

SUSTAINABLE SUPPLY CHAIN MANAGEMENT: SMEs IN ARIZONA AEROSPACE AND DEFENSE INDUSTRY

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ABSTRACT

Small to medium-sized enterprises (SMEs) were surveyed on their strategy for Sustainable Supply Chain Management (SSCM), including relationships with suppliers and customers, methods used in supply chain management, perspectives on sustainability, and financial benefits from going green. Data was collected from a sample of 53 SME managers, CEOs, presidents, vice presidents, and general managers. Results indicate that efficient material tracking systems and green process improvement could play a key role in reducing supply disruptions and improving SC efficiency.

Keywords: supply chain management, aerospace & defense, risk management, efficiency, green initiatives, sustainability.

INTRODUCTION

This research focuses on SMEs in the aerospace and defense (A&D) industry in Arizona with a focus on sustainable supply chain management (SSCM) practices and future plans for green and sustainability (G&S) initiatives. A survey was developed around SSCM and G&S questions similar to those of the 2009 Next Generation Manufacturing (NGM) survey (Next Generation Manufacturing, 2009). The four sections of the survey captured SMEs relationship with suppliers and customers, methods used in supply chain management, perspectives about sustainability, and financial benefits from going green.

Balancing economic and environmental performance has become increasingly important for organizations facing competitive, regulatory, and community pressures. With increased pressures for environmental sustainability, it is expected that enterprises will need to implement strategies to reduce the environmental impacts of their products and services (Zhu, Sarkis & Geng, 2004). To succeed in today's interdependent world is to embrace sustainability by requiring companies to identify a wide range of stakeholders to whom they may be accountable, develop open relationships with them, and find ways to work with them for mutual benefit (Savitz & Weber, 2006). In the long run, this will create more profit for the company and more social, economic, and environmental prosperity for society as a whole.

The supply chain of the U.S. defense industry is one of the most intricate in the world. The constant demand by the Department of Defense (DoD) for original equipment or crucial, often unavailable legacy parts is a daunting challenge, not only for small and medium-sized

manufacturers, but for the entire supply chain (Anonymous, 2007). The current DoD procurement process (DAG, 2010) has established requirements to ensure sustainability within the product lifecycle, and downstream members are required to strictly follow the guidelines and conduct systematic evaluations according to specific timelines.

The recent economic recession from 2008 to 2011 has caused the state of Arizona to lose an estimated 300,000 jobs, and the unemployment rate had reached 9.6 percent as of March 2011 (Vest, 2011). However, SMEs provide opportunities for renewed economic growth and development, and strengthening SME supply chains is beneficial for sustaining competitive advantage. Therefore, this study targets the aerospace and defense SMEs in Arizona to identify companies' current business processes in their supply chain areas, and investigate their supply chain sustainability and green manufacturing activities. A commitment to supply chain sustainability requires awareness of the full product lifecycle, ranging from the conduct of upstream suppliers to disposition of obsolete products (Fiksel, 2010). Therefore, policy makers and corporations should acknowledge how sustainability and continuous improvement within the supply chain can bring a positive impact to the corporate bottom line and strengthen the US economy.

STATEMENT OF RESEARCH PROBLEM

The definition of Sustainable Supply Chain Management (SSCM) is "the strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its supply chains" (Carter & Rogers, 2008, p 368). From SSCM principles, the following research objectives were developed:

1. Identify SMEs relationship with suppliers and customers in: strategic planning, inbound/outbound delivery, and product quality.
2. Investigate what methods have been used to perform sustainability practices within the supply chain.
3. Identify SMEs perspective about sustainability or green focus, current initiatives and barriers toward this direction.
4. Identify economic benefits when going green.

Proactive engagement in sustainable practices could also lower the risk of increased production costs due to the introduction of new and costly government regulations (Carter & Rogers, 2008).

Scope

This study is based on two sections of the NGM (2009) survey questionnaire, supply chain management and sustainability. The research team built a database that included approximately 1300 companies in the aerospace and defense (A&D) industry by gathering information from Arizona Department of Commerce and various online resources. The survey instrument was designed to assess the targeted companies in eight functional areas. Distribution and collection of the survey results was done using SurveyMonkey, an online third party tool. Survey findings were

based on the goal of identifying relationships between supply chain management and sustainability for manufacturers in the target area.

Assumptions

It was assumed that the targeted SMEs would voluntarily respond to the supply chain management and sustainability questionnaires, and that participants would be the organizations' owner/president, general managers or accounting managers, and thus would know how their companies operate. Further, it was assumed that participants could use the online survey tool at their own pace through internet access without further assistance. The goal was for the research team to gather and analyze at least 50 surveys during the allocated three weeks timeframe during April 2011. Moreover, it was assumed that the custom design of the survey instrument had content validity and would capture the important aspects of supply chain management and sustainability/green focus. Because this study related only to the targeted Aerospace & Defense SMEs in Arizona, the results should not be generalized to other States or other areas of manufacturing. The next section presents the research methodology, based on the fundamental theory of triple bottom line in sustainability, and its application to supply chain management (Savitz & Weber, 2006; Smith & Sharicz, 2011; Stefan, et al, 2008; Vachon & Mao, 2008; Yura, 2011).

