A Structural Analysis of Green Supply Chain Management Enablers in the UAE Construction Sector

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Abstract

The aim of the research is to develop a structural analysis of the enablers of green supply chain management (GSCM) in the UAE construction sector. An Interpretive structural modeling (ISM) approach is used to identify the contextual relationship of the enablers and to develop their hierarchical structure. Further the enablers are classified into visual quadrants on a graph using dependence-driving power analysis (DDPA). The hierarchical structure and graph will provide useful insights to corporates, government bodies and supply chain managers to understand and prioritize the key enablers of GSCM and the organizational strategies adopted by firms in the UAE. The study will contribute significantly to the first wave of empirical investigation in the region and will provide useful insights into GSCM in the UAE. A structural analysis of GSCM enablers as well as industry specific research of GSCM in construction sector is not previously developed in the UAE

Keywords: green supply chain management; interpretive structural modeling; dependence and driving power analysis; construction sector

1 Introduction

Construction industry accounts for 30% of the world's total greenhouse gas (GHG) emissions according to UNEP (2007). In UAE, the construction sector is growing at a rapid pace and resulted in environmentally unfriendly projects (Ben Brik et al., 2013). Further UAE leads the other countries in per capita CO2 emissions according to World Bank report (2009) and is estimated to be 22.6 metric tons per capita. Rettab and Ben (2008) conducted a study on GSCM in Dubai and identified more than 60% of firms in Dubai didn't consider GSCM in their corporate strategy. Also 2008, with the start of the economic recession, companies focused on survival and have forgotten their environmental responsibility. Since 2010, UAE have started number of initiatives to reduce its environmental footprints due to growing international pressure from world bodies and environmental groups. Abu Dhabi Urban planning Council in 2010 introduced 'Pearl Rating System' which is a framework for sustainable design and construction. Consideration and documentation of sustainability aspects of new buildings is now a mandatory requirement. Dubai Electricity and Water Authority (DEWA, 2011) announced the green building guidelines and specifications to complement the Dubai Municipality codes which covers site selection, usage of construction materials, waste management and indoor environment quality. The World Energy Forum, 2012 and World Future Energy Summit, 2013 were hosted by UAE in a bid to create awareness and promote sustainable living in the UAE.

The increasing scale of carbon emission throughout the building life cycle has prompted researchers to initiate studies to reduce the environmental footprint of construction sector. The construction sector has amble opportunities to reduce emissions throughout the supply chain. Thomas et al. (2012) explored the options of carbon reduction for each

phase of building life cycle. This covers planning, design, material manufacturing, distribution, construction activities, maintenance, renovation, end of life disposal, recycling and reuse. Sustainability is construction is gaining significance recently. Studies by Marta et al. (2009), Gonzalo and Fernando (2010), Annika et al. (2009), Jung et al. (2012), Sourani and Sohail (2011), Thomas et al. (2012), Zhou et al. (2013) have focused on sustainable construction process.

Similarly GSCM has emerged as one of the best strategies to reduce environmental footprints. GSCM is a management science which integrates environmental concerns into supply chain management. It has gained increasing attention within academia and industry. GSCM not only improves environmental performance but also in reducing cost, improving efficiency and in speeding up innovation. But the main challenges organizations face while going through the green supply chain transition is increasing costs and efficiency of the supply chain. However forward thinking companies use GSCM to their advantage. Innovative sustainable ideas can help organizations become profitable while helping the environment. GSCM integrates green practices such as green design, green purchasing, green manufacturing, green transportation, recycling and reverse logistics (Srivastava, 2007). These practices are merged with the three dimensions of GSCM, which are environmental performance, economic performance and operational performance.

The present research is significant considering GSCM is still at the early stages in the UAE and considerable knowledge gap exist about the enablers of GSCM in the UAE construction industry. Integration of construction sustainability and GSCM is not developed in the region. The aim of the research is to identify the various enablers of GSCM and model the enablers in a hierarchical structure using ISM approach and to classify according to their driving and dependence powers. ISM is a well-known approach for understanding inter-relationship among variables which define a problem or issue (Sage, 1977; Warfield, 1974). The DDPA by (Martilla and James, 1977) is used to plot the enablers of GSCM in a two-dimensional graph which is divided into four quadrants. The hierarchical structure and the quadrant classification will give a crisp understanding of the enablers of GSCM in the UAE.

2 Literature Review

A systematic review of articles from 1998-2013 were carried out. The search used predominantly but not limited to Elsevier, Science Direct, Emerald, Wiley and Taylor & Francis databases. Keywords used for the search include: green supply chain management; sustainable supply chain management; environmental supply chain management, supply chain environmental management. A brief content study is carried out to delimit articles which do not report empirical findings or developed theoretical models. The articles were again delimited to construction industry and ISM methodology. The objective of the review was to identify the enablers of GSCM, applicability of ISM in GSCM and implication of the enablers to the construction sector.

