. Fifth, face jointing produced a smooth surface on the thicker edge of both sides of the wooden stock. Next, poly-seal painting was used to paint the wooden piece by using a brush and touch up-pens. The last step was the final assembly of the diploma frame in which the four pieces of wood were then assembled with screws.

Many dynamics have necessitated an organizational change in SIMCO. These can be summarized by five important factors:

1. The number of student workers (the average number of students, or "employees", in a class is 25. These employees can be managed to be more effective and productive by eliminating unnecessary tasks and positions. Also, this large number of employees can lead to management difficulties (e.g., in dealing with problems and interpersonal conflicts).
2. The price of the raw material is relatively expensive, since it is purchased for each class individually, and in considerably lower quantities than would be found in a real industry. By the end of each semester, some of the unused raw materials become waste and some finished products remain unsold.

3. The high volume of inventory requires significant storage room for unused raw materials and unsold finished goods.
4. The quality of products is acceptable but not of an exceptionally high level.
5. Demand for the products of SIMCO is low. This may be due to the lower quality of the product compared to products on the market, or it may be due to the poor marketing strategy used in SIMCO.

All of these reasons inspired the authors to reorganize the production process in SIMCO. Two major decisions were made: 1) that some of the unnecessary tasks should be eliminated and replaced with tasks that will add value to customers, and 2) that the overall performance and quality of the product should be improved. This research study aimed to apply the technique of value stream mapping (VSM) in the SIMCO class, and to measure the effectiveness of this newly applied procedure (LM). In SIMCO, a mass production technique is used to manufacture products such as diploma frames, clocks, coffee tables, etc. Therefore, there is a need to use Lean Manufacturing techniques in this class to eliminate or minimize waste and to maximize flow. VSM is a constructive technique that can be used to accomplish just such goals. Four steps are followed to effectuate value stream mapping: 1) identify the product; 2) create a current-state value stream map; 3) create a future-state value stream map, and 4) creating an action plan. Takt time, process cycle time, and process cycle efficiency (PCE) analyses are used to evaluate and create the current- and future-state value stream maps.

Literature Review

Lean, as defined by Womack and Jones [1], is the process for doing more with less and less (i.e., less human effort): less equipment, less time, and less space, and all while coming closer and closer to providing customers with exactly what they want. It is also a business system and a generic process-management philosophy that comprises a systematic approach to eliminate waste through techniques such as just-in-time, continuous improvement (Kaizen), and the pull system (Kanban) [2], [3]. Lean Manufacturing and its key principles were based upon the Toyota Production System (TPS), which is more generally denoted lean manufacturing [4], [5]. Ohno defines TPS as the total removal of waste to make product in a continuous flow [6], [7]. According to Womack and Jones [1], lean thinking has five key action principles:

- Define value from the customer's perspective: value needs to be identified from the standpoint of the ultimate consumer. If the customer will not pay for an activity, it is considered as non-value-added and should be eliminated.
- Identify the value stream: the value stream is the set of all steps/action required to produce a specific product or service. All of the steps in the value stream should be identified for each product family and every action and every practice that does not create value must be eliminated.
- Make the process flow: the materials should flow through the system with a minimum of interruption and waiting.
- Pull from the customer: the customer should pull the product from the source as needed rather than have the source push products onto the customer. In other words, no upstream function or department should produce a good or service until the customer downstream asks for it.
- Head toward perfection: after implementing these steps, the managers and teams of employees should eliminate further waste and pursue perfection through continuous improvement.