METHODOLOGY

This study involved the collection of primary supply chain data using a questionnaire based on the Next Generation Manufacturing strategy (NGM, 2009) adapted for Arizona manufacturers in five specific areas: continuous improvement, technology acceleration, supplier development, sustainability, and workforce development. The following steps were taken:

1. Generate Arizona aerospace supplier database.
2. Design and develop the questionnaire with eight functional areas by using Wisconsin Next Generation Manufacturing Study (2008) as the benchmark.
3. Conduct a pilot study.
4. Refine the NGM survey questionnaire based on pilot study results.
5. Distribute NGM survey to selected SMEs in Arizona's A&D industry supply chain.
6. Analyze survey results to determine supply chain characteristics and sustainability practices.

Database Design

The supplier database was created from data sources including: Arizona Dept. of Commerce, D&B Million Dollar Database, Mint Global (BvD), ReferenceUSA, A&D company websites, and the Arizona Corporation Commission-State of AZ Public Access System. The database contains 1311 companies categorized by size and industry, and is divided into three groups based on manufacturing product relationship to AZ A&D industry supply chain (see Figures 1, 2 and 3):

1. Arizona A&D industry supply chain (mainly focuses on the first tier suppliers),
2. Indirect related to A&D supply chain (machine shops and precision companies),
3. Not-related to A&D supply chain (such as roofing companies).

Survey Design and Development

The survey questionnaire includes eight functional areas: demographics, leadership, customer satisfaction and innovation, workforce strategies, supply chain management, lean process improvement, sustainability and green focus, and global engagement. The present study only focuses on two aspects of the survey questionnaire which have a total of 33 questions in supply chain management and sustainability and green focus.

The supply chain management section of the questionnaire asks SMEs to identify the role of their key direct suppliers when establishing the long range strategic plan and frequency for evaluating supplier's product quality and delivery performance. The goal from the sustainability and green focus is to identify SMEs' current attitude and initiatives toward sustainability and green practices.

Survey Distribution and Collection

Surveys were distributed to the email addresses of upper management, such as CEO, VP or general manager in 75% of 1311 companies. The survey questionnaire was sent out through regular mail to the other 25% of the companies. Both the email and regular mail letters included the introduction/cover letter and the web page link to the survey questionnaire. Specific ID numbers assigned to each company enabled tracking of responses. The on-line survey tool helped to reduce the paper trail and get the results in real time. The official start date of this survey was April 2011, and it lasted approximately one month. To encourage a good response rate, email notifications were distributed before and after the survey was conducted, and an electronic follow-up letter was distributed to encourage high response rate.

RESULTS

A total of 1311 copies of the questionnaire were distributed, and 73 responses were collected by the end of the survey time period. The overall response rate of the survey was about 5.6%. The response rate for individual questions varied from about 70% to 3% for the completed surveys.

Demographics of Surveyed Companies

About 48% of respondents were in upper level management roles such as president, vice president, director/vice president of operations and general manager; 33% of respondents were chief executive officer; 6% were the chairman of the board; 5% were chief financial officer; 6% were chief operation officer, and about 5% were branch managers. 90% of the surveyed companies were privately owned.

Most of the companies (60%) have less than 100 employees, about 14% have 100 – 249 employees, 5% have 250 – 499 employees, and 4% reported 500 or more employees. Respondents' sales revenue was about 48% from military aerospace and defense, 33% from commercial aerospace, and 19% was from "other" category, such as the medical or electronics sector.

SMEs Relationship with Suppliers and Customers

Strategic planning

Carter and Rogers (2008) stated that cohesiveness in strategy and transparency between suppliers and customers are needed to achieve successful SSCM. Based on the prior research, we asked our SMEs: (1) if they have included their suppliers in their long-range strategic plans; and (2) how often SMEs interact with their suppliers. Figure 4 presents the results, which indicate that approximately 30% of SMEs include their suppliers in their strategic planning and 35% include only their key suppliers in their strategic planning. About 30% either do not include their suppliers or do not know if suppliers are included in their strategic planning.

The results further suggest that regular weekly contact is important for about 60% of SMEs surveyed. Others (30%) report regular monthly, quarterly, or annual contact. Some SMEs (10%) contact their suppliers only when there is a problem. One company reports continuous contact with suppliers due to a metric development program currently being conducted in partnership with their suppliers as part of a vendor qualification program.

Inbound/Outbound delivery

The survey results indicate that 23% of SMEs evaluate their suppliers' on-time delivery performance on either annual or semi-annual basis, and 31% of SMEs use an "as needed basis". About 29% of SMEs evaluate suppliers' on-time delivery performance on either a monthly or weekly basis. One company reports they continuously evaluate suppliers' on time delivery performance as part of a vendor qualification performance program.

The survey results indicate that approximately 85% of SMEs feel pressure to reduce the lead time to their customers, and about 15% of SMEs either do not or sometimes feel the pressure to reduce the lead time to their customers. Results in Figure 5 indicate that 71% of SMEs have reached 91% or above on time deliveries/shipments to their customers. About 11% have on time deliveries/shipments rate below 75%, whereas 18% of SMEs report on time delivery rates between 76 to 90%.

