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Investigating perceived significance of Green manufacturing practices for spreading GSCM

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Abstract

Research papers have explored the relationship betweenadoption of green supply chain management (GSCM) practices and competitive advantage. Thepurpose of this paper is to further investigate this relationship by examining the case of green manufacturing practices (GMP).Through the path of spreading innovation andresource-advantage theory, the authors examine whether or not consumers perceive products madevia GMPs to be equivalent to brand-new products in terms of reliability.Asurvey method is used togather data from a diverse sample of 287 participants. Data are analyzed via ANOVA to test thehypotheses. The findings suggest that consumers perceive products made via some GM practices tobe inferior to brand-new products in terms of reliability. However, participants indicated no perceiveddifference in reliability between products made by GM practices and brand-new products.The findings suggest that adoption of some GSCM practicesmay not necessarily lead to competitive advantage, which may hinder the process of spreading GSCM. This studyis limited by its focus on just one aspect of competitive advantage. Future studies should examine therelationship between GSCM adoption and other measures of competitive advantage.Understanding that consumers may perceive products made via someGM activities as being inferior to brand-new products, firms wishing to employ GM maywish to compete on other dimensions, such as low price or service.Earlier research findings were studied for this research, which suggeststhat adoption ofGSCM may not fuel competitive advantage. Future research is suggested to find missing links todevelop this body of literature.

KeywordsGreen supply chain management, Logistics management, Green manufacturing, Sustainability, spreading innovation, Resource-advantage, Reliability

Paper type Research paper

1. Introduction

Sustainability is becoming a key driver of spreading innovation (Nidumolu et al., 2009), Businesses in all areas of the supply chain want to achieve competitive advantage by adopting sustainability initiatives. Business leaders and academic researchers focus more on GSCM (Nikbakhsh, 2009; Sarkis, 2003). However, the literature inthis area is not broadly developed and the awareness of spreading various GSCM practices are not well understood (Srivastava, 2007). Additional GSCM research can be done by spreading innovation through different channels.

Some research suggests thatimplementation of GSCM is not directly linked to measures of competitive advantage(Kim, 2011); other studies have found such a relationship to be significant (Rao and Holt,2005; Zhu and Sarkis, 2004).

This study is further strengthened by further investigating therelationship between GSCM adoption and competitive advantage. To do so, theremainder of this manuscript is organized as follows. First, we review GSCMliterature and introduce a common platform for GSCM and green manufacturing (GM) This study explores the impact of GM to spread innovation on GSCM; thus, the idea ofGM is developed through discussion of the overlap between GSCM and Manufacturing. We thenreview literature regarding perceived reliability, where we describe why we use perceived reliability as a tool

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for competitive advantage.This discussion builds the case for our study's hypotheses. Wefollow with an explanation of our research methodology, where we describe a surveymethod to measure relationships between GM adoption and consumers' perceived reliability. The findings of the research are then reported and our hypotheses are tested. Finally, conclusions are discussed, to include practical and theoretical implicationsalong with recommendations for future research.

2. Literature review

2.1 GSCM and GM

Srivastava (2007, pp. 54-5) defines GSCM as:

[. . .] integrating environmental thinking into supply-chain management, including productdesign, material sourcing and selection, manufacturing processes, delivery of the finalproduct to the consumers as well as end-of-life management of the product after its useful life.

There is a broad scope to implement GSCM initiativesthroughout the supply chain. However, green manufacturing is not much debated for operationalizing GSCM.

Usage of renewable energy, conserving water, waste reduction and usage of recyclable material to the maximum are considered to be functions of green manufacturing practices which are responsible for greening the supply chain. Although these green manufacturing functions has been previously discussed, the concept of employing these functions for the purpose ofimplementing GSCM may be thought of as an innovation because it has the ability toprovide new business opportunities. Thus, our study explores GSCMimplementation through the path of spreading innovation, where weoperationalize GSCM via investigation of GM. Before we further discuss our innovative pathways, we must first introduce some additional keyconcepts; we now briefly define the GM concepts of renewable energy usage, water conservation, waste reduction and maximum recyclable material usage and then introduce the concept of perceived reliability.