The lean technique is not just a concept but also a foundational philosophy; it states that every organization and work environment must seek to eliminate waste (non-value-added activities) and to save on labor, material, and machines costs [8]. Lean techniques use standardized work practices to minimize efforts and improve product quality so as not just to meet customer expectations but rather to exceed them [9], [10]. There are many advantages and goals for lean production. These can be summarized via the following needs:

- Improve quality: understanding customer needs helps companies remain competitive in the marketplace. Therefore, a company must design its services to meet customer expectations, needs, and requirements [1], [11].
- Eliminate waste: waste can be defined as any activity that does not add any value to the process (i.e., product or service) [12]. Waste can be due to any of the following: overproduction, superfluous motion, transportation issues, waiting time, setup time, processing time, unnecessary inventory, defective products, and underutilized workers [12-14].
- Reduce production time: using the available time in the most efficient way will reduce the time and effort that is needed to deliver the service or product. This also will help eliminate waste and reduce costs [1].
- Reduce total costs: companies can minimize total cost by producing in quantities that are sufficient to meet customer demand. Producing more than customer demand will increase inventory costs [15], [16].

The VSM technique was essential for the implementation of lean production in SIMCO. VSM was used to analyze the current situation and to develop a new production process to minimize waste, maximize flow, and improve customer satisfaction by improving the product quality. A value stream takes into account all of the value-added and non-value-added steps needed to convert a product or service from a raw material into what the customer ultimately requires. Managing the value stream employs processes for measuring, understanding, and improving the flow and interaction of all of the associated tasks; the goal is to keep the costs, service, and quality of a company's products and services as competitive as possible [17], [18]. Value stream mapping could continuously identify opportunities to enhance value, eliminate waste, and improve flow. There are four steps an organization can use to implement value streams in their production processes. These steps are: identifying the product, creating a current-state value stream map, creating a future-state value stream map, and creating an action plan [19], [20].

In order to improve the production in SIMCO, a lean manufacturing technique has been employed. A comparison was made between the spring 2012 SIMCO class (after lean was implemented) and the pervious mass production process used in the spring 2011 class. The comparison helped the researchers to evaluate the effectiveness of the lean manufacturing technique in classroom settings. The VSM analysis has been invaluable for the improvement of the production process at SIMCO. The Smart Draw Software application was used to develop the maps.

Tracking the time needed to perform each process was important in this research project. Data was collected by the students of the SIMCO class using a digital stopwatch. The time in seconds for each process was measured three times and the average of the three trials was calculated. This method was used to calculate different factors and to build the current value stream mapping that is described in the next section. It was also of great value to determine the cycle time for each process [21]. Different mathematical equations were used to accomplish this. One equation, process cycle efficiency (PCE) [22], is given in Equation (1):

$$PCE = \frac{customer\_value\_added\_time}{process\_cycle\_time} \quad (1)$$

Process cycle time is the sum of design time, manufacturing planning time, manufacturing control time, and manufacturing lead time. Thus, cycle time is the sum of value-added and non-value-added times [23]. Takt time [24] is calculated using Equation (2):

$$takt\_time = \frac{net\_time\_available\_to\_work}{time\_demand} \quad (2)$$

It was assumed that the production year in SIMCO was the academic year that consisted of two semesters, 16 weeks for each semester. The class was scheduled to be held semi-weekly for two hours each day. Also, it was assumed that the walking time was fixed, because the production processes took place in the same SIMCO lab without any changes in the locations of the machines.

Findings

The findings from this study are summarized by three primary factors: organizational structure, budget, and production process and cycle time.

The organizational structure for SIMCO spring 2011 was a functional structure based on job's purpose within the SIMCO Company. Functional organizations were comprised of departments that aimed to accomplish a single function/goal. Figure 1 shows the organization chart for SIMCO spring 2011 before applying the VSM. Matrix structures were developed in SIMCO to generate the best results by which to manage the company. The matrix structure was created by forming a team consisted of the most qualified students/employees (based on their experience) for the project. Figure 2 illustrates the organizational structure for SIMCO spring 2012 after applying the VSM.

Eight departments in the old structure were reduced to five functional areas by using the matrix organizational structure. The packaging department was integrated into the production area. The purchasing department was integrated into sales, but this new entity was denoted as the logistics area. The human resources department was eliminated, as it was not needed under the matrix structure that eliminated centralized management.