The survey results indicate that approximately 52% of SMEs have a tracking system for both suppliers and customers, and 15% have a real time integrated supply chain management system. About 21% of SMEs report no material tracking system in place, and 8% of SMEs either have a tracking system for suppliers or customers, and 4% do not know if their company has such a system in place.

Product quality

Carter & Rogers (2008) stated that reduced costs, shorter lead times, and better product quality are associated with implementation of ISO 14000 standards. Sustainability in product quality can reduce supply chain disruption and eliminate risks. Survey results from Figure 6 indicate that 6% of Arizona A&D supply chain SMEs evaluate their suppliers' product quality, and do so at regular intervals, with every delivery, or they constantly monitor suppliers' product quality. About 27% of SMEs evaluate their suppliers' quality monthly, 10% evaluate quarterly, 36% evaluate "as needed" and one company reports that it never evaluates supplier's product quality.

Current Methods to Perform Sustainability Practices

As product life cycles shorten in an ever-changing economic environment, companies have to be responsive and prepared to quickly meet customer demands. Agility in the supply chain is not just a nice-to-have concept; it has become crucial to the survival of many organizations, and a building block for the most successful companies. Lean productivity promotes the essence of economic sustainability. The following survey questions let us know: (1) the importance of Just-In-Time (JIT) practices to SMEs business success; and (2) the level of supply chain development.

Just-In-Time practices

The survey results from Figure 7 indicate that 46% of SMEs rate JIT practice is either important or highly important to their success. About 17% of SMEs rate JIT practice as either not important to their business success or do not know if the company has this practice in place. 37% of SMEs rate JIT practice is either somewhat or moderately important to their business success.

Survey results also indicate that 39% of SMEs either do not implement JIT purchasing, or have no knowledge of this practice in their supply chain management. About 56% of SMEs have implemented JIT in their SCM. One company uses a planning/purchasing practice in its SCM, and one company reports that it is difficult to implement JIT purchasing because its suppliers do not participate or constantly run out of stock.

Supply chain development of SMEs

The relationship between supply chain management and sustainable development has emphasized green purchasing, reverse logistics and reverse supply chain, product stewardship and green supply chain. This study investigates the current relationship between SMEs and supply chain development.

The survey results indicate that 54% of SMEs are not involved in their major customer's supply chain development, about 36% help manage their major customer's supply chain development, and 10% do not know whether the company helps manage their customer's supply chain development.

Survey results in Figure 8 indicate that 33% of surveyed SMEs actively support and develop their supply chain either with their suppliers or customers. The other 31% of SMEs report that they actively support and develop supply chain with both their suppliers and customers. 27% (14 of 51) of SMEs do not have any supply chain development, and 8% (4 of 51) of SMEs do not know whether their companies have such development. One company reports that it is difficult to accomplish this goal.

SMEs Initiatives or Barriers Toward Sustainability

Most of the surveyed SMEs indicate some difficulty keeping on track with their expenses and establishing guidelines toward sustainable practices. In this section of survey questions, we investigated: (1) do SMEs have any green strategies or green initiatives in place; and (2) what are the barriers to implementation of their green initiatives.

Green strategy or initiatives

The survey results presented in Figure 9 indicate 82% of surveyed SMEs currently either do not have any green strategies in place or these strategies are just being developed. About 14% of the SMEs have had green strategies in place for one year or more, and 4% of surveyed SMEs report they do not know if their company has a green enterprise strategy in place.

Survey results indicate that most SMEs have not investigated any green initiatives for their business; only 8 SMEs report that they have investigated green initiatives. However, this survey question had a great drop in response rate compared to the previous survey questions, so the results may not be complete. The next survey question gives respondents an opportunity to check all scenarios that apply. The survey results from this question indicate that 33% currently have a water recycling process in their companies, and 33% of SMEs have either performed energy conservation or water conservation. Approximately 15% of SMEs do not engage in any green initiatives, while about 10% either have product design from a recycling perspective, or use green as the criteria for suppliers. About 8% of SMEs promote green facilities or actively participate in their local community, and one company reports that it engages in paper elimination procedures.

The major barriers to implementing green initiatives (Figure 10) are reported to be: a lack of resources, lack of knowledge about what is a good definition of “green initiative”, and many are not clear about what kind of processes can be considered as “green”. Many SMEs report a lack of either shareholder or management interest in implementing green initiatives, and about 17% do not see any benefits for undertaking such activities. Another 15% either do not understand the area, or are still identifying the barriers to implementing the green initiatives.

Economic Benefits When Going Green

Savitz & Weber (2006) state that the original “Triple Bottom Line” presenter, Mr. J. Elkington explained how TBL should work from an economic perspective. Elkington suggests that businesses need to measure their success not only by the traditional bottom line of financial performance, i.e. profits, return on investment (ROI), and shareholder value, but also by their impact on the broader view of their contribution to the economy, the environment, and the society in which they operate. Therefore, we use these survey questions to investigate: (1) do SMEs benefit financially from their green initiatives; and (2) have SMEs calculated the ROI from their green initiatives.