2.1.1 Usage of renewable energy. Equipments used for manufacturing parts must drive power from renewable sources. Renewable energy is taken from nature. Using wind/solar as power sources, we eliminate the dependence on coal for power.Hydro electric power plants are a good source for power. Government is giving subsidy measures for factories run on solar power. In case of solar power, investment recovery is made in the long run.

2.1.2 Water conservation: Efficient usage of water is critical during work progress. Waste water has to be processed for reuse. Strategies like installation of sewage treatment plant & rain harvesting structures are followed to enhance green manufacturing. Processed water (waste) can be used for gardening.

2.1.3 Waste reduction: Optimum utilization of material is to be followed to reduce waste. Material (declared as waste) collected during manufacturing process is to be re-synthesized for further use. Waste management strategies to be incorporated in the supply chain.

2.1.4 Usage of recyclable material: Proper percentage of recyclable material must be incorporated into raw material usage. Mixed proportion of virgin material & recyclable material is to be incorporated into raw material so that reliability of product is high. Functional stability of material is important in retaining recyclable material in material composition. Selecting proper material must avoid delusions.

2.2 Perceived reliability as a measure of competitive advantage

Three generic strategiesfor competing in the marketplace described by Porter (1980)are low-cost leadership, differentiation, and focus. Reliability as a performance indicator comprises material reliability and process reliability. These two factors combine to give overall product reliability. Brand reputation is a function of consumer perception of exclusivity, since firmswith a reputation for high-quality differentiate themselves from other firms. Firms attain a competitive advantage when

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consumers perceive products from that firm to be of higher quality compared to the firm's competitors. (Woodruff, 1997).Similarly product having high reliability will be the most sought after by consumers. Firm generating products with high reliability will achieve a competitive advantage. However, we found that investigation of perceived reliability of products made via GM is markedly absent in the literature.Thus, the effect ofadopting GM products on consumer perception of the reliability of the organization'sproducts, and subsequently the competitiveness of the organization, is unknown. There are certain perceptions among people that products made by green manufacturing will not be reliable. Also products made by green manufacturing practices are inferior compared to products manufactured in traditional way.Media articles show that unknownconsumer's perception of Green manufacturing products' reliability is a limitation.Ourstudy seeks to offer insight into how consumers may perceive these products.

2.3 Spreading innovation of manufacturing

Although the efficacy of the R-A theory of competition has been demonstrated in themarketing literature (Hunt and Madhavaram, 2006) and even in some facets of thesupply chain literature (Hunt and Davis, 2008), the theory is still largely untested andhas not been thoroughly extended to other disciplines (Griffith and Yalcinkaya, 2010).

Thus, in an attempt to extend R-A theory to manufacturing innovation and further develop the manufacturing innovation model, our study tests whether ornot adoption of GSCM (operationalized in our study as GM) is positively relatedto competitive advantage (operationalized in our study as consumer perception of reliability). As such, we developed the following hypotheses:

H1. Participants will perceive that a product made by adopting GMP has less reliability compared to brand new products.

H2. Participants will perceive that a product made by adopting GMP has higher cost compared to brand new products.

H3. Participants will perceive that a product made by adopting GMP is found to be inferior compared to brand new products (manufactured in traditional way).

Figure 1 shows how the above hypotheses integrate into manufacturing innovation model.

Analysis is made whether manufacturing innovation is directlyrelated to competitive advantage. We test this proposition by examining how adoptionof GM (manufacturing innovation) affects consumers' perceived reliability (competitiveadvantage).

3. Research design and methodology

The purpose of this study is to investigate the relationship between GSCM adoptionand competitive advantage. To explore this relationship, we use GM as a proxy forGSCM and perceived reliability as a proxy for competitive advantage. Forevaluating the said hypotheses and for considering consumer perceptions of reliability, a surveymethodology was employed. The remainder of this section describes our method forbuilding the study's instrument and collecting data.

3.1 Instrument development

Product reliability comprises material reliability and process reliability. Perceived reliability is defined as individuals'prejudiced judgment of the level of conformance to requirements.