Table 1 illustrates the budget for producing 35 diploma frames before applying VSM. Table 2 shows the budget for producing just 10 diploma frames, i.e., because, historically for this course, the demand for the diploma frame product is 10 units per semester. Therefore, there is no need to order material for more than 10 units unless more units are requested by customers. Thus, the total budget was reduced from the pre-change value of $609.88 to $273.82.

Before applying the VSM, the number of diploma frames to be produced was determined by the number of students in the SIMCO class (in this case, 35). Company departments were also formed based on the number of the enrolled students. The goals were to manufacture diploma frames in large quantities (35 frames) and in standard form. Fifteen main processes were used to produce the diploma frame product. These steps are explained in Table 3.

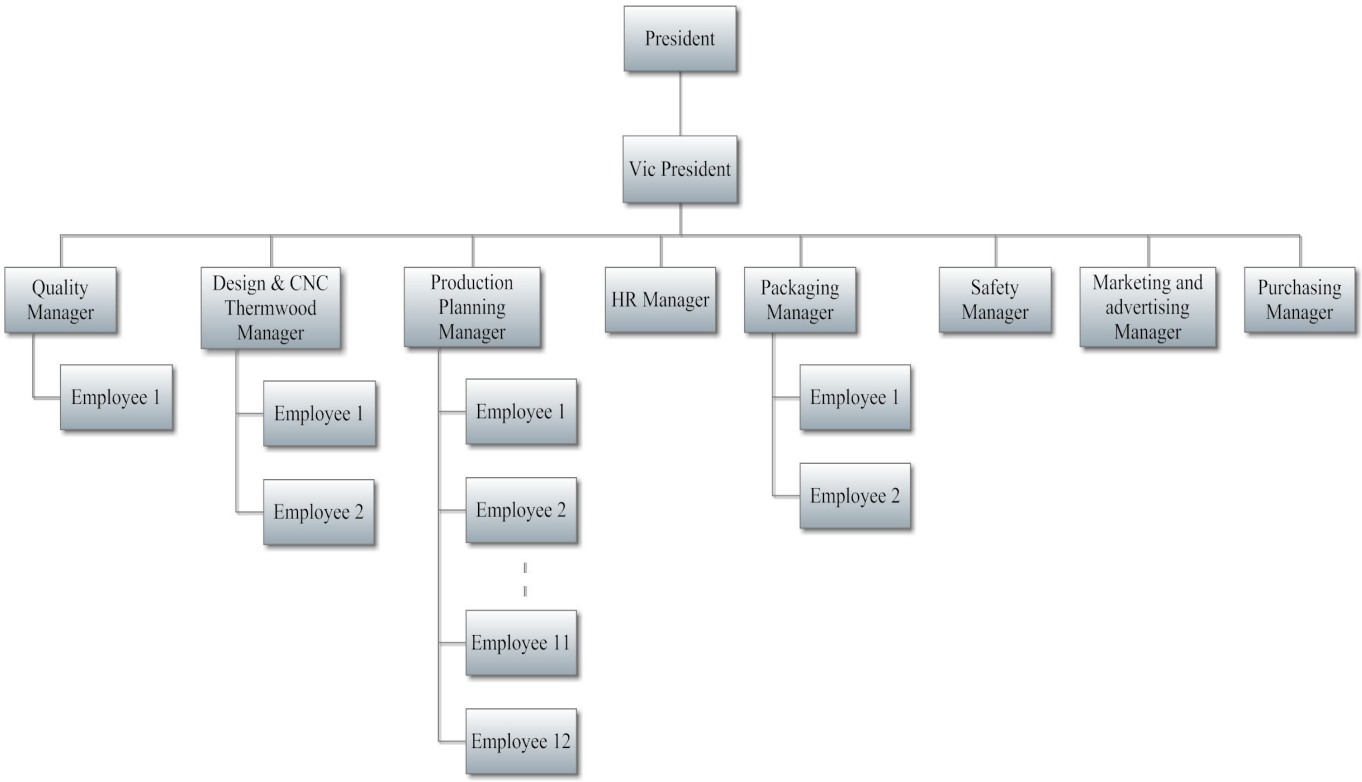

Figure 1. Organizational Structure for SIMCO in the Spring of 2011 Before Applying the VSM