The survey results indicate that 35% of respondents do not get any financial benefits from their green initiatives, and about 46% either get benefit financially or “somewhat” get benefit financially from their green initiatives. About 19% report they do not know if they get any financial benefit from their green initiatives. Results indicate that a majority of SMEs did not collect information regarding their ROI from green initiatives.

DISCUSSION AND RECOMMENDATIONS

The purpose of this project was to identify and investigate whether the SMEs in the aerospace and defense industry in Arizona performed sustainable supply chain management, and findings

indicate that there is currently limited application of these principles for the respondent SMEs. Each project objective will be discussed and conclusions presented based on these findings.

Objective One: SMEs Relationship with suppliers and Customers

Respondents reported on their strategic planning, inbound/outbound delivery, and product quality management as follows.

- 36.5% of respondents include the key suppliers in their strategic planning.
- 32.6% of respondents either do not include or do not know if suppliers are included in their strategic planning.
- 60% of respondents interact with their suppliers on a regular weekly basis.
- 31% of respondents evaluate their suppliers' on-time delivery performance on an "as needed" basis.
- 85% of respondents feel pressure to reduce the lead time to their customers.
- 71% of respondents have reached 91% or above on-time deliveries to their customers.
- 52% of respondents have tracking systems for both suppliers and customers.
- 21% of respondents do not have any material tracking systems in place.
- 36% of respondents only evaluate their suppliers' product quality on an "as needed basis".

Conclusions based on objective one:

SMEs generally recognize the importance of their suppliers and maintain regular contact with suppliers, but many do not evaluate suppliers' on-time delivery performance on a regular basis. SMEs have the ability to reach about 91% or above on-time delivery to their customers, but at the same time SMEs feel great pressure to reduce the lead time. A majority of responding SMEs have material tracking systems in place for both suppliers and customers. This indicates that many SMEs could evaluate their suppliers on a regular basis, and perhaps reduce the lead time of their suppliers, which in turn could help SMEs reduce their delivery time to their customers.

Objective Two: Current Methods Used for Sustainability Practices

- 56% of respondents have implemented JIT practices in their SCM.
- 46% of respondents rate JIT practices as either important or highly important to their business success.
- 37% of respondents rate JIT practices as either somewhat or moderately important to their business success.
- 54% of respondents are not involved in their major customer's supply chain development.
- 31% of respondents actively support supply chain development with both their suppliers and customers.
- 27% of respondents do not have or do not know whether their companies have such developments.

Conclusions based on objective two:

High percentages of respondents realize the importance of practicing JIT and believe this method can bring business success. However, 37% of respondents have a low tendency to value JIT practice as important to their business success. At the same time, high percentages of respondents are not involved in their major customer's supply chain development. This might become a hidden disadvantage to SMEs. In contrast, 31% of respondents actively support supply chain development with both suppliers and customers, which could help SMEs with better planning in raw material procurement, logistic risk management and work order forecasting.

Objective Three: SMEs Initiatives or Barriers Toward Sustainability

- 65% of respondents have not investigated any green initiatives in their business.
- 55% of respondents currently do not have any green strategies in place.
- 33% of respondents have a water recycling process.
- 33% of respondents either perform energy conservation or water conservation.
- 44% of respondents report a lack of resources and knowledge about what kind of processes can be considered as 'green'.

Conclusions based on objective three:

A majority of respondents do not investigate any green initiatives in their business, mainly due to a lack of resources or knowledge. SMEs could benefit from training on green practices. The survey results indicate that SMEs perform some conservation, but there is room for improvement in this area.

Objective Four: Economic Benefits When Going Green

- Response rate dropped to 40% in the last two parts of the survey (31 respondents vs. 52 respondents in the previous sections).
- 46% of respondents report some financial benefit from their green initiatives.
- Most of respondents do not report information regarding their ROI from green initiatives (only 8 respondents answered this question).

Conclusions based on objective four:

Many SME respondents do not report they benefit financially from green initiatives. This indicates an area for training and opportunity for improvement for SMEs.

Recommendations

Supply chain efficiencies can be improved by training in methods to reduce cycle times, and methods for supply chain development. Specific recommendations are as follows.

- Efficient material tracking systems can play a key role in reducing supply disruptions and improve the effectiveness of risk management. The survey results show that 31% of SMEs only evaluate suppliers' on-time delivery performance on an 'as needed' basis.

Therefore, SMEs could benefit from closer monitoring of on-time delivery to reduce risk of increasing costs of inventory.

- Participation in major customer's supply chain development could establish dialogue on sustainability opportunities for both sides. SMEs could engage their own sustainability objectives and report progress back to their customers in order to indicate their strategic capabilities and strength. To be considered as long term supplier, SMEs could move beyond stated goals and efforts in developing the next wave of innovations and initiatives.
- SMEs could focus on knowledge as a resource, which includes the ability to effectively learn and implement changes based on what they have in place. If they start to practice conservation, then the barriers toward sustainability become less. Continued education on green activities encourages a culture of sustainability in supply chain management.
- Once the green activities become routine, SMEs could use a "Global Reporting Initiative" to measure and report the financial impact of their green sustainability programs.