2.1 Review on GSCM enablers

In GSCM, the role of government and legislation plays a vital role. This is considered as the mother of all drivers and leaves no option for a firm but to comply with it or exit the market. (Hall, 2001; Min and Galle, 2001; Zhu and Sarkis, 2006; Walker et al., 2008, Hsu et al., 2013), have all identified in their research, government regulation and legislation as the main enabler of GSCM. Government commitment to sustainability can promote a sustainable culture and can drive clients and contractors serving the government to

comply with sustainability aspects such as ISO 14001 certifications, green building guidelines etc. Similarly clients can influence the contractors which in turn can influence sub-contractors, suppliers to comply with green specifications. Hence the pressure is exerted from top to bottom of the supply chain. (Hall, 2001) identified this top to bottom compliance pressure in the supply chain. Lee (2008) has identified compliance as a major driver for small and medium enterprise.

Alan (2012) identified the triple bottom approach to sustainability in green manufacturing covering environmental, social and economic aspects. Commitment to improve environmental performance is an internal organizational driver in which environmental performance is considered as a major agenda in the company policy (Simpson et al., 2007). Similar to corporate social responsibility, corporate environmental responsibility is taken up by leading firms to reduce their environmental impacts. However commitment to GSCM may not be driven by environmental responsibility or regulatory compliance. Instead many firms have identified GSCM as a strategic imperative to achieve economic benefits. Eltayeb and Zailani (2011) identified economic benefits as one of the four drivers of reverse logistics in the Malaysian manufacturing sector.

The desire to reduce costs represents a common driving force for environmental supply projects (Carter and Dresner, 2001). This view is supported by a number of researchers who find sustainability can lead to cost reduction, savings, benefits and effectiveness (Dhanda and Hill, 2005; Fassoula, 2005; Richey et al., 2005). In addition adopting GSCM can improve the corporate brand image and can lead to better market performance and publicity. Wycherley (1999) identified the first mover benefits in the case of Body Shop International, one of the early adopters of GSCM. This market strategy was also identified by Francesco and Fabio (2010). On the other hand due to increasing competition at national and global level, firms are looking for new strategies like GSCM to achieve competitive advantage through differentiation (Arimura et al., 2008). Hsu et al. (2013) identified competition as a significant driver of GSCM. A proactive GSCM strategic planning can help a firm to gain competitive advantage (Ferguson and Toktay, 2006; Sarkis, 2003; Sharma and Vredenburg, 1998). Similarly, desire to achieve competitive advantage can act as a driver for GSCM (González-Benito and González-Benito, 2005; Rao and Holt 2005). This is important for firms in the region where GSCM is still at infancy stage (Francesco and Fabio, 2010). In addition to environmental and economic performance, adoption and implementation of GSCM can improve the operational performance of firms and thus improve its supply chain efficiency. GSCM management can reduce material waste, promote recycling and reuse (Holt and Ghobadian, 2009; Paulraj, 2009; Vachon, 2007), sale of scrap or used materials, decrease in energy consumption, decrease in material consumption (Zhu et al., 2008). It is important that GSCM implementation should not compromise the supply chain efficiency of the firm. Traditional supply chain efficiency is measured by cycle time, cost and quality. Lippman (2001) and Lee (2009) have identified the adoption of GSCM practices leads to reduction in cycle time and cost, improved quality. GSCM also lead to decreased inventory level, increased product line and improved capacity utilization (Zhu et al., 2008)

Organizations also adopt GSCM because of the strategies adopted by its competitors. Chan and Makino (2007) have identified mimetic isomorphism; a strategy to imitate other firms in the sector especially competitors.

The involvement of top management (Min and Galle, 2001).Vachon and Klassen (2006) identified leadership capabilities of individuals with commitment to environmental issues will determine the adoption of GSCM. Anis et al. (2013) identified leadership have a positive influence on the adoption of GSCM.

Jung et al. (2012) identified government incentives as the major motivator of green construction in China. (Rahman and Sadeghpure, 2010) identified government incentives have led firms to pursue sustainability. Studies by (Hosseini, 2007; Hsu et al., 2008; Yu Lin et al., 2008; Mudgal et al., 2009; 2010; Srivastava, 2007) have all identified the role of government support in GSCM adoption.