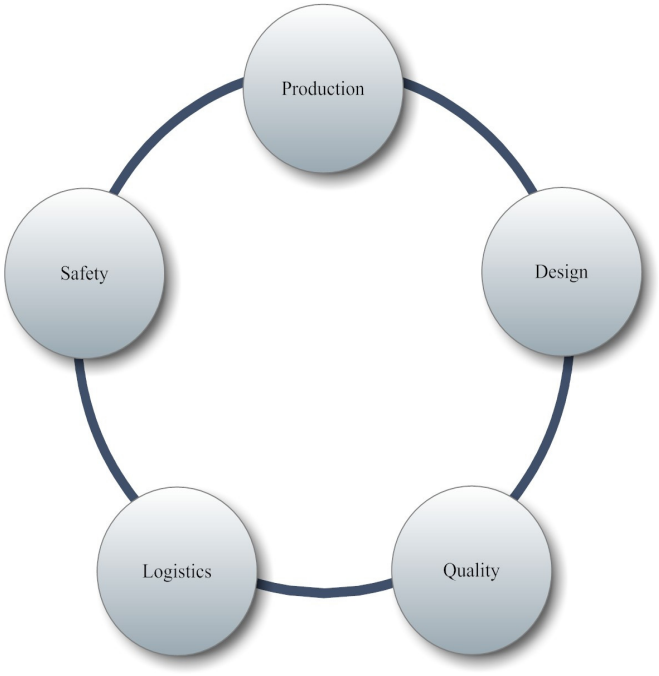

Figure 2. Organizational Structure for SIMCO in the Spring of 2012 After Applying the VSM

Table 1. Budget for SIMCO in the Spring of 2011 Before Applying the VSM

QTY	Description	Unit price	Total
75	White Oak (Board Feet)	$2.50	$187.50
35	S. S. Glass 15.25" x 12.75"	$3.90	$136.50
35	Blue Matting	$3.90	$136.50
35	Gold Matting	$3.90	$36.50
35	1/8 in. Foamcore Board	$1.00	$35.00
1	Custom Frame – Turn Buttons	$5.00	$5.00
1	1” Fine Thread Pan Head Screws	$25.99	$25.99
4	4” All-purpose Glue Sticks (24 pack)	$4.97	$19.88
1	MinWax Polycrylic Semi-gloss (1 Qt.)	$16.57	$16.57
1	6-Pack Foam Brush 2”	$2.98	$2.98
1	Finish Factor 12-Pack Terry Towels	$7.46	$7.46
		TOTAL	$609.88

Table 2. Budget for SIMCO in the Spring of 2012 After Applying the VSM

Quantity	Description	Price Per Unit	Total Cost
5	Frame	$12.31	$61.55
10	Backing 1	$3.41	$57.94
10	Backing 2	$3.41	$57.94
10	Frame Glass	$4.34	$43.40
1	1 pack of 10 30"x20"	$39.97	$39.97
1	Gunstock Color	$6.27	$6.27
1	16oz Bottle	$6.75	$6.75
		TOTAL	$ 273.82

Table 3. The Production Processes for SIMCO in the Spring of 2011

NO	Process Name
1.	Material Inspection
2.	Planning
3.	Edge Joining one side to create 90 degree angle
4.	Ripping
5.	Dado Cutting
6	Routing Inside Edge
7	Routing Outside Edge
8.	Sanding Edges
9.	Sanding Bottom and top surfaces
10.	Miter Cutting
11.	Cutting holes for screws
12.	Engraving upper and lower pieces with Thermwood
13.	Painting Letters
14	Waxing
15	Assembling

Table 4 shows the time in seconds for each of the value-added processes for producing 35 frames by the mass-production technique (Spring 2011 before applying the VSM). Also, the time for each process is summarized in Figure 3. These data helped to create the current value stream mapping illustrated in Figure 4.