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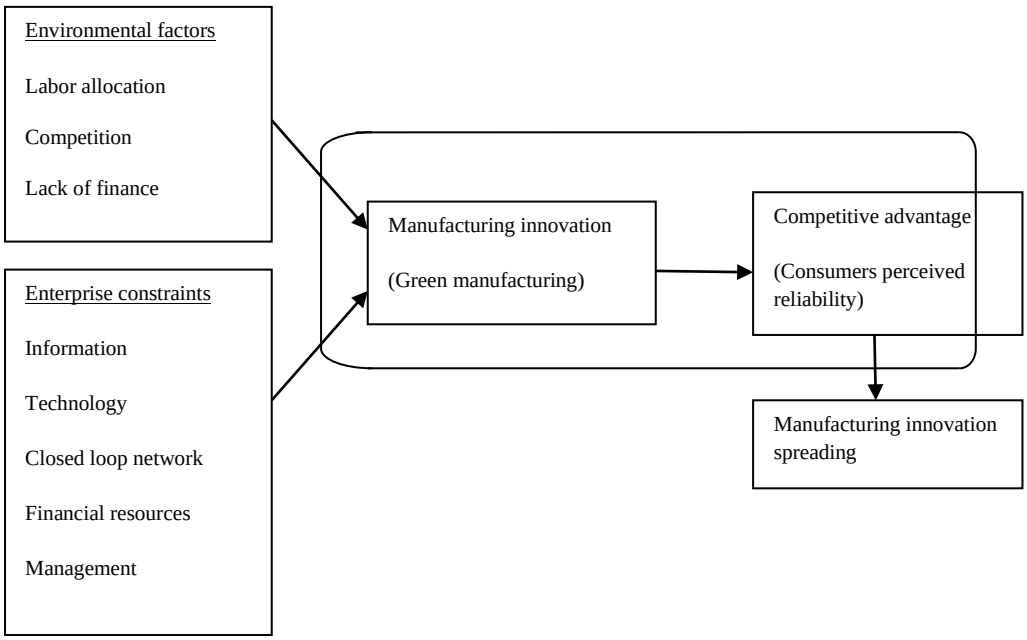

Figure 1.H1-H3 Research model Manufacturing innovation model

We measure perceived reliability of products made by energy efficient systems, products made with optimum resources and products made with recycled materials. Ourquestionnaire asked participants to compare products made by adopting GMP and products made in traditional way. Respondents were told to be aware of brand new items and products made by adopting GMP. Respondents must know to compare brand new products and items made from recycled material. Parameters have to be addressed to evaluate reliability of material. Afive-point Likert-type scale wasemployed and ranged from "new is much higher" to "new is much lower."The instrument was adapted into a web-based format for ease of distribution. Asidefrom the survey items, standard definitions of renewable energy, recyclingwere provided at the top of the survey so as to facilitate consistent understanding of theterms. In order to enhance construct validity, a pilot test and pre-test were conducted.Two production department professionals and three university professors who have publishedextensively in the production field reviewed the instrument for content. Interviews wereconducted with each reviewer and feedback was gathered regarding the wording ofquestions, technical functions of the web-based survey and general concerns regardingthe validity of the survey.

Upon minor revisions suggestedvia the pilot test, the survey was administered to aclass of 20 graduate students in the college of business at a South Indian university.Pre-test results from the sample of 12 respondents indicated consistent responses withineach item and no apparent issues with the instrument or technical services. No furtherchanges were made to the instrument after the pre-test was completed.

3.2 Data collection

Awareness was made for the participants to know about products made via GM. Participants for this study are a section of bank executives and manufacturing company executives of an Indian company. Some students from a South Indian university (referred to as the "student" sample) are also included as stated above.These diverse samples were chosen in order to represent a wide variety.

- a section of bank executivesof a south Indian bank (referred to as the "corporate" sample);
- a set of executives from automobile sub parts manufacturing firm of a south Indian company (referred to as the "industry" sample); and
- Students from a South Indian university (referred to as the "student" sample).

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Authors could explore any significant differences in perception by studying versatile samples. Data collectionprocedures for each of these samples are outlined below.

Students were selected with the help of staff teaching their respective business courses. Staff members helped us in providing web based e-mail link for conducting survey. Web based survey helped us in getting better response rate.Web based survey was sent to the provided e-mail link. Out of 20 student participants, 12 surveys were completed for a response rate of 60%.