Berns et al. (2009) identified consumer concern about sustainability as a significant driver for firms to adopt GSCM. Unlike regulatory pressure which is top to bottom, consumer pressure is bottom to top in the supply chain. Chan and Lau (2001) compared green purchasing behaviour of developed and developing countries using the purchasing behaviour of US and Chinese customers. The study identified green purchasing behaviour of customers is more in developed countries than in developing countries. Lo and Leung (2000) identified the increasing environmental awareness of young customers. Eltayeb and Zailani (2010) identified consumer pressure as an important driver in reverse logistics. Hsu et al. (2013) identified consumer pressure as an important driver of GSCM. Alan (2012) identified the consumer sensitivity to GSCM in the German and Chinese automotive sector.

Internal environmental management (IEM) is a prerequisite for all GSCM practices. Internal environmental management is the practice of developing green supply chain management as a strategic organizational imperative through commitment and support from senior and mid-level managers (Zhu et al., 2008). He validated the importance of IEM in GSCM through various case studies The IEM consist of, but not limited to cooperation, commitment and communication between top management, senior and middle managers, implementation of EMS and ISO14001 certification, environmental compliance auditing programs, cross-functional integration for environmental improvement, advanced information technology, training for staff and proper allocation of human resources, health and safety compliance, tracking sustainability and measuring key performance indicators (KPI). Balan et al. (2012) identified the importance of Information Technology in improving the supply chain performance in the UAE.

GSCM requires skilled professionals both inside the organization as well as throughout the supply chain. Skilled professionals can adapt to the changes quickly, learn new technologies, share ideas and solve environmental problems (Yu Lin and Hui Ho, 2008). So having skilled professionals is essential for the adoption of GSCM. Since adoption of GSCM will not deliver immediate financial benefits, many companies are reluctant to invest on GSCM (Nidumolu et al., 2009). There are a variety of other related expenses when considering green changes, specifically to manufacturing processes. Green materials tend to be more expensive and raise the product's overall cost (Hoffman, 2008). Hence having sound financial resources at the beginning is important of the adoption of GSCM. Husted (2003) identified availability of funds as an important enabler of GSCM.

2.2 Review of ISM in GSCM

Application of ISM in GSCM is growing in terms of publications and is now widely recognized. Ravi and Shankar (2005) identified the barriers of reverse logistics using ISM. Faisal (2010) identified the interaction of enablers using ISM. Mudgal et al. (2010) analysed the barriers of GSCM using ISM. Balasubramanian (2012) developed a hierarchical framework of barriers of GSCM in the construction supply chain. Ali and Kannan (2011) identified the drivers affecting the implementation of GSCM using ISM. Kaliyan et al. (2013) used ISM to identify the barriers of GSCM implementation in the automotive sector. Katarzyna (2012) identified the contextual relation among the enablers using ISM in India. Luthra et al. (2011) analyzed the barriers of GSCM in the automobile sector in India. Mathiyazhagan (2013) used ISM to analyzed 26 barriers to GSCM

implementation in the small and medium manufacturing enterprises in India. Wang et al. (2008) identified the interaction among the barriers of energy savings in China. Tseng (2013) used ISM and fuzzy set theory to model sustainable production indicators. Gorane and Kant (2012) used ISM-fuzzy integrated approach for modelling the supply chain management enablers. Pfohl et al. (2011) used ISM to study supply chain risks.

2.3 Review of GSCM in the construction industry

Recent literature indicates sustainability in the construction process is gaining importance. Marta et al. (2009) identified 20 environmental performance indicators and developed an environmental performance assessment tool for environmental benchmarking among construction companies. Gonzalo and Fernando (2010) developed a methodology to identify, classify and prioritize sustainability indicators based on risk management standards. Annika et al. (2009) identified the importance of green procurement in the construction sector. Jung et al. (2012) identified the green practices, drivers and impediments in the Chinese building industry. Sourani and Sohail (2011) identified the barriers to sustainable construction in the United Kingdom. Thomas et al. (2012) identified the opportunities for carbon dioxide reduction in the building life cycle. Zhou et al. (2013) developed a mathematical operational modeling for construction green supply chain management. Section 2.1 identified the enablers of GSCM in general. The review of articles in the construction sector has helped to align the enablers from section 2.1 to be specific to the construction industry. Further a detailed content study of articles by (Adetunji et al., 2008; Balasubramanian, 2012; Carris et al., 2012; Jonatan and Marcel 2009; Jung et al., 2012; Sourani and Sohail, 2011) with respect to sustainability in construction is carried to understand the implication of GSCM enablers for the construction sector.