Table 4. Total Time for Each Process for SIMCO in the Spring of 2011

Step	Total Time (Second)
Planer	9.73
Sander	51.89
edge Jointing	576
Ripping	0.91
Dado Cut	94.23
Miter Cut	978.67
Routing	589.2
Drill Holes	250.67
Waxing	1246.44
Engraving	600
Finishing	1252.33
TOTAL	5650.07

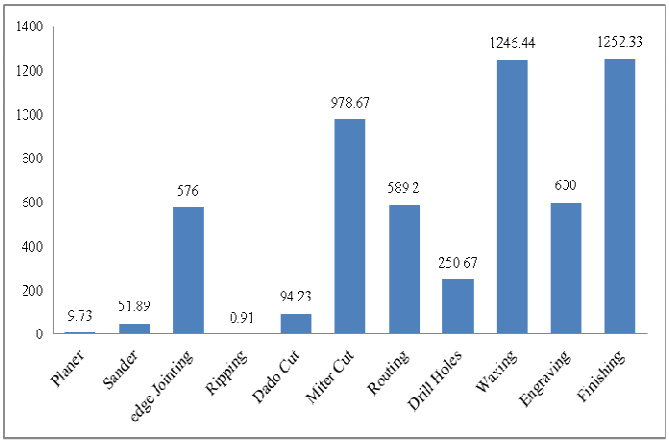

Figure 3. Total Time for Each Process in Seconds for SIMCO in the Spring of 2011

Three parameters were computed: takt time, process cycle time, and process cycle efficiency (PCE). As previously mentioned regarding assumptions, the production year in SIMCO was the academic year that consisted of two semesters, with 16 weeks per semester. The class was scheduled semi-weekly with two hours per class. Therefore, the time available for each class was 110 minutes (= 6600 sec), excluding time for breaks and clean up. Based on the actual sale of the diploma frames, the annual demand was 20 units. Demand per class day was computed by dividing the annual demand by 64 days per year (2 days/week → 8 days/month → 32 days/semester → 64 days/year); daily demand = 0.3125 piece/day. From the value stream map, it can be