Corporate sample was constructed with the help of a bank manager. Bank manager sent us a web based e-mail link. That link comprises group of subordinates and executives working under him. Participants were asked to forward the survey to others in the organizationto maximize participation. After two weeks, reminder was sent to participants to send their responses quickly. This process yielded 120 responses.

Industry sample was constructed with the help of plant head. Plant head along with chief executive officer provided web based e-mail link for web based survey. Then we sent our survey item through e-mail to approximately 372 individuals. Participants included executives from production, quality and vendor development departments. Reminder was sent to executives after two weeks to send their responses quickly. On the whole, 155 responses were received by e-mail with a response rate of 41.6%. Participant demographics are illustrated in Table I.

3.3 Addressing validity threats

Survey responses were immediately collected. Those, who never responded earlier, were met in person by fixing appointment and then responses collected. Thereby non response bias was avoided.

As recommended by Podsakoff and Organ (1986), Harmon's one factor test was done using SPSS to determine if common method bias was a threat. Analysis of the unrotated factor solution revealed that no general factor accounted for more than 50 percent of the variance, thus common method bias does not appear to be a problem. There was no issue of missing values in this survey item.

	Aggregate sample n=287		Student Sample n=12		Corporate Sample n=120		Industry Sample n=155	
	Count	%	Count	%	Count	%	Count	%
Gender								
Male	210	73.2	7	58.3	72	60	131	84.5
Female	77	26.8	5	41.7	48	40	24	15.5
Age								
18-22	12	4.2	12	100	-	-	-	-
25-35	76	26.5	-	-	28	23.3	48	31
36-45	132	46	-	-	56	46.7	76	49
46-55	67	23.3	-	-	36	30	31	20

Table I. Participant demographics

4. Results

One-way ANOVA was used to determine significant differences between perceived reliability of brand-new products and products made via GM. A mean of three indicatesthat participants feel that the GM product is the same as new in terms of reliability.Results of the analysis are illustrated in Table II.

Using the results in Table II, we used a meanscore range to test each of ourhypotheses. If the mean score is between 2.76 and 3.25, we conclude that participantsfeel that the GM product is similar to brand-new products in terms of reliability. If themean score is between 1.00 and 2.75, we conclude that participants feel that the GM product is lower in reliability than brand-new. If the mean score is between 3.26 and 5.00,we conclude that participants feel that the GM product is higher in reliability thanbrand-new. Table III summarizes the results of the hypothesis tests.

	Cronbach's α	$Mean^a$	SD	$Sig.^b$

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Green manufacturing				
Product reliability	0.79	2.63	0.46	<0.01
Product cost	0.74	3.29	0.41	ns
Product inferiority	0.81	2.85	0.43<0.01	

Table II. Results

Notes: $^{a}Five$point scale: 1- new is much higher;3- new is similar;5- new is much lower; ^{b} $significantly$ differs from brand new product; ns- nothing significant;

Hypothesis	Result
H1. Participants will perceive that a product made by adopting GMP has less reliability compared to brand new products.	Accept
H2. Participants will perceive that a product made by adopting GMP has higher cost compared to brand new products.	Accept
H3. Participants will perceive that a product made by adopting GMP is found to be inferior compared to brand new products (manufactured in traditional way).	Reject

Table III. Hypothesis results

5.Discussion

Theresults suggest that products made using renewable energy, recyclable materials, water conservation and waste reduction increases cost, reduces reliability of product. But adopting GMP sustains brand of product in terms of look, ease of handling and material finish. These findings open a gateway to both practicaland theoretical implications in relation to GM and GSCM.

5.1 Theoretical implications

Findings suggest that consumer perception of reliability is becoming a hurdle in spreading GSCM practices. Consumers feel that using renewable energy, water conservation and waste reduction increases the cost of product. Consumers feel that products made by adopting GMP do not lack in aesthetics, ease of handling and surface finish.

Cost factor can be compromised by good service. Sending product updates via e-mail to consumers and fast action plan for consumer complaints helps in improving consumer perception about GM products and least consideration to cost. Consumers' thought on inferiority stems from media advertisements. Media advertises on product looks, ease of handling, less injury to the user, life span of product, customer care facilities. After understanding the outlook of GM products, consumers feel that GM products compete to that of brand new products. Always the rule is to reduce resources and maximize value.