3 ISM methodology and model development

In the literature we have identified the enablers of GSCM in the UAE construction sector. However it doesn't provide clarity on the important enablers and all the enablers seem equally important and independent. ISM provides clarity on the contextual relationship among enablers and develops a hierarchical structure, providing decision makers a clear understanding of the enablers. The ISM approach involves the following steps:

3.1 Identification of enablers

A total of 14 enablers were identified from the extensive literature review. The identified enablers of GSCM from the literature are presented in Table 1. The set of enablers 'E' is denoted as

$$E= \{e (i)| (i=1, 2\ldots n)\} \quad (1)$$

Where 'n' is the number of enablers.

Table 1 Summary of identified enablers of GSCM from the literature

Enablers of GSCM	Implications in the construction industry	Sources
1. Government regulation and legislation	Compliance to green design guidelines, green construction and safety practices in the construction industry.	Hall (2001), Min and Galle (2001), Walker et al. (2008), Zhu and Sarkis (2006)
2. Compliance to client specifications	Top to bottom compliance pressure from regulatory bodies to clients, consultants, contactors, sub-contractors, suppliers etc.	Hall (2001), Lee (2008)
3. Proactive GSCM strategic planning	Differentiation from the competitor, new market opportunities, long term vision etc.	Ferguson and Toktay (2006), González-Benito and González-Benito (2005), Rao and Holt (2005), Sarkis (2003), Sharma and Vredenburg (1998)
4. Leadership	Sustainable leaders in the construction sector such as owners, top management, senior managers etc.	Hall (2001), Min and Galle (2001), Anis et al. (2013)
5. Availability of resources	Availability of skilled professionals and availability of funds	Hoffman (2008), Husted (2003), Nidumolu et al. (2009), Yu Lin and Hui Ho (2008)
6. Internal environmental management	IT infrastructure, ISO 14001, EMS implementation, cross functional integration of departments, environmental auditing, training, safety etc.	Zhu et al. (2008)
7. Achieve economic benefits	Substantial opportunities in reduction of construction costs through reduction in energy, water, materials and through waste management and recycling	Carter and Dresner (2001), Dhanda and Hill (2005), Fassoula (2005), Richey et al. (2005)

8. Commitment to improve environmental performance	Incorporating sustainability strategy as a part of organizational strategy	Simpson et al. (2007)
9. Improving operational efficiency of the supply chain	Improving construction productivity, reduce project time, improve quality etc.	Holt and Ghobadian (2009), Lee (2009), Lippman (2001), Paulraj (2009), Vachon (2007), Zhu et al. (2005;2008)
10. Competition	Closely monitor the GSCM practices of the competitors and imitate them if required.	Arimura et al. (2008), Chan and Makino (2007)
11. Stakeholder pressure	Stakeholder desire for environmental friendly buildings	Berns et al. (2009), Chan and Lau (2001), Lo and Leung (2000)
12. Achieve preferential treatment and government incentives	Government subsidies, award of government projects and award and recognition for GSCM practices	Hsu et al. (2008), Hosseini (2007), Mudgal et al. (2009; 2010), Srivastava (2007), Yu Lin and Hui Ho (2008)
13. Achieve first mover benefits	Improve corporate brand image of the company and hence winning construction projects.	Francesco and Fabio (2010), Wycherley (1999)
14. GSCM practices	Green design, green purchasing, green manufacturing, green transportation, recycling and reverse logistics	Srivastava (2007)

3.2 Focus group and development of Structural Self Interaction Matrix (Sij)

After identifying the 14 enablers, a 3 hour focus group session was conducted involving academics and industry practitioners from supply chain and construction industry. Attendance of the focus group session was 12, including middle to senior level managers, consultants, assistant and associate professors in the related field. The 14 enablers identified from the literature were given well in advance to the participants to familiarize with the definitions and its implication to the construction industry supply chain. In the brainstorming session, experts were asked to identify the mutual relationship among the enablers. Consensus was reached on the direction of the relation between any combination of enablers i and j. Total number of pair-wise combination addressed in the focus group session for developing Sij is (N*(N-1)/2). In the present study, number of pair-wise combination addressed is 91, since the number of enablers N=14. Direction of the relationship between the enabler i and j is denoted using four symbols V, A, X and O. The representation is as follows:

V – enabler i lead to enabler j

A - enabler j lead to enabler i

X - enabler i and j will lead to each other

O - enabler i and j are unrelated

The Sij matrix developed is given in Table 2

Table 2 Structural Self Interaction Matrix

Enablers of GSCM	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1. Government regulation and legislation	X	O	O	O	O	V	O	V	O	O	V	O	O	V
2. Compliance to client specifications		X	O	O	O	V	O	V	O	O	O	O	O	V
3. Proactive GSCM strategic planning			X	A	A	V	V	V	V	O	O	V	V	V
4. Leadership				X	A	V	V	V	V	O	O	V	V	V
5. Availability of resources					X	O	O	O	O	O	O	O	O	V
6. Internal environmental management						X	A	A	A	O	A	A	A	V
7. Achieve economic benefits							X	O	A	O	O	A	A	V
8. Commitment to improve environmental performance								X	A	A	A	O	O	V
9. Improving operational efficiency of the supply chain									X	O	O	O	O	V
10. Competition										X	V	O	O	V
11. Stakeholder pressure											X	O	O	V
12. Achieve preferential treatment and government incentives												X	V	V
13. Achieve first mover benefits													X	V
14. GSCM practices														X

3.3 Development of Reachability Matrix (Rij)

To develop the reachability matrix Rij, first Sij is altered into a binary matrix called initial reachability matrix (IRij) by substituting *V, A, X, O* by *1* or *0* using the following conditions:

If the value *(i, j)* in Sij is *V*, then *(i, j)* value in Rij becomes *1* and (*j, i)* becomes *0.*

If the value *(i, j)* in Sij is *A*, then *(i, j)* value in Rij becomes *0* and *(j, i)* becomes *1*.

If the value *(i, j)* in Sij is *X*, then *(i, j)* element in Rij becomes *1* and *(j, i)* becomes *1*.

If the value *(i, j)* in Sij is *O*, then *(i, j)* element in Rij becomes *0* and *(j, i)* becomes *0*.

The IRij matrix is given in Table 3. The final reachability matrix (FRij) is attained by applying the transitivity rule, an assumption made in ISM, which states if the enabler ‘a’ is related to ‘b’ and if ‘b’ is related to ‘c’, then ‘a’ is necessarily related to ‘c’. The FRij thus obtained is given in Table 4.

Table 3 Initial Reachability Matrix

Enablers of GSCM	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Government regulation and legislation	1	0	0	0	0	1	0	1	0	0	1	0	0	1
2. Compliance to client specifications	0	1	0	0	0	1	0	1	0	0	0	0	0	1
3. Proactive GSCM strategic planning	0	0	1	0	0	1	1	1	1	0	0	1	1	1
4. Leadership	0	0	1	1	0	1	1	1	1	0	0	1	1	1
5. Availability of resources	0	0	1	1	1	0	0	0	0	0	0	0	0	1
6. Internal environmental management	0	0	0	0	0	1	0	0	0	0	0	0	0	1
7. Achieve economic benefits	0	0	0	0	0	1	1	0	0	0	0	0	0	1
8. Commitment to improve environmental performance	0	0	0	0	0	1	0	1	0	0	0	0	0	1
9. Improving operational efficiency of the supply chain	0	0	0	0	0	1	1	1	1	0	0	0	0	1
10. Competition	0	0	0	0	0	0	0	1	0	1	1	0	0	1
11. Stakeholder pressure	0	0	0	0	0	1	0	1	0	0	1	0	0	1
12. Achieve preferential treatment and government incentives	0	0	0	0	0	1	1	0	0	0	0	1	1	1
13. Achieve first mover benefits	0	0	0	0	0	1	1	0	0	0	0	0	1	1
14. GSCM practices	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Table 4 Final Reachability Matrix

Enablers of GSCM	1	2	3	4	5	6	7	8	9	10	11	12	13	14	**Driving Power**
1. Government regulation and legislation	1	0	0	0	0	1	0	1	0	0	1	0	0	1	**5**
2. Compliance to client specifications	0	1	0	0	0	1	0	1	0	0	0	0	0	1	**4**
3. Proactive GSCM strategic planning	0	0	1	0	0	1	1	1	1	0	0	1	1	1	**8**
4. Leadership	0	0	1	1	0	1	1	1	1	0	0	1	1	1	**9**
5. Availability of resources	0	0	1	1	1	1*	0	1*	1*	0	0	1*	1*	1	**9**
6. Internal environmental management	0	0	0	0	0	1	0	0	0	0	0	0	0	1	**2**
7. Achieve economic benefits	0	0	0	0	0	1	1	0	0	0	0	0	0	1	**3**
8. Commitment to improve environmental performance	0	0	0	0	0	1	0	1	0	0	0	0	0	1	**3**