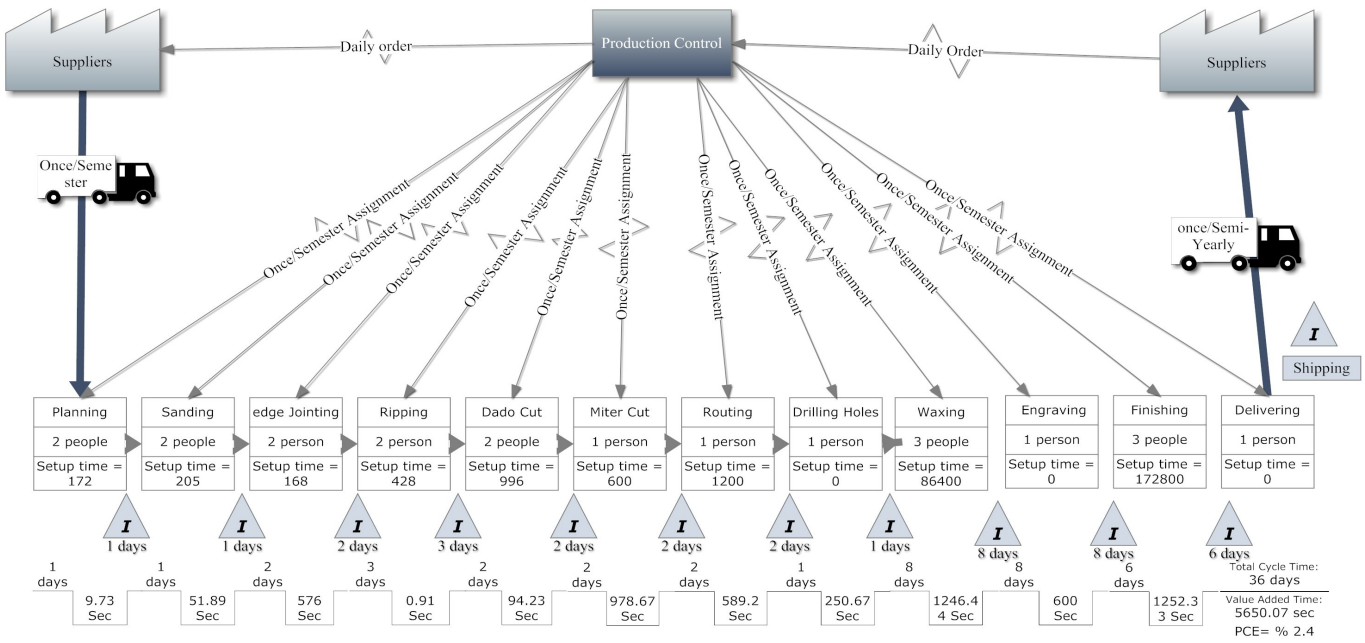

Figure 4. Value Stream Mapping for SIMCO in the Spring of 2011

found that the value added time required was 5650.07 sec and total process cycle time (PLT) was 36 days (37×6600 = 237,600 sec). From Equation (1), PCE = 5650.07/ 237,600 = 2.4%. From Equation (2), takt time = 6600/0.3125 = 21,120 sec/piece. Table 5 summarizes the result of the calculations.

Table 5. The Production Measurements for Mass Production Before Applying the VSM

Measurement	Result
Daily demand	0.3125 pieces/day
Takt time	21,120 sec/piece
PCE	2.4%
Process cycle time	237,600 sec
Value-added time	5650.07 sec
Non-value-added time	231,949.93 sec

The scheduling of the production process for spring 2012 was amended using Lean Manufacturing concepts. The change was accomplished with four important steps. First, the product was advertised to determine the actual demand. Second, the number of employees that would just satisfy that demand was determined. Third, the list of materials that would just meet the required demand was computed. Fourth, customers were given the option to customize their frames. It was found that the demand per semester for this product was 10 frames (annual demand = 20). Prior to the change, 25 students (employees) were needed to produce 35 diploma frames. After this change of manufacturing protocol, six employees were now needed to produce 10 frames. Thus, the other students, typically 19, could engage in other organizational or manufacturing functions rather than work on producing frames. The new production method reduced the number of processes from fifteen to ten by eliminating those deemed unnecessary, and by doing the following:

- Purchasing finished wood: This eliminated the time needed to inspect the incoming material and reduced the number of production steps, such as planning and sanding the unfinished wood.
- Using product design driven by customer requirements: This was implemented by changing the product design, making it simpler so as to be accomplished with fewer and simpler steps and fewer machines. Customers now had the option to customize their frames by selecting them from a variety of prespecified designs.
- Changing some production processes: Waste was greatly reduced by modifying some production processes, such as the method of connecting the edges. The joint process was changed from using screws to biscuit connections; this reduced the time needed to make a corner joint from 250.67 sec to 12.9 sec. Table 6 shows a comparison of the time in seconds needed for the main processes for SIMCO in the spring of 2011 (before VSM) and spring of 2012 (after VSM).

Table 6. Time Needed for Each Process Before and After Applying the VSM

Processes Before VSM (Time in Seconds)		Processes After VSM (Time in Seconds)	
Finishing	1252.33	Finishing	1627
Waxing	1246.44	Waxing	57
Miter Cut	978.67	Miter Cut	59.7
Engraving	600	Engraving	765.3
Routing	589.2	Routing	65.1
Dado Cut	94.23	Dado Cut	46.1
Drill Holes	250.67	Biscuit cut	12.9

Table 7. The Production Processes Employed in SIMCO in the Spring of 2012

No	Process
1	Rough Cut
2	Dado Cut
3	Routing
4	45° Cut
5	Biscuit Cut
6	Sanding
7	Thermwood Routing
8	Pre-Stain
9	Stain
10	Assembly

Table 8 illustrates the time in seconds for each of the value added processes for producing 10 frames. The times required for each process are summarized in Figure 5. A flowchart and the time required for each process helped to create the value stream mapping shown in Figure 6.