Future comprehensive studies are recommended to investigate how JIT practices can be integrated with concepts of SSCM - social, environmental and economic sustainability - to further improve the A & D supply chain in Arizona.

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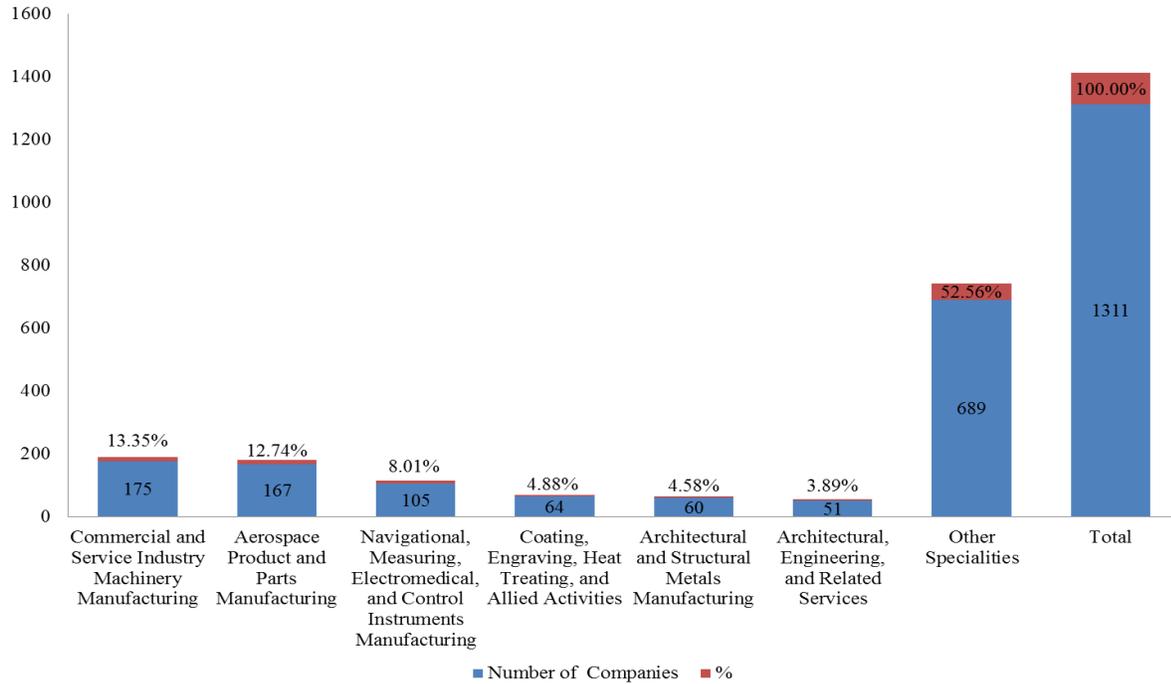


Figure 1. Suppliers’ product distribution within Arizona A&D industry supply chain