9. Improving operational efficiency of the supply chain	0	0	0	0	0	1	1	1	1	0	0	0	0	1		**5**
10. Competition	0	0	0	0	0	1*	0	1	0	1	1	0	0	1		**5**
11. Stakeholder pressure	0	0	0	0	0	1	0	1	0	0	1	0	0	1		**4**
12. Achieve preferential treatment and government incentives	0	0	0	0	0	1	1	0	0	0	0	1	1	1		**5**
13. Achieve first mover benefits	0	0	0	0	0	1	1	0	0	0	0	0	1	1		**4**
14. GSCM practices	0	0	0	0	0	0	0	0	0	0	0	0	0	1		**1**
Dependence Power	**1**	**1**	**3**	**2**	**1**	**#**	**6**	**9**	**4**	**1**	**3**	**4**	**5**	**14**		**67/67**

*The transitivity links are denoted by **

3.4 Level Partitioning of Final Reachability Matrix

This step is extracting the hierarchical order of the enablers from FRij (Warfield, 1974). First the reachability set R (Si) and antecedent set A (Si) is extracted from FRij. R (Si) consist of the enabler itself and the others enablers it may help achieve, while A (Si) consists of the enabler itself and other enablers which help in achieving it. The intersection of A (Si) and R (Si) is identified for all enablers. The enabler for which the condition R (Si) ∩ A (Si) = R (Si) is ranked 1st and placed in the top level of the ISM hierarchy and there would not be any other enabler placed above it. After identifying the top level enabler, it is removed and the iteration is continued to find the level of each enabler. In this case, the levels of all the 14 enablers are identified in 7 iterations. The 1st iteration and the final level partitioning of the enablers are given in Table 5 and Table 6 respectively.

Table 5 First iteration of enablers

Enablers of GSCM	Reachability Set R (Si)	Antecedent Set A (Si)	Intersection	Level
1. Government regulation and legislation	1, 6, 7, 8, 11,14	1	1	
2. Compliance to client specifications	2, 6, 7, 8, 14	2	2	
3. Proactive GSCM strategic planning	3, 6, 7, 8, 9, 12, 13, 14	3, 4, 5	3	
4. Leadership	3, 4, 6, 7, 8, 9, 12, 13, 14	4, 5	4	

5. Availability of resources	3, 4, 5, 6, 7, 8, 9, 12, 13, 14	5	5	
6. Internal environmental management	6, 14	1, 2, 3 ,4, 5, 6, 7, 8, 9,10, 11, 12, 13	6	
7. Achieve economic benefits	6, 7, 14	1, 2 ,3, 4, 5, 7, 8, 9, 10, 11, 12, 13	7	
8. Commitment to improve environmental performance	6, 7, 8, 14	1 ,2, 3, 4, 5, 8, 9, 10, 11	8	
9. Improving operational efficiency of the supply chain	6, 7, 8, 9, 14	3, 4 ,5 ,9	9	
10. Competition	6, 7, 8, 10, 11, 14	10	10	
11. Stakeholder pressure	6, 7, 8, 11, 14	1, 10, 11	11	
12. Achieve preferential treatment and incentives	6, 7, 12, 13, 14	3, 4, 5, 12	12	
13. Achieve first mover benefits	6, 7, 13, 14	3, 4, 5, 12, 13	13	
14. GSCM practices	**14**	**1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14**	**14**	**I**

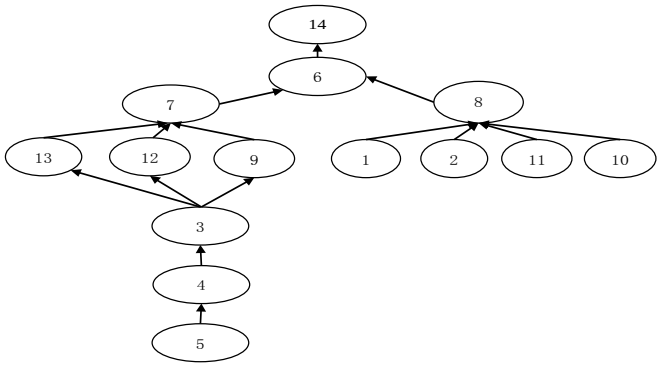
Table 6 Final level partitioning of enablers

Enablers of GSCM	Level
1. Government regulation and legislation	VII
2. Compliance to client specifications	VII
3. Proactive GSCM strategic planning	V
4. Leadership	VI
5. Availability of resources	VII
6. Internal environmental management	II
7. Achieve economic benefits	III
8. Commitment to improve environmental performance	III
9. Improving operational efficiency of the supply chain	IV
10. Competition	VII
11. Stakeholder pressure	VII
12. Achieve preferential treatment and incentives	IV
13. Achieve first mover benefits	IV
14. GSCM practices	I

3.5 Development of Diagraph

The enabler ranked 1st is placed at the top level and succeeding ranks are positioned below it, till the lowest level is placed in the diagraph. Then the direct relationship between enablers i and j is shown by an arrow directing from i to j. Indirect transitivity links are neglected and the final digraph is obtained and is given in figure 1.