Three parameters were computed: takt time, process cycle time, and PCE. As mentioned previously regarding assumptions, a production year in SIMCO is the academic year that consists of two semesters and 16 weeks per semester. Table 9 summarizes the results of the calculations. The class was scheduled semi-weekly with two hours per class; however, under the new procedure, the class time available each day was 90 minutes, excluding the time needed for breaks and clean up. Daily demand = 20/64 = 0.3125 piece/day. From Equation (2), takt time = (90×60 sec)/0.3125 = 17,280 sec/piece. From the value stream map, value added time was 2648.3 sec and total process cycle time was 29 days × 90 min × 60 sec (= 156,600 sec). From Equation (1), PCE = 2648.3/156,600 = 1.7 %.

Table 8. Time for Each Process per Second

Process	Time in seconds
Ripping	15.2
Dado Cut	46.1
Routing	65.1
Miter Cut	59.7
Biscuit cut	12.9
Waxing	57
Engraving	765.3
Finishing	1627
Total	2648.3

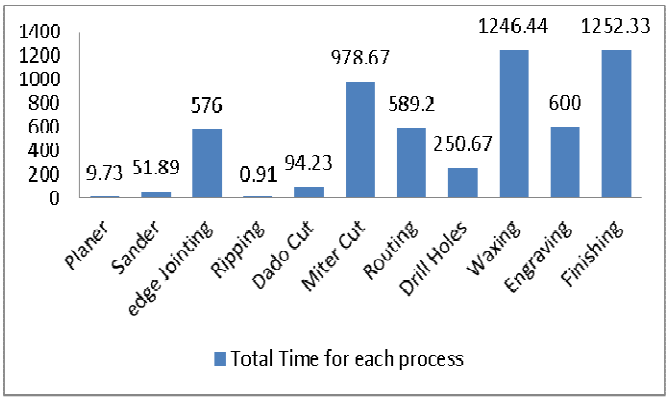

Figure 5. Time Required for Each Process after Applying the VSM

Conclusions

It can be concluded, then, that the new procedure was effective in reducing the takt time from 21,120 sec/piece to 17,280 sec/piece. Also, the process cycle time was reduced from 237,600 sec to 156,600 sec. In addition, non-value added time was reduced from 231,949.93 sec to 153,951.7 sec. Moreover, the new process reduced the budget for producing this product from $609.88 to $273.82. The new process also provided an opportunity for those students not involved in the frame process to engage in different organizational and production activities. Table 10 summarizes the difference between production process for SIMCO in the spring of 2011 and the spring of 2012.