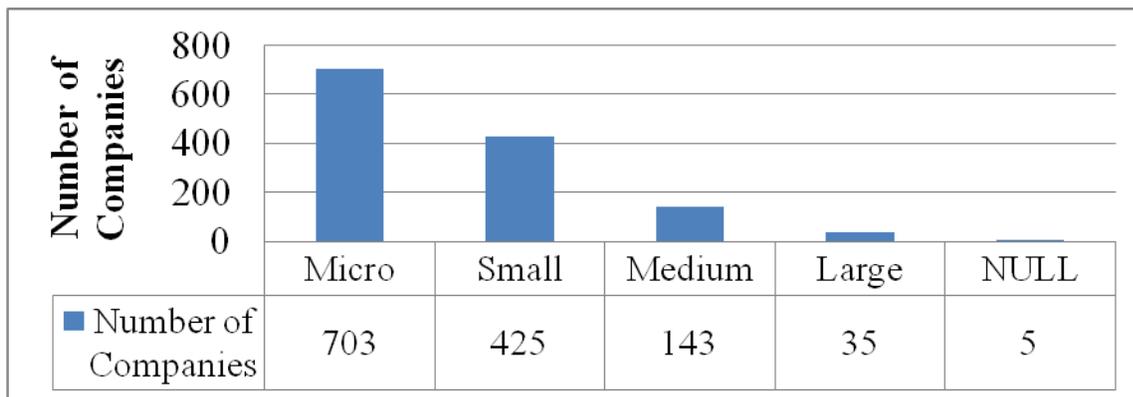


Figure 2. Size of companies in database

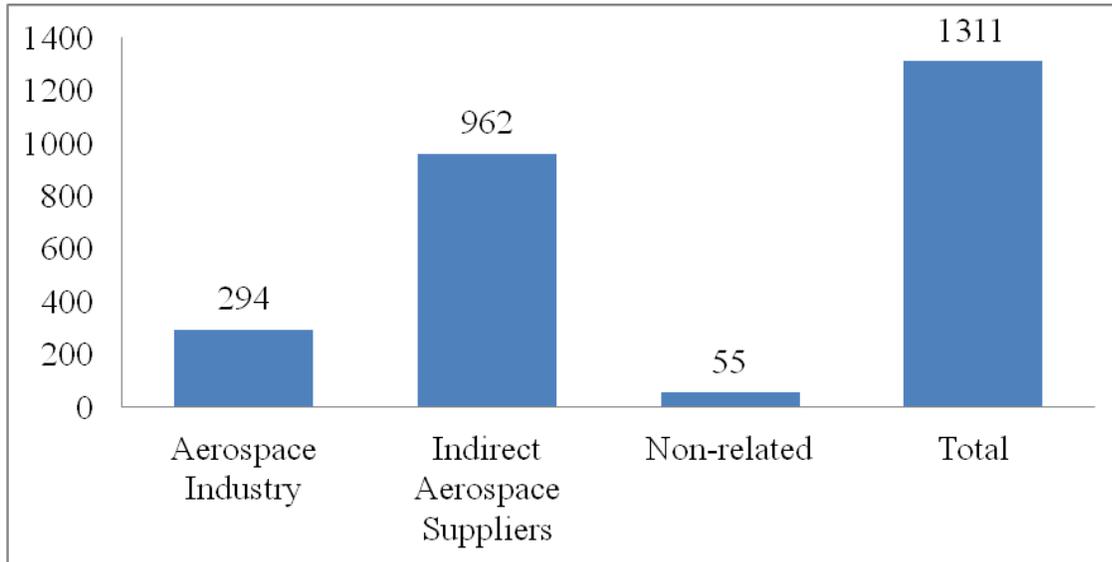


Figure 3. Suppliers' relationship in Arizona A&D industry supply chain

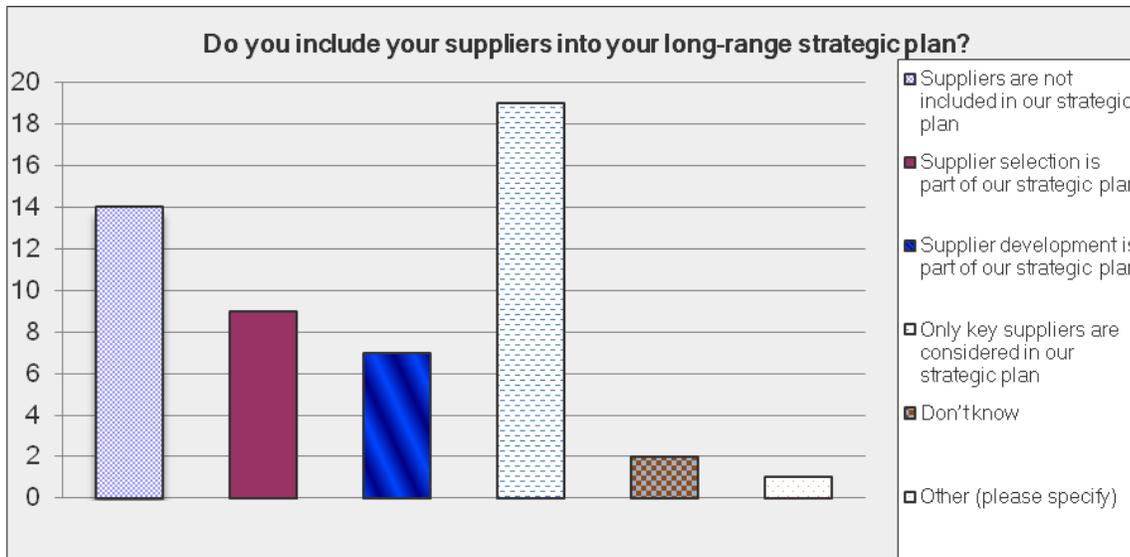


Figure 4. Distribution of SMEs' suppliers included in the company's strategic plan