Manufacturing activities include

- Use of optimum level of virgin material & calculated proportion of recycled material
- Selection of machine and its process parameters
- Methods employed for loading and unloading
- Water conservation
- Usage of power and its source
- Process done on the machine & its environmental constraints
- Handling post manufacturing measures
- Preventing human resources from injury

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- Time calculation for desired activity

While greening the manufacturing process, we need to look out for a method which requires fewer resources to return the product to a market. We rank the items from the less impact the process has on the environment. Further, we assume that the less work required to release a product back into themarket, the closer it should be to new in terms of reliability. Thus, the GM options shouldlogically be ordered from most desirable to least desirable as follows:

- ✓ Optimum use of raw material
- ✓ Waste reduction
- ✓ Water conservation
- ✓ Usage of renewable energy

This gives us the opinion that in reality, cost is most desirable followed by reliability. Product outlook is followed later on.

The Environmental Protection Agency andlocal governments often advertise the importance and significance of recycling(Environmental Protection Agency, 2011).

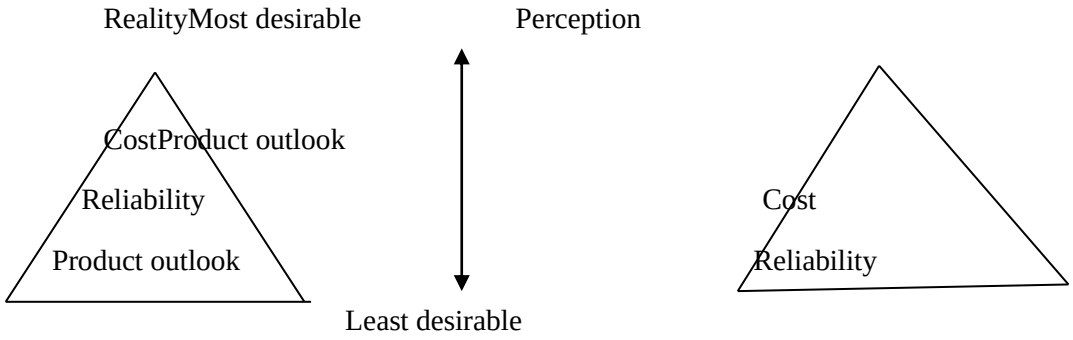

Figure. 2

5.2Practical implications& limitations

Results indicate that consumers view products made via GM practices as being lower in reliability than new products. This is consistent with previousliterature that assumes consumers perceive these products to be of lower quality(Arunkundram and Sundararajan, 1998; Debo et al., 2005; Tan and Kumar, 2006;Vorasayan and Ryan, 2006).In accordance with Porter's (1980), firms should adopt a competitive strategy to compete on price, focusor another facet of differentiation.In contrast, our findings suggest that firms that employ GM practices and wish tocompete on reliability may not be negatively affected. This presents a win-win situationfor those adopting GM practices – firms may be able to save money on materials, present a"green" image, and still compete with brand-new products.

Our survey is limited to a narrow sample and in future, versatile samples have to be taken. Depictions from survey methods have been shown in figure. 2. Survey methods can be improved in future studies by closer interaction with respondents.

This study is limited by its focus on just few aspects of competitive advantage.Future studies should examine the relationship between GMPadoption and othermeasures of competitive advantage. In addition, other GSCM activities should beexamined in the same manner.

6. Conclusions and further works

Green practices and environmental stewardship are beginning to shape our economyand drive the way in which firms compete (Lubin and Esty, 2010).Thus further exploration of this mega trend is needed. Our study of adapting the logistics innovation model to manufacturing innovation model is used as a framework, toevaluate how consumer's perception of reliability may affect the GSCM spreading gateway.Wefound that participants view products made by GMP to be oflesser reliability than brand-

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new products.Products made by adopting GM practices werefound to be perceived by participants as being equal to brand-new products in terms of product outlook.Industry professionals can use the results of this study to better analyzethe perceptions of their consumers when deciding whether or not to adopt Green Manufacturing.Researchers can use this study as a starting point to further investigate therelationship between GSCM and competitive advantage.

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