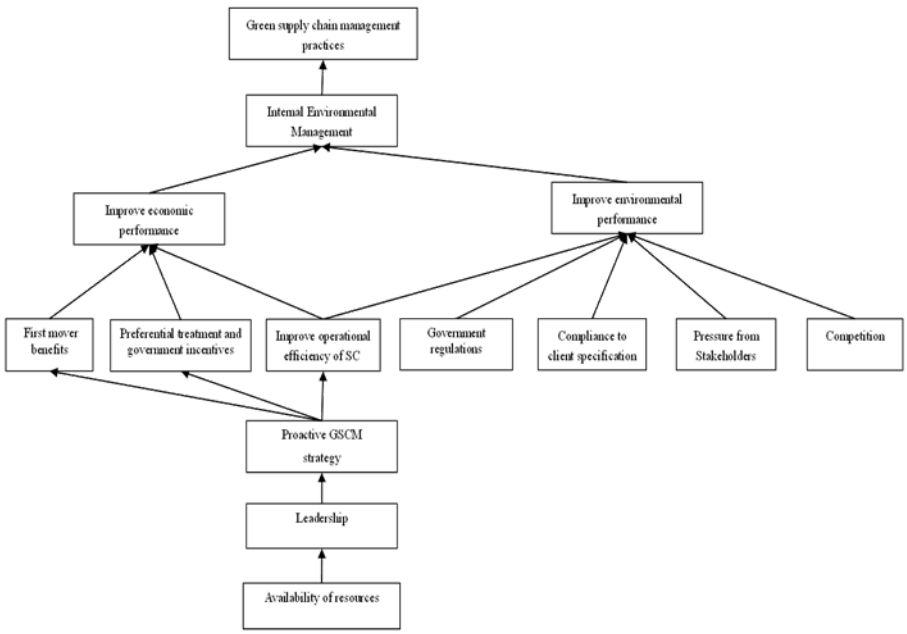
Figure 1 Diagraph of enablers



3.6 Development of ISM model from the Diagraph

The digraph in figure 1 is transformed to ISM model by replacing enabler nodes with statements. The ISM model is checked for conceptual inconsistency and necessary modifications are made if necessary to obtain the final ISM model presented in figure 2.

Figure 2 Final ISM model of enablers



4 Dependence and Diving Power Analysis (DDPA)

The DDPA is imperative in providing managerial implication about the enablers. The objective of the DDPA is to analyze the driving and dependence power of enablers.

The driving power of an enabler is the total number of enablers (including itself) it may help achieve, whereas dependence power of the enabler is the total number of enablers (including itself) which may help achieve it. Driving power is obtained by tallying the number of ones in the columns of the final reachability matrix (FRij), while dependence power is obtained by tallying the number of ones in the rows of FRij. Table 4 provides the DDPA of all the 14 enablers. Based on the driving and dependence power, the enablers of GSCM are classified into four categories as follows:

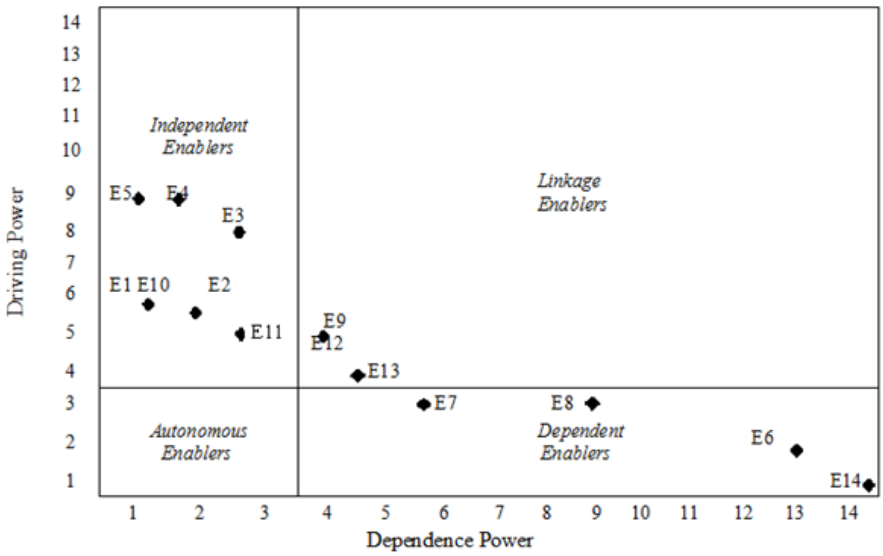
- Autonomous enablers: They have weak driving and dependence power. They stay disconnected from other enablers.
- Dependent enablers: They have weak driving power and high dependence power.
- Linkage enablers: They have relatively strong driving power and strong dependence power. The behaviors of the linkage enablers are dynamic as any action on them will have an effect on others and vice versa.
- Independent enablers: They have strong driving power and weak dependence power.