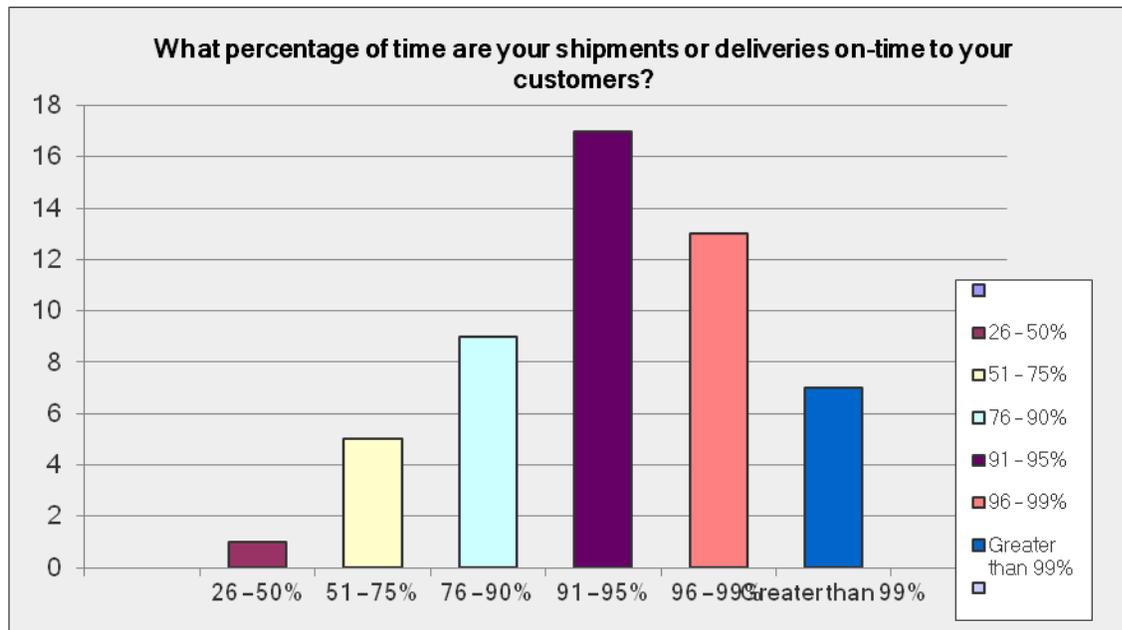


Figure 5. Distribution of On-time Shipments or Deliveries to the Customers

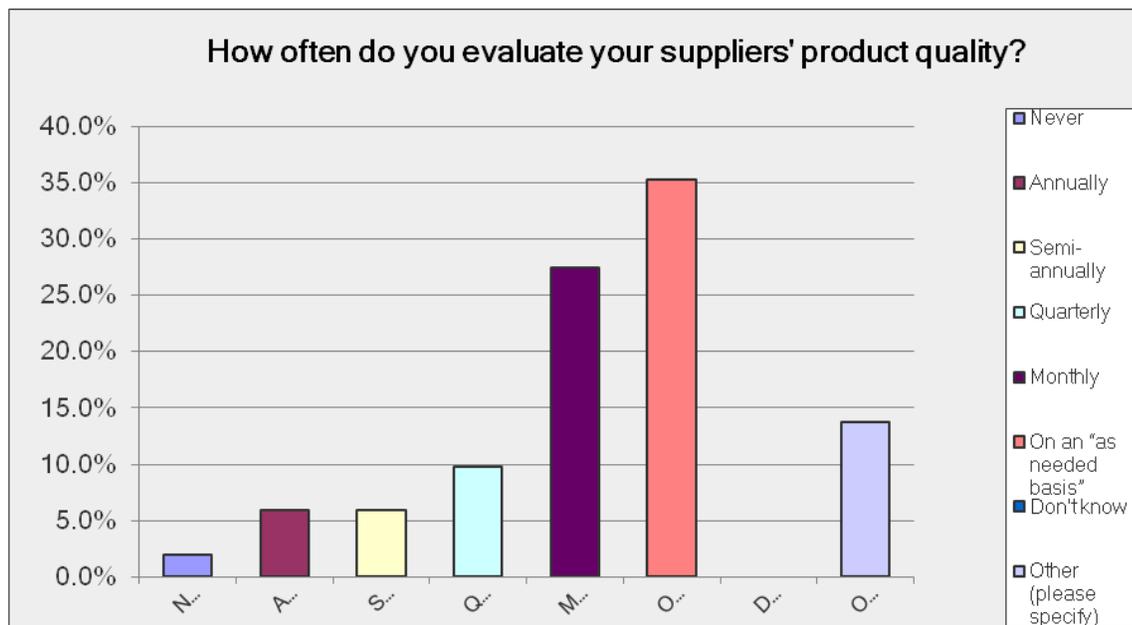


Figure 6. Distribution of SMEs to evaluate their suppliers' product quality



Figure 7. Distribution of SMEs rate of importance of JIT practices

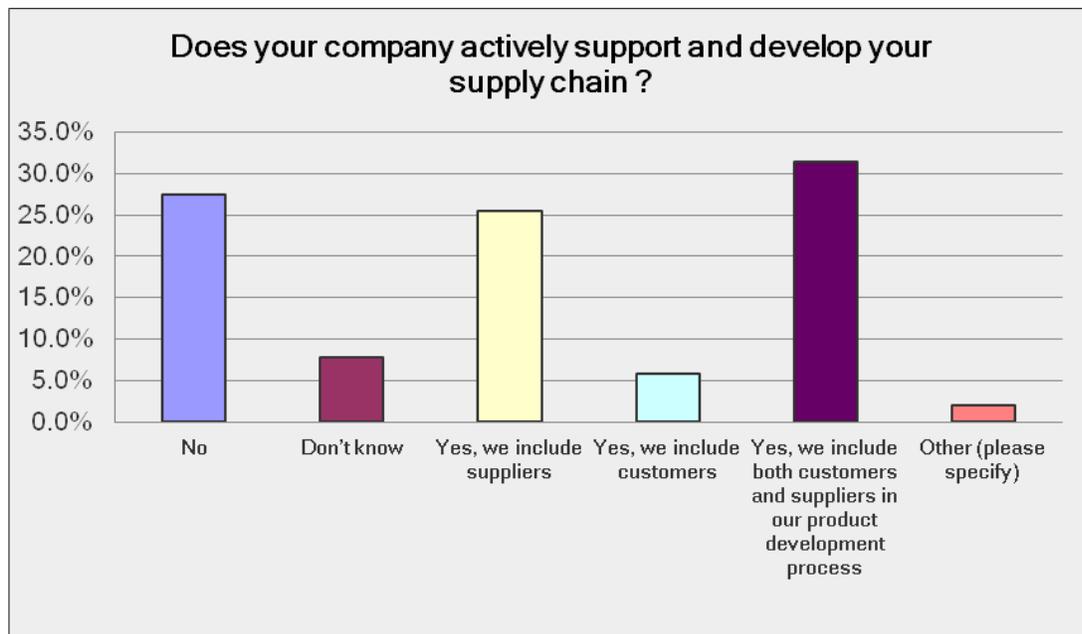