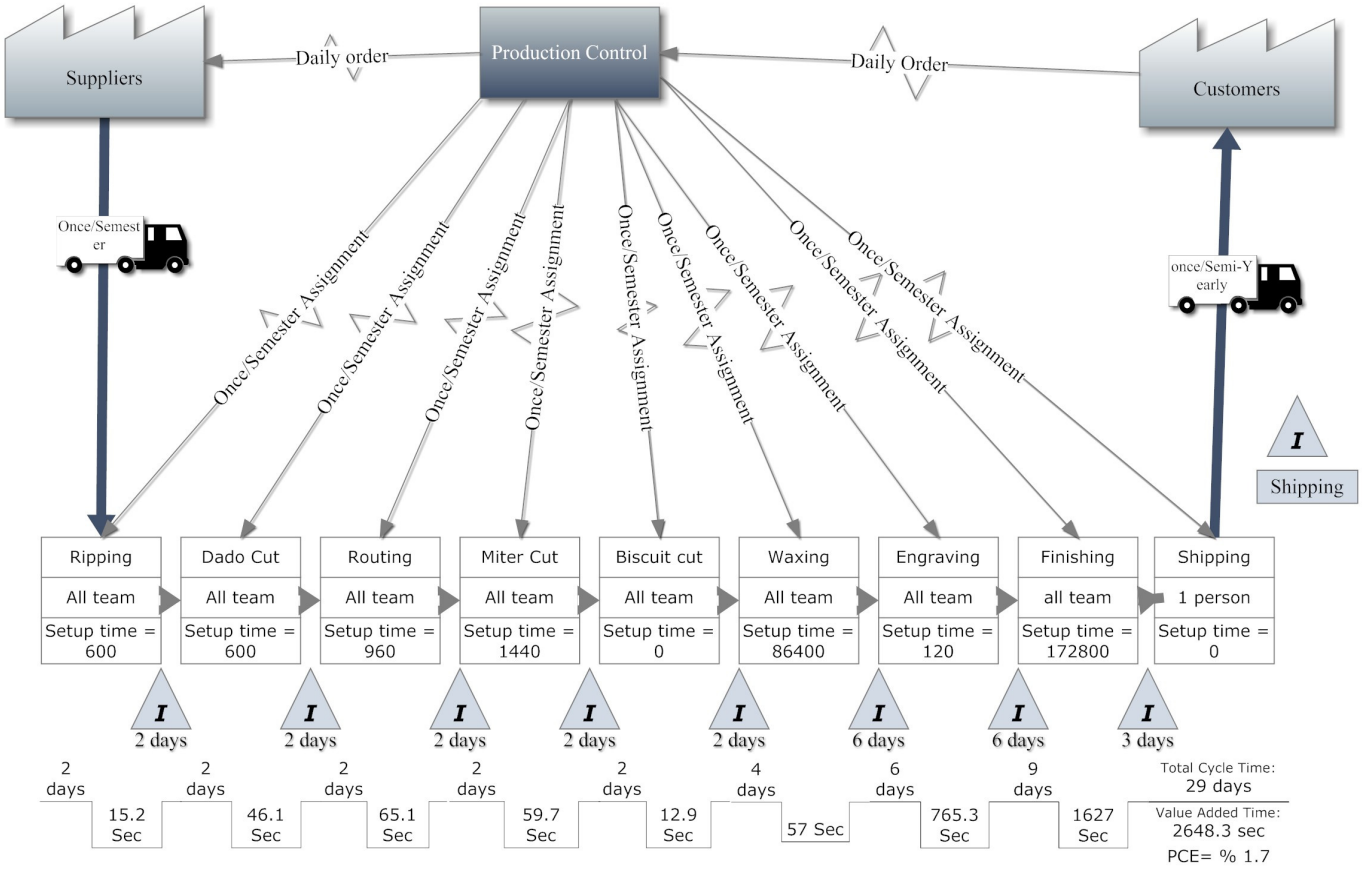

Figure 6. Value-stream Mapping for SIMCO in the Spring of 2012 After Applying the VSM

Table 9. Measurements for Lean Production in SIMCO in the Spring of 2012

Measurement	SP 2011- before VSM	SP 2012- after VSM
Daily demand	0.3125 pieces/day	0.3125 pieces/day
Takt time	21,120 sec/piece	17,280 sec/piece
PCE	2.40%	1.7%
Process cycle time	237,600 sec	156,600 sec
Value added time	5650.07 sec	2648.3 sec
Non-value-added time	231,949.93 sec	153,951.7 sec
budget	$609.88	$273.82
Employees	25 employees	6 employees

It is clear from Table 10 that value stream mapping helped the researchers improve the SIMCO class significantly. Looking at the post-change data, PCE did not improve; however, other parameters such as cycle time, non-valued added time, takt time, budget, and number of required employees to make the diploma frames, all were reduced significantly.

Table 10. Production Measurements Before and After Applying the VSM

Measurement	Result
Daily demand	0.3125 piece/ day
Takt time	17280 sec/piece
PCE	1.7%
Process cycle time	156600 Sec
Value added time	2648.3 Sec
Non-value added time	153951.7 sec

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