The results are then plotted graphically on a two dimensional graph with dependence power on the X axis and driving power on the Y axis. The graph is divided into four visual quadrants. Quadrant I represents autonomous enablers, Quadrant II represents dependent enablers, Quadrant III represents linkage enablers and Quadrant IV represents independent enablers.

4.1 Classification of GSCM enablers into quadrants

The classification of 14 enablers into four quadrants is given in Figure 3. There is no autonomous enabler in our study that falls in the first quadrant of the graph. The absence of any autonomous barrier indicates that all the enablers considered in the study have significance in the model. There are four dependent enablers that fall in the second quadrant, namely commitment to improve environmental performance, achieve economic benefits, internal environmental management and GSCM practices. These enablers are dependent on the other enablers in the system and appear at the top of the ISM hierarchy. Third quadrant consists of two linkage enablers. First mover benefits and improving operational efficiency of the supply chain fall in this category. They will appear in the middle of the ISM hierarchy. The independent enablers government regulation and legislation, compliance to client specifications, proactive GSCM strategic planning, leadership, and availability of resources, competition and stakeholder pressure falls in the fourth quadrant of the graph. They are also called key enablers because of its importance and form the base of the ISM model. Priority should be given to these enablers, since it possess high capability to influence others.

Figure 3 Classification of enablers by quadrants



5 Discussion and conclusion

In this paper, ISM methodology is applied to understand the nature of the enablers of GSCM in the UAE construction sector. The hierarchical model developed will assist policy makers to better understand the nature of the enablers and their mutual influence and hence prioritize actions to improve GSCM in the UAE. In the study several managerial implications can be drawn about the nature of the enablers of GSCM in the UAE. The final ISM model indicates two distinct path ways in the hierarchical model. From the diagraph (Fig. 1) the path 5-4-3-(9, 12, 13)-7-6-14 shows a proactive organizational strategy while path (1, 2, 11, 10)-8-6-14 shows a more reactive organizational strategy.

5.1 Proactive Vs. Reactive Strategy

In a proactive organizational strategy, availability of resources is the key driver of GSCM practices in the UAE. This includes both financial and human resources. So organizations having skilled professional and financial back up are more likely to implement GSCM. These organizations will act proactively, with leadership having the confidence to adopt GSCM. So proactive firms try to achieve first mover benefits, preferential treatment and government incentives and also try to improve the operational efficiency of the supply chain. Hence these companies have long term vision to improve their economic and environmental performance. They will incorporate necessary internal environmental management changes to implement GSCM practices. On the other hand in a reactive organizational strategy, government rules and regulations, compliance to client specifications, stakeholder pressure and competition will force organizations to improve their environmental performance. So firms have no option but to comply with the external forces. From a government perspective for implementing sustainable development, a balance should be kept to promote proactive GSCM practices and at the

same time tighten the rules and regulations to ensure organizations consider GSCM in their organizational strategy. However a research gap exists to understand the actual benefits of a proactive strategy as opposed to a reactive strategy or vice versa.

5.2 Limitations of the study

The ISM approach has its fair share of limitations. In ISM, inherent subjectivity in the selection of the panel, the subjective judgment of the group in deciding the direction of the relationship between the enablers can be biased or may not reflect the real world scenario. Further ISM considers the mere relationship among the enablers and doesn't provide the strength of association of the enablers. In the current paper only 14 enablers were identified from the literature. There can be more enablers influencing the GSCM practices in the UAE, and the process of identifying the enablers should not be limited to the literature.

5.3 Future extensions of the study

In the future study, the model can be further developed by incorporating higher number of enablers of GSCM. This can be achieved through focus groups and interviews with wider audience. The subjective nature of the judgment panel can be minimized by applying fuzzy set theory; an integrated fuzzy ISM approach will significantly improve the model. In addition the ISM model can be tested and validated using structural equation model (SEM) which can provide more reliable quantitative measure of the strength of association of the enablers. Case studies can be conducted in the future for select organizations to test the practical application of ISM. Further the model can be extended to other countries in the GCC having similar characteristics as UAE in terms of per capita emissions, GDP, human development index etc. In the way forward ISM methodology has significant piratical implications as a decision support tool in the future were sustainable development and carbon reduction is no longer an option but a must for all countries

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