Figure 8. Distribution of SMEs that actively support and develop their supply chain

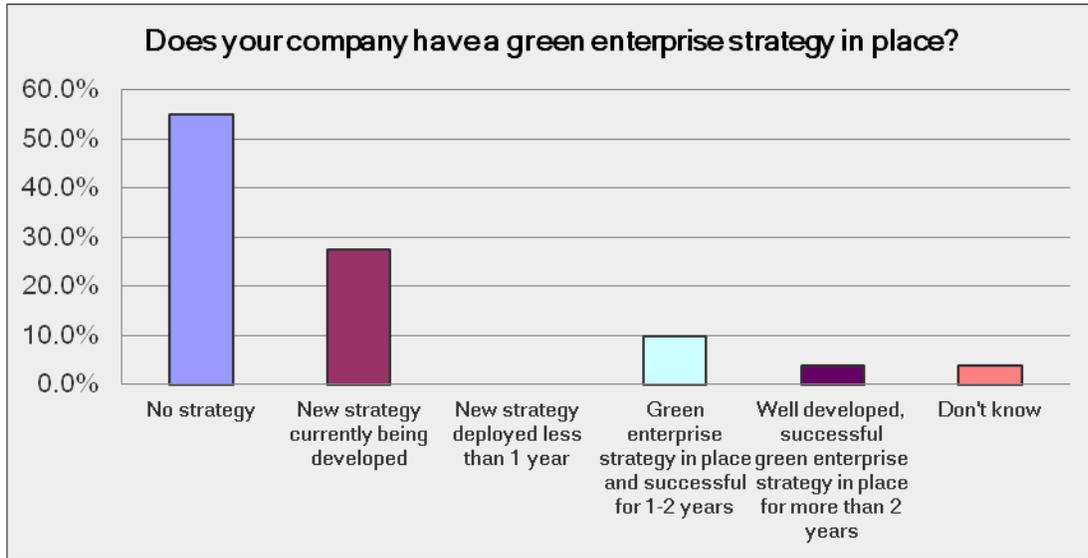


Figure 9. Distribution of SMEs to have a green enterprise strategy in place

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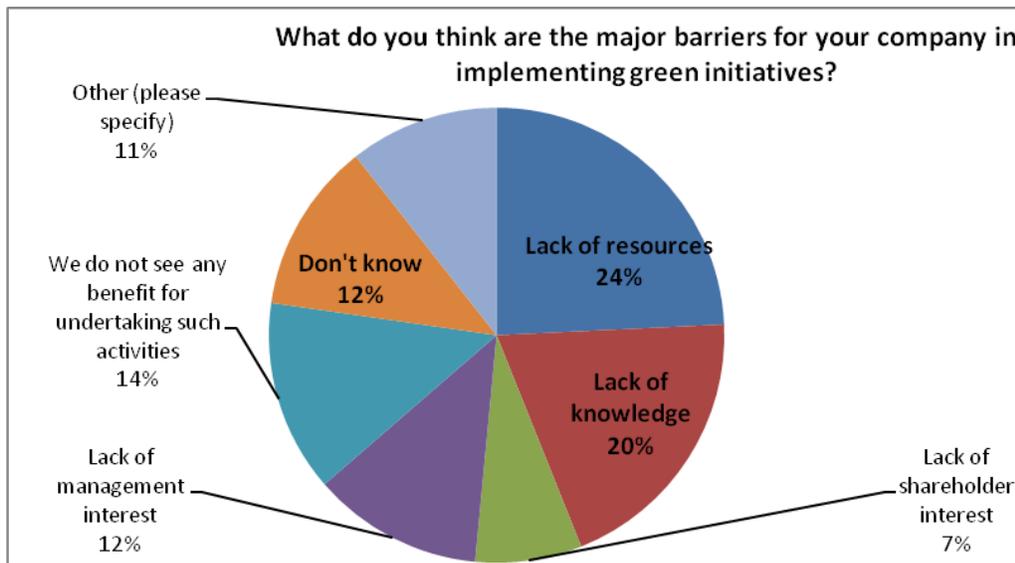


Figure 10. Distribution of SMEs' major barriers when implementing green initiatives